Dr. JOHN HOPKINSON, F.R.S.

THE

ELECTRICAL REVIEW.

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Index Supplement to the Electrical Review,
July 1st, 1898.

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THE ENGINEERS' STRIKE.

CURIOUSLY enough the *Engineer* of last week propounded the idea that the strike was past help or advice, and the daily press of even date contained a notification from Cantuar and Ebor, which are understood to stand for the Archbishops of Canterbury and York, commending the whole business to prayer. It is recorded among the profane that when two men were cast away in an open boat and felt themselves to be very much *in extremis*, they deemed it necessary to pray. They were unequal to this, so a hymn was suggested. This also proved to be outside the sphere of their practical politics, and, as a last resource, in order that something religious should be done, they had a collection, that perennial joy to the churchgoer which possibly so well answers the oft-repeated cry, "Why do not the poor go to church?" Our good archbishops have seen probably that it is to long-continued collections that the strike owes its continuance, and so they have turned to prayer. Well, this is better than the ill-informed interference of the Bishop of Hereford. On the bishop's interference we cannot do better than quote the *Engineer* as follows:—"If, for example, the bishop could be led to understand the position in which he would be if his coachman refused to permit his lordship to use his carriage as he pleased, limited the hours during which it was to be out of the coach-house, refused to permit anyone else to drive it but himself, settled the rate at which it was to be driven, and the number of individuals it was to carry, and lastly, if dismissed for incompetence, or refusal to obey orders, took all the rest of the bishop's household with him, and then prevented him getting others in their places, we fancy the bishop would regard the position of the employers in the present struggle with a little more favour."

We hope someone has sent this copy of the *Engineer* to the good bishop, because it puts the whole case in a nutshell. The carriage is a machine in which a rich bishop is carried from place to place, where a poor clerk would have to walk. It is a luxury under the full control of the bishop. A machine tool is a machine costing, as a rule, more than a carriage. It is not a luxury, but is used as a means of obtaining bread and clothing for an employer and his family, and that of the man who is paid to work the machine. Yet this necessity—for a machine tool is a necessity—is to be provided by the employer, housed by him, and he is not to have a word to say as to how it shall be worked, but is to pay a fixed sum to have a man attend to it, and receive himself no return. It is as though the bishop were compelled by his household servants to keep a carriage, but only allowed to use it himself when no one else wanted it.

If the bishop did not approve he could, of course, cease, as the law now stands, to use it, he could cut off his carriage and the annoyance at once. He could walk, and no one would be the worse, except the coachman; indeed, the bishop would probably benefit by the exercise. But England would not suffer by the suppression of 50 bishops' luxuries.

England does suffer if a single machine tool is stopped or hindered, and the very men suffer the most who are doing the evil deed. Last week we proposed a new form of trades union which we hoped might at least provide food for thoughts that would lead to something being done. Further thought on the subject has not moved us from our feeling that the scheme, we ventured to propound, has in it the elements of success. We know the difficulties in the way. Men have been too prone to throw aside the decision of arbitration when it suited them to do so. The employers repudiate outside interference, for they have already had so much of it with such ruinous results, that they are strong in their refusal to budge an inch. We do not wish to appear unduly unfavourable to the men, but we are, and have been, convinced that their executive are elected or appointed in a wrong manner. We think that if our suggestion of a permanent joint committee could be brought about, the men's representatives should be drawn from the various districts in the country according to number of members in the different districts. No man should serve longer than, say, three years, and every year one-third would retire and go back to the bench. The pay of a member should be little more than his wages. Votes should accrue to the men for purposes of election in the ratio of their years of membership. This would steady the ship greatly.

As the war is now going on again in full blast, we would appeal to the men, especially to the older and steadier among them, to carefully consider their present status, and the true facts of the present dispute. We would ask them, Does it appeal to your common sense that machinery should be run slowly to reduce its output? Does this cause commend itself to you as a means for you to earn higher wages? Does it not occur to you that the mechanics of America, whose skill as a mass is not greater than that of the labourers who work machines in English shops, are earning bigger wages very largely because American shop management is conducted upon the lines you are fighting against? Can you not see that your persistence in your present course can have only one of two endings? Either you must be hopelessly beaten, or trade will go to foreign countries, and very few of you will get back again to work. Can you not already see that you are fighting against sense and reason, as did the mistaken Luddites and machine wreckers generally? We tell you plainly you cannot win this battle, into which we know from conversation with many of you, you have been driven by a fatuous and wicked policy. For six months you have been fighting, and for what end? If you are wise, you will reconsider your position and place trades unionism on a sound basis. You will put a stop to the use of benefit funds for fighting purposes. You will have a secretary whom you can dismiss at a day's notice if he misbehaves himself, or mistakes himself for the Almighty.

Above all, beware of talkers. When a man like John Burns goes on a platform and says he will have the strike all over in a fortnight, as he did say half a year ago, you believe him; you always do believe these stump orators; they turn a working man inside out, because working men, as a rule, are not prone to making speeches, and are apt to take the ability to talk as evidence of wisdom. Are not the sufferings of the past half year a severe enough lesson for believing Mr. Burns, that you must still go on believing men who are leading you deeper and deeper into the depths of misery and poverty? Do you not know that every week sees the workshops getting into fuller work *without your aid*, and that unskilled labourers and apprentices are proving the possibility of easily doing more and better work than your executive has been allowing you to do, on the pretence that, to obtain a full day's pay for half a day's work, is to your benefit? Can it be possible that you believe these absurdities? Are you willing to allow Mr. Barnes to continue to trade on your simple trust? There are about half a million men in the engineering trade, and only about 80,000 of them are members of the A.S.E.; of these 80,000 there are 55,000 at work under the very conditions which you are striving against, and they do not complain, but are earning good wages, working overtime, and paying levies to keep you idlers half fed. There are 25,000 of you, or, perhaps, now nearly 30,000, undergoing semi-starvation for a false idea. One man of you is out of work for every 19 men, unionist and non-unionist at work. Are you willing to go on with a hopeless fight while the other 19 are in full swing? Go back to work. See to it that English workshops turn out as much per man as the workshops of America, by putting a stop to this folly of restriction. Let the employers have a free hand to manage their business and a heart to seek orders and take contracts with no misgiving, and then ask them to raise your pay.

If you act as above, the profits of the employers will be so ample that not one of them will care to risk their stoppage by refusing your proper demand. In the present dispute you have made an unreasonable demand upon your employers, and you have been in the position of a footpad, who, in asking a man for his purse, has given him the alternative of death by shooting if he acceded or by drowning if he refused. Even a coward will fight if he must otherwise die. You have compelled your employers to fight for their lives, and you have been beaten; and if you had won, there are two men behind the hedge would take the spoil, and leave you as dead as your employer. These two men behind the hedge are encouraging you, and helping you to fight your employer until you are both exhausted. Their contributions will cease as soon as they see both you and your employer have bled each other to death.

Men of the Amalgamated Society of Engineers! have you positively ascertained that among the agitators who are goading you on to your doom there is not one who is in the pay of Germany or America?

Note on Helium and Argon.—An attempt has been made to cause helium or argon to pass through red-hot metals, such as iron, palladium, and platinum, and the results form the subject of a paper by Prof. William Ramsay and Morris W. Travers, which was communicated to the Royal Society on May 14th. To chronicle experiments which produce no result is a necessity, though not entirely an agreeable one. Whatever the reason of the passage of hydrogen through red-hot iron, and through moderately heated palladium and platinum—whether it be due to the solubility of the gas in the metal, or to the formation of an easily decomposable compound—neither argon or helium is able to pass through any one of these metals, even at a fairly high temperature. This would imply their inability to form any compound, however unstable, with these metals, or to dissolve in them at a red heat. Such inactivity is in accordance with their general behaviour, and is still another proof of their inertness.

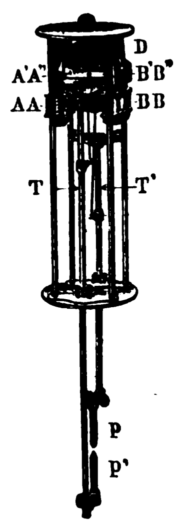
HENRION'S ALTERNATING ARC LAMP.*

By M. ALIAMET.

ALTERNATING current arc lamps are beginning to be somewhat extensively used, and, with the exception of a few rare types, their regulating mechanism does not act very satisfactorily with the alternating current, at any rate with frequencies included between 39 and 45, these being the prevailing limits in France at least.

The firm of Fabius Henrion, which at one time brought about a revolution in the market of continuous current arc lamps by bringing out the Pilsen lamp, has just produced a regulator for alternating current lamps, with an asynchronous reversible motor to effect the regulation.

Principle.—The two carbon-holders, *p p'* (see figure), are balanced and kept in position by a band to which they are



suspended. This band passes into the groove of a pulley, P, on the axle of which is mounted a disc, D, of red copper.

It is this disc that, by turning in one direction or the other, separates the carbons or brings them together. The rotary movement is obtained by the following arrangement:

An electro-magnet, A A, with a core of insulated sheet-iron, has its pole-pieces shaped in the form of jaws, A' A", between which comes the edge of the disc, D. The bobbins of this electro are connected in series with the arc, and the play between the disc, D, and the pole-pieces, A' A", is reduced to a minimum.

When the current passes through the bobbins it generates an alternating flow in the electro-magnet; this flow is closed in the air on passing through the disc, D. The flow produced by the bobbins agrees within very little, with the difference of potential at the terminals of the lamp, whereas the magnetic field developed by the currents induced in the disc, D, lags by about a quarter of a period behind this difference of potential.

Repulsion is then produced between the periphery of the disc and the pole-pieces, the effect being of the kind of the electro-dynamic repulsions discovered by Elihu Thomson in 1884. Every point of the disc tends to be repelled in an upward direction, away from the field of the electro-magnet A A' A". The disc then turns in the direction of the hands of a watch; moreover, the couple is greater in proportion as the intensity of current is stronger. At B B, B' B" is another electro-magnet, the bobbins of which are connected in derivation on the terminals of the lamp. This magnet tends to make the disc revolve in the opposite direction to the hands of a watch by the very fact of its symmetrical position with regard to the magnet A A' A". The couple produced in this last case is in proportion to the ampere-turns acting on the magnet B B' B", *i.e.*, to the difference of potential at the terminals or to the length of the arc.

Lastly, the disc, D, acts as the armature of an asynchronous motor with two independent inductive fields acting in opposite directions on this common armature. The rest of the construction of this lamp reminds us very much of the Pilsen model. There is the same case, the same guiding apparatus for the carbon-holders, T T', which pass through the lower base of the case, being guided by three rollers placed in three planes 120° apart. This arrangement ensures the perfect centreing of the carbons.

Working.—When the current is sent through, the carbons being separated, for instance, the magnet, B B' B", acts alone, and makes the disc, D, revolve so as to bring the carbons together. When they are in contact, the current passes into the electro-magnet, A A' A", and makes the disc revolve, thus separating the carbons, for, at the moment of contact, the electro-magnet, B B' B", ceases to act. The arc being thus lighted, regulates itself according to the predominance of effect of the A A' A" or B B' B".

The lamp is therefore differential, and a recoil can always be produced and the arc relighted when, through any cause, the carbons come in contact. The production of this recoil is a necessary consequence of the independence of action of the magnets in series and in derivation.

The lamp is regulated to work at 33 volts, so that three can be connected in series at 110 volts.

Two types are in course of construction which only differ in the length of the working range of the carbon-holders. The smaller model enables 400 mm. of carbons to be used, and allows of from 6 to 10 hours of lighting.

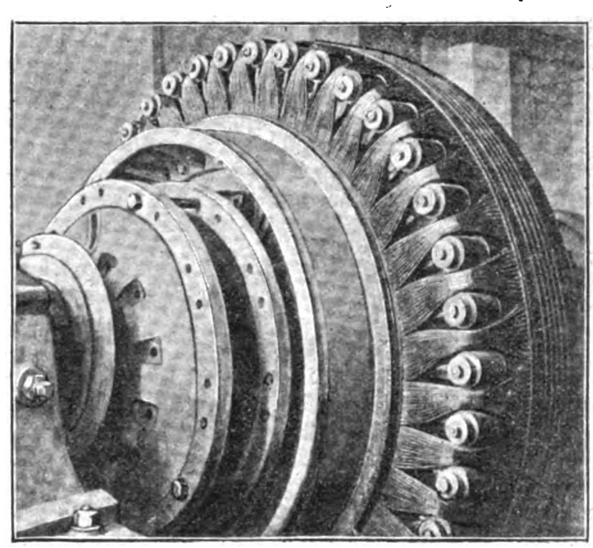
The larger model has a length of 560 mm., and, according to the diameter of the carbons, has a duration of 8 to 16 hours.

The steadiness of the light is guaranteed, and also the fact that the lamp requires no attention or cleaning. It seems that the motor answers to a variation in E.M.F. of ·1 of a volt, which seems somewhat exaggerated. What surprises us somewhat in this lamp is the absence of any slackening apparatus for the purpose of avoiding pumping.

* *L'Electricien.*

GENERATORS IN THE UNION LOOP STATION.*

THE illustration represents the armature and commutator of one of the Siemens & Halske 1,500-kw. generators now being installed in the Union Loop power house in Chicago. The arrangement of the armature winding and the connections to the commutator are clearly shown. This construction has all the advantages of internal fields; great radiating



surface and maximum magnetic effect are to be found. The commutator is on the armature spider, and its construction and insulation are for large current capacity and long life. The armature winding is such as to give good ventilation. The poles will be 16 in number.

The armature was entirely assembled at the company's works and had to be transported on a special car, on account of its great size and weight. For such service the company has designed and built two or three flat cars, with two out-

* *Street Railway Review.*

board bearings, on either side of the car near the middle. The armature shaft rests on these bearings and part of the armature projects beneath the car floor, but far enough above the roadbed to prevent any damage from obstructions there. By this means armatures of very large diameter can be transported and come beneath the limit of height prescribed by the railroad companies. This armature had to be moved for some distance through the streets, from the tracks of the Chicago & Northern Pacific to the station. The trucks were removed from under the car body and it was let down on skids and pulled along on rollers by means of a capstan. The rest of the machine is so divided as to be easily handled.

This is the first of three machines to be installed in a short time, and the work on the station is being pushed as rapidly as possible.

CANDLE-POWER OF ARC LAMPS.

We (*Canadian Electrical News*) have already had occasion to refer to the candle-power of arc lamps, and the very indefinite way of specifying it. It seems to have become fixed in the minds of a large number of persons that a 9·6 ampere arc lamp will give 2,000 candle-power, and that a 6·8 ampere will give 1,200 C.P. When, therefore, such lamps are put into circuit, and seem to give a light deemed not up to their standards, disappointment and dissatisfaction result. The manufacturing companies are blamed for trying to sell under worthless guarantees, and the customer considers himself badly treated. Now, it is not the business of this journal to take the part of manufacturers against the public, but we deem it in the true interests of the electrical industry to point out to our operating readers that the above dissatisfaction is most emphatically largely their own fault. A man who does not take the trouble to study the details of a business out of which he makes his living almost deserves to be deceived, more especially when the whole literature of the subject is at his disposal, is extremely interesting, and written in a state to suit not only the technical, but also the popular reader. When purchasing an arc dynamo the purchaser usually asks for a 2,000 or a 1,200 C.P. outfit, and without giving the matter a moment's thought, concludes that a "nominal" 2,000 C.P. lamp will give actually 2,000 C.P. If he were to devote to the subject as much thought as he gives to the purchase of a hand lamp for his kitchen—to use oil—it would probably occur to him that just as the amount of light given to his coal oil lamp depends on the quality of the oil, the size of the wick, and whether the wick is turned up or down, so the light given by an arc lamp depends not merely on the current, but also on the quality of carbons, their size, and the distance between their points. As a matter of fact, anyone can prove for himself that one can get more light from a 5-ampere lamp than from a 10-ampere one, by simply varying the size, quality and distance of the carbons. An arc lamp is nothing more or less than a mechanism for keeping two carbon rods always a little distance apart, and the lamp itself has no more to do with the light than has the bulb of the hand lamp that holds the oil, or the screw that raises the wick. So that if a purchaser desires to buy arc lamps properly, he should not ask for one of a particular candle-power, but for one adapted for the use of a certain current to maintain the carbon rods a certain distance apart, and with a certain drop of potential across its terminals. The candle-power is then entirely his own affair, and if he wishes to be very severe in his requirements he will then need to specify that with such a lamp as above, and using carbons of such and such a particular make, the candle-power observed at such and such a distance from the crater, and at a specified angle from the horizontal plane passing through the crater, must be what he considers he wants. With a specification such as this he is equipped and is in a position to talk to manufacturers, but to consider himself badly treated and deceived because a lamp bought as a supposed 2,000-C.P. does not give it with any kind and size of carbon, and at any distance from the ground, is just about as business-like as to buy a heating stove without saying whether it is to burn wood or coal. As a matter of fact it has been over and over again again proved that a nominal 2,000 candle-power lamp does not give more than 800 C.P. in the most intense direction with ordinary carbons, &c. If the electrical operating industry would take a hold of its interests a little better and would dictate its requirements it would be better for both operators and manufacturers.

ONE OF THE USEFUL APPLICATIONS OF THE STORAGE BATTERY.*

By WILLIAM BAXTER, Jun.

When the storage battery first came prominently before the world, it was thought that its great field of usefulness would be that of the transportation of energy from coal fields and large water power sites to centres of industry. It was also believed that it would enable the electric motor to become a formidable rival of the steam locomotive, not only because it would reduce the cost of hauling a train, but because, in addition, it would remove many of the objectionable features of steam transit, such as smoke, cinders, &c. When put to the test it was found that the batteries, at least as then constructed, could not withstand the hard usage to which they were subjected in railway work; and as to their value as transferrers of energy from the source of supply to the points of demand, it was found upon investigation that they could not compete with existing methods, even if made sufficiently substantial to endure constant usage with slight deterioration, and so perfect electrically as to have the greatest storage capacity, per unit of weight, consistent with theoretical possibilities. In this latter field they would necessarily fail, because, if made as light as possible, they would weigh at least 12 lbs. for each horse-power hour capacity, and as good steam engines can develop the same amount of energy from 3 or 4 lbs. of coal, the weight of batteries to be transported back and forth would be three to four times that of the coal necessary to do the same work. The batteries then made weighed from 150 to 200 lbs. per horse-power hour capacity, instead of 12; hence, the difference in weight to be transported under the actual conditions was so great as to render it impossible to accomplish anything practical in that field, even if the energy could be obtained free of cost.

When it was seen that the storage battery could not accomplish anything of a revolutionary character, those interested in its development began to study its adaptability to less pretentious work, and soon realised that it would be decidedly valuable as an adjunct to electric lighting stations, as it would be to these what the gasometer is to a gas distributing system—a reservoir from which the demand of customers could be supplied, should it become necessary at any time to stop the machinery for a few hours. Without the aid of storage batteries, if from any cause the operation of the generators is suspended, the lights will instantly go out and remain out until the generators are set in motion again. After years of persistent and very commendable experimental work, the inventors of storage batteries succeeded in making these devices sufficiently durable to withstand the wear and tear they are subjected to in station work, without unreasonable deterioration. Since that time they have been used to a considerable extent in that field, and within the last two years their use has been increasing at a very rapid rate; in fact, a first-class station of to-day would not be considered complete without a storage battery plant.

The first battery plants installed in lighting stations were intended simply as a safeguard, to render it possible to keep up a supply of current in case of accident to the machinery; but it was not long before it was realised that by enlarging the capacity of the batteries, the output of the station could be greatly increased without materially increasing the expense of operation. How this result can be accomplished will be readily understood when it is considered that the demand for light is not uniform throughout the whole 24 hours, but varies from little or nothing, during the day and the early hours after midnight, up to to the maximum

* *Scientific American.*

amount between 9 and 10 in the evening. The station capacity, however, must be sufficient to meet the greatest demand; therefore, during the greater part of the time the machinery is only worked to a fraction of its full capacity. By using storage batteries, the generators can be worked to their full capacity all the time, and when the demand of consumers is small the surplus energy is stored, to be given out when the demand is in excess of the amount developed by the machinery.

From the very fact that the demand for current is variable, it becomes possible for batteries to be used not only to reduce the cost of production and increase the capacity of the station, but also to reduce the cost of line wires. This last result can be accomplished in any case where the station is located at some distance from the district in which the current is distributed. To illustrate this point, suppose the station is located, say, one mile from the centre of the city or town in which the lights are used. If the current runs direct from the generators to the customers' lamps, the line wires must be of sufficient size to carry the maximum supply with a loss of pressure low enough to not interfere with the brilliancy of the light. If the maximum demand lasted for a considerable portion of the day, the full capacity of the line wire would be used to a reasonable extent, but the duration of this maximum demand is seldom over one-half, or, at the most, one hour; therefore, during the rest of the time a large portion of the line capacity may be regarded as wasted. The difference between the average and the greatest demand varies within wide limits, in different stations, but in the majority the ratio is not much below one to two. Whatever it may be, however, if the current could be supplied at the average rate, and the excess over the demand when the consumption is small were stored, the amount so stored could be used to supply the deficiency when the demand is large. This is accomplished in many cases at the present time by placing a storage battery plant at the centre of the district in which the customers are located. The wires coming from the generating station are so connected with the battery and the distributing mains that, whenever the drain is less than the current coming from the station, the batteries are charged, and when the demand is in excess of the current from the station, the battery feeds into the distributing mains. The current passing from the generating station to the battery station is about 10 per cent. more than the average demand, so as to cover the loss in the charging and discharging of the batteries.

The saving in wire by this arrangement will run from about 25 to 75 per cent., depending upon the relation between the average and the maximum current, and also upon the amount of energy that is lost in transmitting the current from the generators to the battery. When the generating station feeds directly into the distributing mains, the loss of energy in transmission is governed by the condition that the pressure of the current must not drop so much as to interfere with the brilliancy of the lights, and therefore, the line loss is generally low; but when batteries are used, located at the centre of distribution, they regulate the pressure of the current supplied to the lamps; and, therefore, the loss between generator and battery may be made anything desired, without affecting the brilliancy of the lights. If the power is obtained from a waterfall or from coal near a railroad, when it can be obtained at a very low price, it may be more economical to increase the loss of energy between generator and battery, and thus reduce the cost of line wire, but such conditions cannot be taken advantage of if the battery is not used.

ELECTRICAL BOOKS—PRACTICAL AND ELEMENTARY.

"Oh, that mine enemy would write a book!" is a wish that might not inaptly proceed from the thoughts of many a practical electrical engineer to-day, for undoubtedly were the said enemy to do so, it may be taken for granted that the work would be constructed upon the same lines that have now apparently become stereotyped, and thus would arise the opportunity for attack. Perchance from out of the resulting conflict might arise some truths that would impress themselves upon those who seek to impart their knowledge of electrical engineering to their less learned brethren. That the writers responsible for many existing treatises have not been assailed more often is possibly due to the imposing effect of the professional character and reputation that surround them, or it may be that they are fortunate enough to exist without enemies.

Nevertheless, it is a fact that a current of opinion is commencing to flow, which will, sooner or later—and the sooner the better—sweep away not a few prevailing opinions as to the proper manner of compiling the works required by the electrical engineer for the furtherance of his knowledge.

Almost the first impression that one receives after studying a few of these books, both those recognised as standards, and others of less note, is that each individual author seems to arrogate to himself the honour of being the reader's sole teacher of all the elementary facts regarding electricity. In the case of a work that is not only professedly but *actually* introductory to the study of a subject, no objection of this nature can reasonably be made. The majority, however, while claiming on their title pages, or in the prefaces, to be elementary, have, as a matter of fact, ceased to be so, long before the concluding chapter is reached. In a very limited sense they may indeed be termed "elementary," but for all practical purposes this description is misleading, and affords no complete and real intimation of the nature of the contents. A work that, for instance, discusses, amongst other things, the design of 500 kw. dynamos, the effects of self-induction in alternators or combinations of resistance, self-induction and capacity of transformer circuits, cannot fairly be regarded as elementary, even though it also deals in its early part with the units of measurement or the method of calculating horse-power. While it is true that instruction in first principles is necessary in order that a grasp of any branch of electrical science may be obtained, it does not follow that the beginner should be dragged through the whole range of electrical engineering in one volume; and, conversely, the man who has passed the initial stages should not be expected to go over again and again work with which he already is conversant. Some day it will dawn upon a writer that the average engineer who seeks to enlarge his knowledge has gone through the electrical alphabet, and no more requires to repeat his letters than he does to learn his own name. Then all those points of information which at present seem to be included in the majority of works—the statements regarding the supposed natures of electricity, the description of simple experiments from the rubbing of amber or sealing wax, to that hoary-headed and inevitable old friend, the demonstration of the lines of magnetic force by means of iron filings on a card,—these and the multitude of others will become incorporated into true elementary works alone. Everything has its place, and there is just cause for complaint at the inclusion of these facts in works that subsequently attain to heights quite above the reach, for some time to come, of the learner who is a learner from the beginning.

The practice is to be regretted for more reasons than one. Even in the case of those who have justly earned the right to be regarded as the authors of standard works, it would undeniably be of benefit to their writings if a division into different volumes of elementary, middle, and advanced stages were made. Thus each course would receive more ample and explicit treatment than is now practicable, owing to the necessity of paying due regard to considerations of space.

To the electrical engineer a technical library of his own is an absolute necessity; more often than not it is formed slowly, for generally the princely remunerations that are the rule in this, the richest country in the world, become in most cases attenuated almost to the vanishing point when the ordinary cost of living has been met, and consequently books can only be indulged in at infrequent intervals. When the majority of works that in their main part are really helpful to the practical man, each contain from one to five, or more, chapters devoted to the simple elementary principles of electricity before proceeding to instruct in modern methods and applications (the matter that sells the book), an injustice is done to the purchaser, who has to take what he does not want, in order to obtain that which he does. It may perhaps be contended that one or two standard works on any theme contain practically all that the average man requires to know, therefore no real ground for objection to the inclusion of the introductory course exists, seeing that these are sufficient in themselves for instruction in the subject they deal with.

Admitting, for the sake of argument, that it is not necessary to possess more than this number, there still remains the fact that knowledge should be imparted in accordance with the needs of the learner. To assume a man's complete ignorance of everything connected with electricity because he asks for information on dynamo design or polyphase power transmission practice is nothing less than to offer him an insult. A writer on the derivation of language does not commence a treatise by instructing his readers how to spell, neither does the political economist consider it necessary to first explain to his disciples the meaning of such words as "land," "king," or "people." And yet this is precisely the kind of error that so many writers of electrical books commit to-day! With the class of works compiled expressly for the use of the students of A Technical College, or B Engineering Institution these remarks are not now dealing. Such form a class to themselves, and exist for a specified purpose that is distinct from the one under discussion. But in the case of those put forward for the use of the practical electrical engineer—the man who is engaged in handling, operating, or manufacturing apparatus and plant—it is time that attention should be paid to actual requirements.

The present mode of treatment would appear to be a survival of that past day when the various branches of electrical science were more or less in an embryo state—when, in fact, electricity was "in its infancy"—and could be adequately dealt with between the covers of one volume. The advance of knowledge has already brought us specialised works; it yet remains to separate in these the elementary portions from the more advanced. With the accomplishment of this "consummation devoutly to be wished" will come a satisfaction to the young beginner, to the practical man, and last, but not least, to the author.

SOME PRACTICAL POINTS ON THE DESIGN OF A SHUNT DYNAMO.

By V. ZINGLER, A.I.E.E.

So much has been written, and is still being written, on the design of dynamos as they now are, that it is, perhaps, difficult to attack the subject from any point of view without having been anticipated, or in default of this, without being expected to say something quite new or to announce some startling discovery. It has, however, occurred to the writer that very little is found either in text-books or in papers, other than the theoretical discussion of the question, and if examples of building up and winding are given, they are usually obtained by working backwards from a dynamo which the author has before him, or of which he has all the finished data; or else the usual well-known formulæ are given and the winding is then laid on—piled on—as it were, without any reference to small details of insulation, &c., which are so absolutely necessary in making out specifications for the shops—quite apart from considerations of a physical kind.

The object of these notes is, therefore, not to discuss formulæ or the methods by which they are arrived at (it will be assumed that the reader is acquainted with the dynamo design as set forth in text-books, and the elementary theory of magnetism), but an attempt will be made to show how a dynamo may be calculated from first principles so that it may be put into the shops, and so that the winding as specified by the calculations will actually go on. In order to simplify matters we will take an ordinary two-pole inverted shunt dynamo with drum armature, a type such as is perhaps more frequently employed than any other. The methods we employ for winding this machine will of course hold good—as far as mechanical considerations go—for any other type of machine; the electrical considerations will, of course, vary according to the type of machine, but with these it is not proposed to deal, except so far as they concern the particular machine under discussion; the designer will use the same methods for winding different types of machines, and in accordance with his particular shop practice, although many other *forms* of winding have to be employed to give the various electrical duties required from more complex types of machines. The words "shop practice" are perhaps the only ones which raise any difficulty in the subject before us and which obliges us to assume something; for every shop has its own particular data as to insulation of the various parts of the machines, thickness of insulation for different voltages, method of forming armature bars, of winding same on the core and so on—which ultimately determine the whole method of building up the machine, although its efficiency and weight for output may be the same in any number of shops. The designer has therefore to fix on certain insulating materials, to gauge them accurately and to always keep these figures before him as constants. He has also to decide on a definite way of building his machine and then to use these constants in his calculations for winding.

We will, therefore, decide on building our machine in a definite way, and perhaps the simplest case is to assume that the armature should be built up of round core discs and the bars or wires laid on the periphery and keyed by wooden pegs, thus forming part of the air-gap. We will also assume that the bars are built up of copper strips of a minimum gauge of ·036 inch, placed edgeways on the core; the component strips of one bar being separated by thin paper to stop eddy currents. The bars will be wound round with shellaced cotton or other tape to a thickness of ·02 inch; the armature core will be insulated from the bars by means of presspahn or other insulating material to the thickness of ·05 inch; and the finished armature will be bound with piano wire over mica insertion to thickness of, say, ·065 inch. These figures are such as are used in actual practice, and may, for convenience of reference, be tabulated thus:—

Insulation on bars	·02 inch.
" " wire (d.c.c.)	·008 "
" " core	·05 "
Wire bands and mica	·065 "
Paper	·003 "
Minimum copper strip	·036 "

In any case, the designer will gauge the particular materials he proposes to use and endeavour to see that these do not vary in thickness.

In order to more easily demonstrate the process of winding, we may assume that a machine of a certain output is required, and that there are no other data to hand by which this machine can be approximated from others. For when a dynamo has once been built and another is required which varies only slightly in amperes, speed, or volts, or any combination of these, it is seldom necessary to do more than to alter either the winding of the armature, the section of the iron, or the winding of the fields. Dynamos of any one type are rated by the number of watts per revolution, and it is found in practice that, after taking a certain diameter of armature, a machine can be built round this up to a limited number of watts per revolution only—that is, after the armature has become twice the length of its diameter, in order to allow for an increased section of iron; or after the current has become so big that the size of bars required to carry it have reduced the number of bars to less than 40; or if the field winding takes up so much room that it cannot be put on the magnets without causing serious overheating due to want of radiating space; these, and several other factors, determine a figure for the watts per revolution (= w.p.r.), after which it becomes necessary to take a larger diameter for the armature.

Having then established a certain number of sizes of machines as fixed by their armature diameters or w.p.r., we can, within limits, tell at a glance on seeing the output required for a dynamo, what size of machine to take. This, of course, would not apply to plating dynamos or high voltage machines.

We will now take a machine with the following output:—400 amperes, 80 volts, 320 revolutions per minute (an Admiralty size). This gives 100 w.p.r.

We have now to decide on the size of armature, and it may be convenient to standardise our armatures by the diameter of the bore of the magnets—that is, the diameter of the armature if the air-gap were infinitely small. This allows us to vary the depth of winding or the diameter of the core plates without reference to the diameter of the armature. The question therefore arises: given our output, what sized armature shall be taken. This we can arrive at approximately in the following manner. Our fundamental equation is:—

$$N = \frac{E \times 60 \times 10^8}{n \times c}$$

where N = total number of magnetic lines.
n = revolutions per second.
c = number of convolutions or bars.

It is clear then that c is the only quantity wanting to determine N. Now, in fixing c, we are met by two considerations: (1) that c should not be much greater than 160 owing to expense, or below 40 owing to sparking; also (2) that it should be an even integer and preferably divisible by 8. Let us take $c = 120$, which will give us approximately the value we require for N, and will allow of altering the actual number of bars afterwards either way.

We therefore get

$$N = \frac{80 \times 60 \times 10^8}{320 \times 120}$$

$$= 12{\cdot}5 \times 10^6 \text{ nearly.}$$

To N we should add 10 per cent. for armature and demagnetisation losses $= 13{\cdot}75 \times 10^6$. Assuming our induction in the core to be 10,000 lines per square centimetre, this gives a total area of 1,375 square centimetres. To this we must again add about 20 per cent. to allow for the shaft, whose permeability will be much lower than that of the soft iron core, and also for the ventilation shafts through the core—always assuming that the armature is very little longer than its diameter.

This gives us 1,650 sq. cms., or about 250 sq. ins. to deal with. Now we have 120 conductors, and assuming a depth of bar of ·5 in., and a current density of 1,500 per sq. in., the area of bars will be

$$\frac{200}{1{,}500} = {\cdot}1333 \text{ sq. in.,}$$

and the breadth of bar = ·266 in., or with paper insulation, &c., about ·325 in.

The total periphery required will thus be

·325 × 120 + say 2 inches for pegs = 41 inches say 42 inches,

and the diameter of core

$$= \frac{42}{\pi} = 13\tfrac{1}{2} \text{ inches.}$$

The length of core will be

$$\frac{250}{13{\cdot}5} = 18{\cdot}5 \text{ inches.}$$

The core for 120 bars is thus $13\frac{1}{2}$ inches × $18\frac{1}{2}$ inches.

But as our desire is to make the core nearly square, even if a few more bars are put on, it can be made

$$15\tfrac{1}{2} \times 16 = 250 \text{ sq. ins. nearly.}$$

Now, assuming $\frac{3}{4}$-inch air-gap all round (our bars are $\frac{1}{2}$ inch deep), this gives us 15 inches + $1\frac{1}{2}$ inch, or, say, 17 inches for bore of pole-pieces, or armature rating.

Having now fixed the size of the armature (and as explained before, this can be done forthwith after a little experience), we can proceed with the proper winding. We have:

Current density, 1,500

Area of bars, $\frac{200}{1{,}500}$ ...	=	·1333 sq in.
Depth of bar	...	·5 inch.
Width of bar $\frac{{\cdot}1333}{{\cdot}5}$ ...	=	·2666 inch.
Minimum of gauge of strips	=	·036 inch.
Say seven strips, each ·038 ...	=	·266 inch.

Bars.—The bar will now be built up as follows:—

Copper, width	=	·266 inch.
Paper = 6 × ·003	=	·018 inch.
Insulation ·02 × 2	=	·040 inch.
Width of bar ...	=	·324 inch.

Also

Copper, depth	=	·500 inch.
Insulation	=	·040 inch.
Depth of bar ...	=	·54 inch.

Air-Gap.—

Depth of two bars	=	1·08 inch.
Insulation on core = ·05 × 2	=	·10 inch.
Wire bands and mica = ·065 × 2	=	·13 inch.
Clearance $\frac{1}{8}$ inch all round ...	=	·25 inch.
Total air-gap ...	=	1·56 inch.

(*To be continued.*)

ACCUMULATOR TRACTION.

By R. KENNEDY.

Prof. Ayrton, in his remarks on this subject in criticising Mr. Epstein's paper, gives a table on p. 860, No. 1,047, December 17th, 1897, of the Electrical Review, which would have been of great value had another column, giving the rate of discharge per pound of plates, or, better still, per pound of positive plates, at which the watt-hours capacity per pound gross was obtained for the last column.

For the purpose of the worthy Professor the table is all that is required, and his allowance of nine watt-hours per pound of battery is a very generous one considering all things. But that table, like many others given regarding storage batteries, is apt to be used by other people for other purposes, which the addition of a column of rate of discharge per pound of plates would have effectually defeated. Further, it ought to be pointed out that the results of tests on a 7-plate cell cannot be compared with the results of tests on a 17-plate cell; the table shows this clearly.

It is high time for electrical engineers to agree upon some orderly method of tabulating battery performances; at present complete chaos exists, so that fair comparisons are impossible. In any case the watt-hours discharge per pound must always be taken, with the rate of discharge per pound, and the cells compared must be of nearly the same rate of amperes discharge. If these two simple precautions are omitted the figures are valueless for comparative purposes.

The mean P.D. is not a matter of much importance, as in most cells it makes little difference in the total watt-hours whether it is 1·9 or 1·8, or even 1·7 volts; but it makes a vast difference if one cell is discharged at 0·75 amperes and another at 1·0 per pound of plates.

CORRESPONDENCE.

A Defence of Germany.

I regret to notice in No. 1,048 of the Electrical Review, under "Notes," a rambling rhapsodical recitation: "A Daniel come to Judgment," launched against the head of a neighbouring and friendly nation, against a Sovereign just as highly esteemed in Germany as Her Gracious Majesty Queen Victoria is in Great Britain and Ireland. If such contributions were the reciprocal effusion of bad temper, they might perhaps be explainable; but Germans have never gone so far, and a feeling of international decency will always prevent them from personal insults of other nation's monarchical personages.

It would be the proper thing to ignore similar productions, if they were not the outcome of a widespread contagious disease, which threatens in England to assume an alarmingly dangerous character. What must be the standard of mind of authors who produce such discord-sowing rhapsodies! Do they really dream for a moment that their assaults would change the conduct of the performers of their imaginary or wilfully distorted complaints. Certainly such assumption would be ridiculous, especially in a country whose educational standard is continuously and emphatically recommended for emulation, by the highest statesmen in England, such as by Lord Rosebery at Colchester, by the Marquis of Salisbury's nephew, Mr. Balfour, at Sheffield; by Mr. W. Woodall, M.P., and Imperial counsellor of technical education; by Mr. A. J. Mundella, M.P., at Birmingham; Sir A. Arnold, President of the London County Council; Mr. John Morley, M.P.; Sir Henry Roscoe, and the Duke of Devonshire; Lord Playfair, writer, politician, and M.P.; Mr. Doxford, M.P., one of the most celebrated ship-builders; also recommended at the opening of the Davy-Faraday Research Laboratory by the Prince of Wales (the laboratory is a present of the value of £100,000 gratuitously given to the English nation by the German chemist, Dr. Ludwig Mond); as also recommended by many others, including even Mr. H. M. Stanley, M.P., of "dark country" fame; the press, as for instance, the *Daily Telegraph*, of November 20th of last year, and "last, but not least," by the *Board of Trade Journal* in the December number of the same year.

What then could such discord-hunting epistles aim at? Do they intend to hit German self-esteem and national enviousness, or do they perhaps wish to contribute to a desired change in the new course of national economy and commercial policy in Germany in favour of English interests? I can assure you most emphatically that neither one nor the other could be attained by any such chauvinistic writing. The German people, who read English papers very much indeed, are by this time fully accustomed to see through the coarse meshes of clumsily distorted misrepresentations. They recognise at the bottom, under the sieve, the real motive of the outburst, which is always the result of some political or commercial disappointment, which could not be helped, and they look at it, to say the least, with equanimity and smilingly.

With regard to the new course of German commercial policy, no light-handed talking could have the slightest effect upon it, as it not even depends upon the wish nor the will of the nation, but is forced upon the country and laid down by the inflexible laws of nature. On this point, and with the hearty desire to arrive to a mutual understanding, I beg you to grant a German with 25 years' residence in England a few more words.

The greatest modern politician of Great Britain, Joseph Chamberlain, expressed at the Birmingham Chamber of Commerce, if not in exactly the same words, but as near as I can repeat them, the following doctrine: "The culminating point of governmental triumph consists in the extension and security of commerce. One must, however, never forget that other nations have the same desire as we in England, and that the demand of Germany, France, and Russia for colonial extension must be principally attributed to the longing for buying, selling and profiting!" In these few sentences the experienced politician and shrewd business man laid down the principle of policy of civilised nations, the fulcrum upon which all business and political transactions now-a-days are supported. Another great Englishman of the present day, the Viscount Wolseley, has said: "Cosmopolitanism is the excrescence of an unhealthy civilisation, and the product of a senseless and unpatriotic philosophy."

These dogmas, although recently uttered, are not at all new; in fact, one might say they were recognised and religiously followed in England since 300 years. They were the prime motor during the long and destructive wars against the Spaniards, Dutch and French; they achieved the exclusion of the German Hansa, destroyed armadas and empires, which even in those days were more extended than the British Empire of to-day. The same political dogma, with the help of German troops and the timely arrival of Blucher, crushed at Waterloo the ambition of Napoleon, who craved to dispute the supremacy of English commerce at sea. If this supremacy, since the accession of Queen Elizabeth, was not always the primary cause of English wars, it certainly was always the leading principle in concluding peace. England, by these principles, and the political testament of Elizabeth—"to be friends with all, and allied with nobody," became a self-relying, commercial and naval nation of the very first rank. It is, therefore, perhaps natural, that this supremacy at sea, and of commerce, supported by an enormous accumulation of wealth, should have created a national feeling, that a monopoly of commerce and a claim on any part of the globe, not yet included in the sphere of civilised nations, should fall to Great Britain as an inheritance of priority, there we arrive at the foundation of all the evil!

"*Tempora mutantur et nos mutamur in illis.*" During the centuries when England was fighting for the supremacy of commerce, Germany was involved in mighty continental disturbances, of which the 30 years' war, which reduced the population from 25 millions to 12 millions, threw the country into exhaustion and internal disorder, and it took all the time till the reign of the Emperor William I. to strengthen the shattered race and reunite the Empire. With a population of 30 millions, as Germany had in the year 1830, it was quite rational, to be principally an agrarian country, the competition in North American and British-Colonial agricultural products not yet existing. But the German population having now risen to 54 millions, with a yearly increase of 670,000 inhabitants, and after American and British-Colonial products have ruined German agriculture, the law of self-preservation has forced Germany, *nolens volens*, to cease being an agricultural country, but to enter the rank and file of industrial competitors, which, in due course, and in strict accordance with the Chamberlain dogma, led Germany to colonial and sea power. Thus, German increase of population, North American and British agricultural competition forced Germany to become a competitor of industrial, commercial, and colonial England. No light-handed grumbling about imagined interferences with rights, which have no legal standing, nor any amount of national outburst of bad temper could change the logical sequences of Nature's laws. There are only two alternatives for England to meet the altered state of things, viz., either to destroy by force of arms half of the German population, its industry and commerce, and thus to reduce the empire to its former state of under-population and disorder; or, to accept the altered state of international position, and to undertake, shoulder to shoulder with Germany and with all other competing nations, the peaceful development of civilisation and culture of industry and commerce. Fortunately there is still plenty of room for all of us in many foreign lands! Although Germany is fully prepared for any attempt in the direction of the first alternative, everybody in the country is most heartily wishing for the latter, and the sooner such also becomes recognised in England the better for general peace, and for the welfare of the world.

Only a few words more about the fallacy of chauvinistic literature. Your correspondent suggested to the head of the German Empire, "to purchase for a few marks some patent or other from one of his *starving subjects*," evidently endeavouring, and perhaps succeeding, to make his countrymen believe that German industry and trade are in a starving condition.

Now, then, sir, as starvation and emigration always go side by side, let us look at the figures of emigration in Germany and in England. As long as Germany was principally an agrarian state, the annual emigration reached a few hundred thousand; thus the year 1882 still showed 220,902 German emigrants. From that year, and hand in hand with the development of German industry and commerce, the emigration gradually dwindled down, till it reached, in the year 1896, the insignificant figure of 33,824; and this in spite of an increase of population of 6,944,000 during that period of 14 years. The statistics of English emigration, on the other hand, show quite a different picture. England, including Scotland and Ireland, with a much smaller population than Germany, always showed a larger emigration, which amounted to a yearly average of 256,726 persons during the eightieth years, and rather increased during the later period, shewing 271,772 emigrants during the year 1895. I leave it to the judgment of the impartial reader on which side starvation is most likely to be; anyhow, it does not seem to be on the German side.

Hoping that these lines might contribute somehow to a better mutual understanding with regard to the inflexible laws of international and political economy and to smoothing existing friction.

R. von Fischer-Treuenfeld.

Dresden, *December 28th*, 1897.

Dust Destructors.

Mr. Raworth's letter on the subject of the Shoreditch Dust Destructors is opportune, as hitherto there has not been much point in the arguments advanced. But he fails entirely to appreciate the question, which, to those of us who are looking on, is at issue in this connection. We are not wanting simply to be told that, providing the extra capital expenditure does not exceed a limit, a combined dust destruction and electric lighting station is an economical undertaking. This we can pre-determine with fair accuracy for ourselves.

What we *do* want to know is the actual practical value of the method of thermal storage in use? This, for us, is what is under trial at the Shoreditch station. Mr. Raworth's diagrams and arguments ignore this question of storage altogether; and, therefore, although by contrast so clearly and vigorously expressed, they are really beside the question.

Is the thermal storage effective for the purpose for which it was designed? The fact that some coal is already necessary, although the station is but lightly loaded electrically, while supplied with its full quota of refuse, in the absence of other information, affords reasonable excuse for doubt that it is. Either the storage capacity is too small, or the practical thermal efficiency of the plant is extremely low. Imagine balance-sheets of two instances, the one as at Shoreditch, the other similar in every respect, except that the thermal storage paraphernalia is absent. On the debit sides are the total calorific values of all the available refuse of the parish, and that of certain quantities of coal; on the credit sides are the electrical outputs. Question: would the Shoreditch balance-sheet show any substantial advantage over the other? and if so, is it sufficient to justify the extra capital charges incurred on the storage plant?

Now, it is scarcely reasonable to expect Mr. Kershaw to decide technical points of this nature; rather it is for the designers and contractors to take up the challenge that has been thrown down, and to give figures to show that the innovations they have introduced have proved a success. If they can it is in their interest to do so; but are they not very agreeably surprised by the somewhat mistaken view of the Shoreditch scheme that has been taken by the public in general, and Lord Kelvin in particular?

It must not be forgotten that Shoreditch is not the first district in which the heat of dust destruction has been utilised for the purposes of electrical supply. It is simply the first of such undertakings in which thermal storage has been attempted.

It is very clear, nowadays, that unless some really effective system of storage can be devised, the advantages derivable from the combination of these essentially antagonistic processes of dust destruction and electricity generation, cannot be of attractive dimensions, and they have an unpleasant habit of vanishing altogether when put to the practical test. There are several methods of storage, the three most direct and obvious are:—

1. Storage of refuse, and the provision of means by which it can be burnt at any desired rate.
2. Storage of heat.
3. Storage of electricity.

Two years ago the Battersea Vestry invited schemes for the utilisation of the waste heat of their dust destructors in connection with electric lighting. As one of the competitors, I proposed a rather fanciful system of storing the heat, by means of regenerative stoves of brickwork. As an alternative, I outlined a scheme of refuse storage, in which I have still much faith. The time allowed for this competition was much too short, otherwise it might have been productive of some useful and interesting proposals.

The third method, storage of electricity, is rather under a cloud, because of the poor results at St. Pancras. But has it had a fair trial? Its great advantage is the way it economises boilers and generating plant, and in this way it partially balances the extra capital expended on the batteries. I am much inclined to prophesy that eventually the Shoreditch plant will be worked wholly on this method.

James Whitcher, A.Inst.E.E.

January 1st.

New Thermal Ampere-meter.

Referring to a note in your last issue on a new thermal ampere-meter, the following remarks may be of some interest:—

Many years ago, in 1881 and 1882, I experimented with several forms of instrument on much the same principle as that described in your note. In some, the bulb of an ordinary thermometer was closely surrounded by a conductor heated by the current to be measured, in others the bulb was forked, and the current, or a derivation from it, passed up one leg and down the other.

The object was to provide a means of measurement for alternating currents. A sliding scale, calibrated by means of continuous currents, was used, the zero of the scale being made to correspond with the height of the thermometer before the current was applied. Several of these instruments were useful at the time, but I did not consider them as practical for ordinary use, partly as being very delicate and of limited range, but chiefly because their indications depended, to some extent, on the conditions as regards the radiation and convection of heat from them.

I therefore much preferred the principle of the voltmeter, which has since become well known, in which the wire heated by the current is entirely enclosed within a thin tube of an equal coefficient of expansion to which the wire is fixed, so that the expansion measured is not absolute, but relative to the enclosing tube, to which all the heat generated in the wire must pass.

Thus the instrument reads the difference of temperature between the wire and the tube. I consider this principle very important for accuracy in any instrument depending upon the expansion of a conductor heated by an electric current.

P. Cardew.

January 3rd, 1898.

Localising Faults in Submarine Cables.

The following, read in conjunction with Mr. H. C. Cann's communication, published in your issue of December 18th, 1896, may prove of use to some of your readers.

Modification of the Kennelly break test:—

The battery to be grouped in certain determined ratios, such as 1—2—4, or 1—4—16; if the former, we shall have from the rule of inverse square roots the resistance of the exposed end, as 1, 0·696, 0·485.

Measurements to cable current zero, and zinc to line. When measuring with the intermediate and lowest powers, insert in the battery circuit a resistance equivalent to the difference between the internal resistance of the cells in use, and that of the total, or greatest number; then it will be found that X = A — 4·75 (B—C).

The measurements, A, B, C, as usual, A being that obtained with the lowest power. For breaks close to the observer, the above will be found to give excellent results.

A few examples.

Break at 10 ohms distant.

Grouping of cells, 16—8—4. I.R. of battery 48 ohms.

100/100 zinc to line, measurements to cable current zero:—

C = 25 ohms.
B = 33 ohms (24 added to battery cct.)
A = 48 ohms (36 " ")
∴ X = A—4·75 (B—C) = 48—38 = 10 ohms.

Ditto at 20 ohms.

C = 35
B = 43 (add as above).
A = 57 (" ") X = 57—38 = 19 ohms.

Ditto at 30 ohms.

C = 44
B = 52 (add as above)
A = 69 (" ") X = 69—38 = 31 ohms.

Ditto at 40 ohms.

C = 55
B = 63 (add as above)
A = 78 (" ") X = 78—38 = 40 ohms.

Ditto at 50 ohms.

C = 67
B = 75 (add as above)
A = 90 (" ") X = 90—38 = 52 ohms.

Break at 80 ohms.

C = 96
B = 105 (24 added to battery cct.)
A = 123 (" ")
X = 123—42·75 = 80·25 ohms.

Ditto at 100 ohms.

C = 117
B = 125 (added as above).
A = 138 (" ")
X = 138—38 = 100 ohms.

Ditto at 150 ohms.

C = 170
B = 180 (added as above).
A = 197 (" ")
X = 197—47·5 = 149·5 ohms.

Ditto at 500 ohms.

C = 522
B = 235 (added as above).
A = 562 (" ")
X = 562—61·75 = 500·25 ohms.

Ditto at 1,000 ohms.

C = 1,050
B = 1,070 X = 1,100—95 = 1,005 ohms.
A = 1,100

Break at 20 ohms.
Another set, bridge 100/10. I.R. 44 ohms.

C = 273
B = 302 (add to battery cct. 22 ohms)
A = 350 (" " " 35 ")
X = 350 — 137·75 = 212·25 = 21·22 ohms.

Break at 45 ohms. 100/100.

C = 51
B = 62 (add as above)
A = 72 (" ")
X = 72 — 28·5 = 43·5 ohms.

Ditto. ditto. 100/10.

C = 534
B = 568 (add as above)
A = 638 (" ")
X = 638 — 161·5 = 476·5 = 47·65 ohms.

Break at 20 ohms.
I.R. 16 minottos = 162 ohms. Bridge 100/10.

C = 365
B = 450 (added to battery cct. 81 ohms)
A 590 (" " " 120 ")
X = 590 – 4·75 (450 – 365) = 18·6 ohms.

Break at 500 ohms.

C = 5,250
B = 5,380 (added as above)
A = 5,580 (" ")
X = 5,580—4·75 (5,380 – 5,250) = 496·2 ohms.

John McGill.

Alexandria, Egypt, *December 22nd*, 1897.

Shoreditch and its Dust Destructor.

My attention having been called to the letter in your last week's issue signed "Power," and having also read the two letters in this week's issue signed by Mr. Raworth and Mr. F. W. Brookman—although, as I have already stated, it was not my intention to continue a newspaper correspondence with anonymous letter writers—I feel that, as the two letters in this week's issue are signed by gentlemen who show their *bona fides* by writing over their own names, I must, in courtesy, reply, as far as I am able, to the position of the Shoreditch destructor as they put it.

I must thank Mr. Raworth, whose acquaintance I have not had the pleasure of making, for his very lucid letter, which shows that, in contradistinction to your anonymous correspondents, he has at least grasped the reasons that have induced the Shoreditch Vestry to embark on this undertaking, and realises the certainty of their making some profit out of the combination which must, at least, be worth the having, whilst it may result in savings of a most considerable nature.

Referring to the remarks that appear over the *nom de plume* of "Power" once again, and to the general tone of the correspondence of this gentleman, "X. Y. Z.," and "Anti-Humbug," and likewise to the position you yourselves have thought fit to assume in this matter, I wish to protest in the most emphatic manner against the false impressions that are being disseminated amongst those who may be interested in adopting such a combination as we have, and who are more than likely to assume by you and your unknown correspondents' attitude that the allegations of deception and fraud so constantly reiterated by you and your anonymous friends must of necessity have some justifications in fact.

My Vestry have entered upon an experiment which they were led to believe would save them in the expense both of the disposing of their ash-bin refuse and in the production of electricity for the supply of their parish, and if these two hopes are realised, as they bid fair to, then they will have achieved all they hoped to do.

As you are well aware, quite recently attempts have been made in two London districts to effect the same object, with signal failure in both cases. By this I mean that in neither case has the refuse destructor been of any practical use in the generation of electricity in the electric light stations erected in proximity to these two dust destructors.

As I have constantly reiterated, so far the electricity supply in Shoreditch has been maintained by the combustion of the refuse, only excepting on those occasions when there has been no refuse to burn; and every fair-minded man holding unprejudiced views cannot but admit that the efforts of my Vestry have already resulted in turning into a not inconsiderable success that which has been attempted previously by others without success, and therefore some credit is due to us and our engineers for a pioneer effort in the direction of the utilisation of a waste product, even though it may be possible that in the future plant may be designed which may give better results than the first successful combination of the kind.

To read your own remarks and those of your anonymous correspondents, one would almost imagine that your journal had changed hands and is now being controlled by some journal having antagonistic interests to the advancement of electrical industries. I should myself have thought that your journal would have been the first to have congratulated us on the undoubted success we have met with, instead of doing all in your power and in that of your anonymous correspondents to make it appear that not only is the undertaking not a success, but that fraudulent means have been adopted to make it appear so.

I note, indeed, that you say "And if the first twelve months' work show that their combined scheme of dust destruction and electricity is successful we shall be the first to acknowledge it." Would it not have been fairer and in every respect more desirable—assuming you really had any desire to see the success of an electrical scheme, such as this, involving substantial progress—if you had left your remarks unsaid until such time as the works publish their first accounts, and then, and then only, used the influence and power of your journal to criticise it unfavourably, if it so deserved, than to endeavour to hound it down at this moment so as to discredit it in the eyes of others, who must undoubtedly be influenced by the erroneous view you take of the matter, and who, unfortunately, are hardly likely to notice those few words in which you may in the future acknowledge that you were mistaken in your previous impressions so continuously and emphatically reiterated in your paper from week to week by the shamefaced utterances of anonymous correspondents?

As an example of the way in which you and your correspondents endeavour to turn an easily explainable fact into a proof of the justness of your and their remarks, one cannot do better than read that portion of "Power's" letter in your issue of last week, in which he refers to the letter of the "Engineer in charge of the Dust Destructor, Shoreditch," to the *City Press* of August 11th, stating that "It is the fact that coal was used on the opening day, but that because we had no refuse, and therefore had to burn coal to generate the steam required," and in reference to which "Power" goes on to state that Lord Kelvin said dust only was used, while the engineer says that they had no refuse, but burnt coal to generate the steam, and that therefore Lord Kelvin was not in the coal secret, and ending up by inferring that a lie was told the assembled company in stating that the current was generated from dust, and dust only.

Now, Mr. Editor, what were the facts. The current during the morning and the afternoon was generated entirely by ash-bin refuse as stated, and would have continued to have been generated by ash-bin refuse throughout the night, had it not been that the Vestry had a parade of their dust carts in connection with the opening ceremony, as you yourself must have seen when you were there, and which naturally resulted in the dustmen not collecting any further refuse with contradictions, and are strangely out of agreement with each other. Having shunted the dispute once to the popular issue of hours, he does not find this to work, so he has tried to shunt on to an attack upon unionism. But his own friends have found him out, and we scarcely think that the A.S.E. is going to get its further funds for fighting, unless it be from Germany or America.

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending Jan. 4th, 1897.	£	s.
Bombay	32	0
Buenos Ayres	30	0
Calcutta	473	0
Cape Town	149	0
Durban	272	0
East London	2,130	0
Flushing	80	0
Melbourne	189	0
„ Teleph. mat.	45	0
Sydney	213	0
Total	£3,613	0

Week Ending Jan. 4th, 1898.	£	s.
Alexandria. Teleph. mat.	109	0
„ Teleg. mat.	34	0
Albany	38	0
Amsterdam	81	0
Antwerp	65	0
„ Electric fuse	410	0
Auckland	20	0
Bangkok	35	0
Barcelona	55	0
Bermuda. Teleg. cable	95,000	0
Bombay...	40	0
Bordeaux	20	0
Borneo	1,206	0
Brussels	396	0
Calcutta...	313	0
Cape Town	1,095	0
Colombo	36	0
Copenhagen	96	0
„ Teleg. mat.	54	0
Delagoa Bay	36	0
Demerara	135	0
Durban	506	0
East London	822	0
Gibraltar	24	0
Gothenburg	24	0
Halifax. Teleg. mat. ...	138	0
Hamburg	33	0
Jamaica. Teleg. mat....	174	0
Kurrachee	150	0
Lyttleton	408	0
Melbourne	52	0
Montreal	30	0
New York	10	0
North Atlantic. 3,000 lbs. Teleg. cable	—	
Ostend	85	0
Port Said	101	0
Rio Janeiro	10	0
Rotterdam	33	0
Stockholm. Teleg. mat.	24	0
Sydney	1,186	0
„ Teleg. mat. ...	133	0
Turk's Island. Teleg. mat.	15	0
Vera Cruz	69	0
Wellington	83	0
Yokohama	576	0
Total	£103,956	0

Foreign Goods Transhipped.

	£	s.
Christiana	84	0

Additional Premises.—Owing to the increased business, Mr. F. C. Allsop has had to take large new additional premises at 126, Queen Victoria Street.

Business Announcement.—Messrs. Handley & Shanks have opened new offices and showrooms at 12, Dawson Street, Dublin. Mr. Arthur Handley, A.I.E.E., will act as manager for Dublin and neighbourhood. The firm undertakes all classes of electrical work, including town and private lighting, and transmission of power. They are carrying out important contracts for the principal railway companies in Ireland.

Calendars, &c.—Messrs. W. H. Willcox & Co., send us an 1898 Date Remembrancer, having a detachable sheet for each month.

We have also received, as usual, one of the E.P.S. Company's very useful blotting pads, with almanack for 1898, memoranda book, &c., attached, and some general information regarding the company's batteries. We believe there are many electrical men who, like ourselves, find these pads very serviceable.

Messrs. Hasel, Watson & Viney are sending out the seventeenth edition of the Hardware Trade Diary and Cash Book to the subscribers to the *Hardware Trade Journal*, in accordance with usual custom. This volume, we have no doubt, is welcomed by that class of business men for which it is intended, and particularly to those having to make a good number of cash entries every day. The book is ruled cash throughout, with the exception of a few memoranda pages, and there is half a page set apart for each day. All the pages are interleaved with blotting paper.

The Brockie-Pell Arc Lamp Company send out a handy pocket-card, with revolving arrangement, by means of which dates for any day up to 1903 may be ascertained.

Messrs. Jackson & Coleby, electrical engineers, of Thayer Street, W., have issued an 1898 calendar with a sheet for each month.

Messrs. Hodges & Todd, of Hampstead Road, N.W., have brought out a very neat and well printed calendar. There is a sheet for each month, and each sheet has a complete calendar for the year. This firm reports with regard to the business of last year that, notwithstanding the serious labour troubles, they have had a very successful year. Their trade in large switchboard and central station requirements has been quite unprecedented, whilst the demand for ammeters and voltmeters, together with their specialities in high tension apparatus, has been far ahead of previous years. During the year they have extended operations by opening premises in George Street, and cabinet works in Seaton Street, to cope with the large increase of trade.

Catalogue.—Messrs. W. M. Still & Co., of Charles Street, Hatton Garden, have compiled a new catalogue. Among a host of general brass and copper fittings for a variety of purposes, we observe stamped ornamental switch bases, or feet, for floor lamps, brass and copper art fittings, electric globe carriers, counterweights and pulleys, reflectors, switch covers, bell pushes, and numerous electrical accessories. There are further various artistic designs of coronets for arc lamps, the Still incandescent lamp, &c. The catalogue, which contains over 150 pages, and is well studded with illustrations, is bound in stiff green covers.

Changes of Address.—Mr. A. A. Crawford (The Bombay Electric Company), of Bombay, announces that owing to increased business, he has taken more extensive business premises at No. 9, Meadow Street, Bombay, where letters should now be addressed. The workshops are also being extended.

Owing to 19, Great George Street being required for the site of the New Government Offices, Edmundson's Electricity Corporation, Limited, have removed their offices to Broad Sanctuary Chambers, Westminster.

Messrs. Handcock & Dykes are removing from 5, Victoria Street, S.W., on January 29th, to Westminster Chambers, 1, Victoria Street, S.W.

Dissolution of Partnerships.—Messrs. Henry Lea and W. H. Thornbery, carrying on business as consulting engineers at Bennett's Hill, Birmingham, as Henry Lea & Thornbery, have dissolved partnership. The business will be continued by Mr. Henry Lea and his son, Mr. F. M. Lea, under the style of Henry Lea & Son. See our "Official Notices" for further particulars.

Messrs. C. F. Slater, S. R. Slater, and F. Crossley, manufacturers of surgical appliances and electrical apparatus, and manufacturing electricians, of 20, Baker Street, Portman Square, trading as Slater, Bros. & Crossley, have dissolved partnership. Debts will be attended to by C. F. & S. R. Slater.

Liquidation Notices.—A general meeting of the Acme and Immisch Electric Works, Limited, will be held on February 4th, at 3 o'clock, for receiving an account of the winding up from the liquidators, Messrs. E. Wilding and J. Gray.

Partnership Notice.—We are informed that Messrs. S. V. Clirehugh & F. A. Cortez Leigh have entered into partnership with Mr. E. M. Lacey, A.M.Inst.C.E., and Mr. A. M. Sillar, M.Inst.E.E. The title of the firm will now be Lacey, Clirehugh & Sillar, and the offices will henceforth be situated at 78, King Street, Manchester, and at 10, Delahay Street, Westminster. Each partner will, as heretofore, give personal attention to the work on which he is at present engaged. The notice we have received does not make it quite clear whether Mr. Cortez Leigh is included in the arrangement. His name is printed at the top of the printed circular, so we assume he is a partner.

Change of Name.—We are asked to state that the name of the firm of Venner & Sillar, of Delahay Street, has been changed to Venner & Co.

Electrical and General Engineering Company.—This company informs us that the electric lighting of Wellington Hotel, Tunbridge Wells, to which we referred recently, is being carried out by them; and they have also carried out other private installations in that town, including "Firmount." The same company has recently completed the wiring of Collins's Music Hall, having installed the equivalent of 3,000 8-C.P. lamps in a month. Among other contracts now in hand are mentioned installations for the Canterbury Arms, Brixton (including engine and dynamo), various City hotels, the Synagogue, St. John's Wood, the new Synagogue, Great St. Helen's, St. Swithin's Church, Wesleyan Chapel, East Road, &c.

Electrical Engineering in Italy.—A company has just been formed at Florence, with a capital of £80,000, to be known as La Società Toscana per Impresi Elettriche, to establish an electricity generating and distributing station in that city. It is said that Messrs. Schuckert & Co., of Nuremberg, Germany, are interested in the new undertaking.

Electrical Engineering in Germany.—Large new works for the manufacture of electric cables are about to be established at Spandau by Messrs. Siemens & Halske, of Berlin.

Gas.—A gas explosion, which occurred at Leicester on Saturday night last, did a great deal of damage to property. A nurse was thrown violently against the wall and killed on the spot.

Harrison & O'Brien.—This firm, owing to increased business, have removed their offices and testing department from Albany Buildings, 45, Victoria Street, Westminster, to 19 and 21, Queen Victoria Street, E.C. At their new address they are increasing the size of their laboratory and testing department, and will now be able to undertake all classes of work in that line, in addition to out-door testing and inspecting.

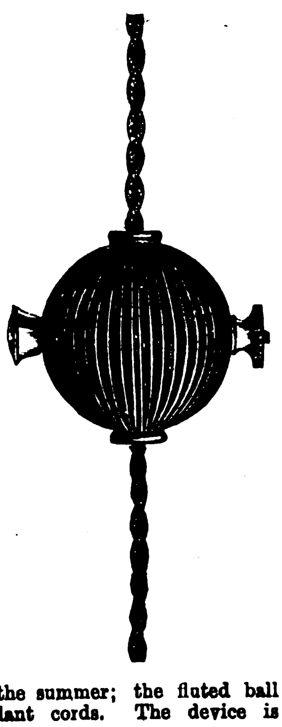
New Firm.—We are informed that Mr. J. Foxcroft and Mr. W. J. V. Duncan, late of the firm of Paterson & Cooper, Dalston, have started in business as electrical and mechanical engineers, at 24, Queen's Road, Dalston, where they propose manufacturing arc lamps, switchboards, indicators, &c. We understand that Mr. Foxcroft has had large experience in the manufacture of such goods, having been foreman and manufacturing contractor with the firm mentioned for 20 years.

New Journal.—We have received a copy of No. 1, December, 1897, of a new paper known as the *Journal of Acetylene Gas Lighting*. The journal will be published monthly from 13, Farringdon Avenue, London, E.C. The first number contains, among other items, an introductory article by Prof. Vivian B. Lewes, and "Some Notes on Acetylene" by Hiram S. Maxim.

New Premises.—Mr. Albert C. Hands announces that he has taken showrooms recently occupied by Messrs. Winfield, Limited, at 39, Snow Hill, E.C. Mr. S. Croneen, late of Winfield's, Limited, and Mr. G. Boorman, will represent the firm jointly in London and suburbs, and the country ground will be covered as usual by Messrs. A. C. & G. Hands. Mr. Hands has arranged a partnership with Mr. Harold Davis, of Star Works, Stafford Street, Birmingham.

Refuse Destructors.—Messrs. E. Green & Son, Limited, have received instructions to supply one of their economisers to the Shoreditch Vestry electric light and destructor works. We understand their apparatus is already used with highly satisfactory results at several other destructor plants, including Oldham and Winchester.

Regulating the Height of Incandescent Lamps.—Messrs. Chas. Joyner & Co., Limited, of Icknield Square, Birmingham, are just putting on the market a little contrivance to provide a simple and inexpensive means for altering the height of incandescent lamps without the need of counterweights. The firm is hoping that the device will supersede the unsightly method of looping and knotting flexible cords now used to shorten incandescent leads, which we illustrate herewith. A fluted ball divided into two halves forms the cover to a small reel upon which the flexible cord is wound by turning the fixed nut on the one side. This nut is serrated, so that when the lock-nut on the other side of the ball is screwed up tight the projections on the lock-nut engage in the grooves of the fluted cover and thus prevent the reel turning further. There are two types of this fitting made, one to be fitted up whilst the installation is being erected, and the other a pattern which can be applied to existing lamps by slipping sideways on the flexible cord. The advantages claimed for this device are: it is cheaper and more sightly than counterweights; the best height for the lamps can be found experimentally without knotting cords or breaking connections; the lamps can be wound up to the ceiling if not required in the summer; the fluted ball forms an ornament to plain pendant cords. The device is provisionally protected.



Reported Amalgamation.—It is stated from London, says the *Newcastle Daily Leader*, that the well-known firm of Easton, Anderson & Goolden, Limited, engineers and millwrights, of the Thames Ironworks, Erith, Kent, and Palace Chambers, Westminster, London, S.W., have amalgamated with Sir W. G. Armstrong, Whitworth, & Co. Messrs. Easton, Anderson & Goolden are at present engaged in substituting electric for hydraulic lifts on the Electric Railway, Stockwell and London Bridge, in addition to important contracts for Woolwich Arsenal.

Ryman v. Salmony & Co.—In our recent report of this case heard at the Westminster County Court, we stated that judgment was given for the plaintiffs for the balance of £8 10s. This, we are informed, should be 8s. 10d., which was for postage account. The only business done and paid for was £190 10s. 9d.

The Aston Lamp-Holder.—We illustrate below this new lamp-holder, which is being put before the electrical trade by Messrs. Veritys, Limited. It is claimed that the holder will meet with commendation from the fact that it possesses in a marked manner the two essential features of an ideal lamp-holder—small size and high insulating properties. With respect to the former characteristic, the "case" is $\frac{3}{8}$-inch shorter than that of the ordinary lamp-holder, while a neat and symmetrical outline has been preserved; as to insulation, the holder is provided with a new interior (M. B. Cotterell's Patent), which we illustrate. Fig. 1 shows the "base" end, and Fig. 2, the "lamp" end. Some of the strong points claimed by Messrs. Verity are that (1) Absolutely no metal of either conductor is exposed at the base end of the insulator. The fear of short-circuiting through one conductor being pinched down on to a terminal or plate of opposite polarity is thus altogether avoided. (2) The end of the insulator exposed to the lamp is of solid china, the two plungers alone protruding. Here, again, a short-circuit cannot occur under ordinary circumstances. (3) The chief danger in block terminal insulators is that a strand of flexible or other wire, by protruding too far through

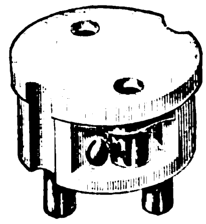


Fig. 1.

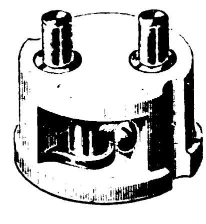


Fig. 2.

the terminal, is liable to short-circuit on to the other pole. In Cotterell's patent interior this is impossible, as the wire can only be passed a slight distance through the terminal. (4) The manner in which the metal parts carrying current of opposite polarity are separated leaves nothing to be desired as to insulating properties. The construction of the interior renders this holder admittedly suitable for use on 220 volt circuits, or even at higher E.M.F. Further, it is extremely easy to wire; its construction is simple; and, although its insulation is so high, the size of the holder is small, being that known as the dwarf type. We have before us a sample of this lamp-holder, and it is excellently made and finished off—in fact, it is one of the best we have seen.

1897.—Messrs. Geipel & Lange, in sending notes of last year's operations, report that the business in Geipel's steam trap or automatic drain cock has increased rapidly during the year, particularly with respect to the electricity supply stations. At present upwards of 40 stations, have adopted these traps, which have already been described in our columns. This trap is also being largely adopted in the States, in Europe, and in the Colonies, for pressures up to 300 lbs. per square inch, while it was awarded the gold medal at the Brussels Exhibition. The manufacture of these traps continues in the hands of the Shillingford Works Company; but on and after January 1st, the sales will be conducted entirely through Messrs. Geipel & Lange, of 68, Victoria Street, Westminster, S.W. During the past year the Westminster business of Messrs. Paterson & Cooper has been sold to Messrs. Geipel and Lange, and notwithstanding the transfer, their staff are stated to have been fully employed. Amongst work which they have carried out during the year, is the complete equipment of the Kennington Road Baths, the new Royal baths at Harrogate, the Church Missionary Society's premises in Salisbury Square, Lambert & Butler's new factory and offices in Drury Lane, Emanuel & Co.'s new premises, Fore Street, Public Market Hall, Harrogate, Dr. Palmer's new house in Queen Anne Street, &c. Messrs. Geipel and Lange have been appointed agents for Messrs. T. Richardson & Sons, of Hartlepool, for the Brown-Boveri power transmission plant, and by Messrs. Ganz and Co. for the Blathy alternate current meters, &c.

ELECTRIC LIGHTING NOTES.

Aberdeen.—Mr. Smith, gas manager, and Mr. Blackman, electrical engineer, have reported to the Gas and Electric Lighting Committee that additional motive power will be required at the electric station in view of the extension of the system. The lighting of the quays from the corporation mains will considerably increase the pressure on the plant, which even now is occasionally very heavy. The engines at present in the station have an aggregate of fully 1,000 H.P., and the committee is to invite tenders for an additional engine of from 600 to 700 H.P.

There is a proposal to light the streets with electricity where electric mains are available, and to light all other streets with incandescent gas lamps.

Belfast.—The Electric Committee report that the new station buildings are now progressing satisfactorily. The contractors expect to have completed the first section of the work by the middle of February, and soon after that the committee hope to be in a position to supply current. The Council has approved of the adoption of Wright's system of charging for electric current from July 1st next. The committee also desire authority to supply and let on hire motors, for which they propose to charge a rental of 15 per cent. on cost to cover interest, sinking fund, and depreciation.

The Council had a brief discussion regarding several increases which it is proposed to make in certain officials' salaries. Mr. V. M'Cowen, the Corporation electrical engineer, was spoken of in very high terms by several members, one speaker saying that he had saved the city at least £3,000 in the drawing up of plans and other matters in connection with the electric light station.

Bexhill.—There will be a Local Government Board inquiry on 12th inst. in reference to the Council's proposed £20,000 loan for electric lighting.

that day after the early morning, and as we have not yet solved the problem of raising steam without either refuse or coal, we were under the necessity of continuing with coal, when the refuse was completely burnt out, for the rest of that evening.

Referring now to Mr. Brookman's letter, I would again point out to you the damage that is occasioned by you and your anonymous correspondents' erroneous expressions, as is exemplified therein, for Mr. Brookman, who writes most fairly on the subject, states in his letter "As to anyone being ashamed of Shoreditch, I give the chairman credit for having done his best, and no one can do more, and that being so there is no need for shame, even if the scheme was an absolute failure, which cannot be said of Shoreditch *I think*." From which it is evident that he too has been misled by you into believing that there is certainly a taint of failure about the Shoreditch scheme, for he evidently is not quite sure but that it may possibly be a complete failure.

The destructor works being still under the guarantee of the contractors for this portion of the work, it is impossible for me, without violating my position as chairman of the Electric Light Committee, to give Mr. Brookman such answers to his questions as might place the Vestry in a false position with their contractors, especially seeing that Mr. Brookman, at the time when the contract for the said works was being settled, approached the Vestry as representing or assisting one of the competing contractors who did not obtain the work, and I would, therefore, ask him to wait for an answer to most of his questions until we are able to answer them authoritatively without prejudice to the contract, and would further point out to him that the total number of units sold as against the actual refuse burnt, could convey no conclusions to his mind, since the number of units that was sold from the combustion of that amount of refuse, although very considerable, does not represent the number of units that could be sold from the combustion of this amount of refuse, if the output demanded a further supply. I can, however, answer his question as to the size of the accumulator battery we have installed. It is only proportioned to give an output of 25 kw. during the hours of maximum load, and is therefore not a material help at that time, but is rather intended to provide an unfailing source of current whence to magnetise the fields of the various generators.

I therefore ask Mr. Brookman, and all the many readers of your Journal who may have been misled by the misstatements you and your anonymous correspondents have so consistently made, and which I am powerless to contradict while the matter remains still *sub judice*, to wait until that time when our first year's running accounts are published, as they will doubtless all perceive that the proof of the pudding is in the eating, and not in the interested remarks of anonymous correspondents (competing dust destructor manufacturers, coal merchants, dust removal contractors, &c.), or the opinions of editors of journals, who have no practical experience of the subjects about which they write.

H. E. Kershaw.

129, Curtain Road,
Shoreditch, *January 3rd*, 1898.

[We must protest strongly against Mr. Kershaw's allegations that we have suggested, or even hinted at, there being deception and fraud going on at Shoreditch, and we much prefer that in future he should deal with our comments separately and not recklessly mix them with what our correspondents, who are well able to take care of themselves, have said. Our own remarks were based solely upon Mr. Kershaw's official statement as chairman of the Electricity Committee, and it seems to us that this worthy gentleman himself would have been better advised had *he* refrained from giving figures until the works' accounts were out, unless he were content that they should be criticised. It is important to observe that though Mr. Kershaw has given certain "official figures" regarding the dust destructors, he objects to give more on account of "the destructor works being still under the guarantee of the contractors." As to the few words at the end of our amiable correspondent's letter, we are content to rest in the knowledge that he is not in a position to judge.—Eds. Elec. Rev.]

THE ENGINEERS' STRIKE.

When the late Conference was proposed, the men's executive professed themselves most anxious to hold it, and the Employers' Federation came in for a good deal of abuse for not running hastily to it. It was generally understood that the two sides at the Conference would come to certain agreements which would be endorsed by their respective supporters. On the side of the men, however, while agreeing to things at the Conference, their representatives have practically told the men not to endorse their action. Below we print a statement of Col. Dyer's, made on behalf of the Employers' Federation:—

"The conditions of freedom to the employers in the management of their works, which was one of the subjects before the recent Conference, are not merely proposals of the employers, but were agreed to by the representatives of the allied unions, who introduced some modifications of the original terms to safeguard the position of the unions. It is also highly significant that the leaders of the allied trades offered that their men would return to work on the following Monday under these conditions of management, provided the employers would agree to a 51 hours' week.

"This offer conclusively proves that these conditions are not in any way incompatible with the proper functions of trade unions. The federated employers have resolved to adhere to them in future. The federated employers have repeatedly declared that they cannot agree to any reduction of hours, and nothing has occurred to alter their decision. No prolongation of the dispute can, therefore, affect their position with regard to the conditions of freedom in the management of their works and the hours of labour.

"Under these circumstances, the federated employers invite the serious attention of the workmen concerned to the fact that these conditions of management will afford an opportunity to the individual workmen to earn much higher wages, that any man desiring to improve his position will have opportunities of acquiring greater skill, and that every man will have the right to bring any grievances to the direct notice of his employer, either individually or through his union. It does not appear that these advantages were brought before the notice of the workmen, nor that it was pointed out to them that there is no intention of imposing novel conditions, or of reducing the rates of wages paid to skilled men; but that the freedom which the workmen enjoy in many of the federated workshops is to be extended to all of them.

"The Federation hope that the time is not far distant when the workmen will appreciate the goodwill of their employers, and will frankly accept the situation by withdrawing their demands for a diminution of the working hours, and by accepting the conditions of management agreed upon at the Westminster Conference, which closed on December 17th.

"(Signed) Henry C. S. Dyer, President."

We would draw special attention to the fact that the conditions as to non-interference were agreed to, and that this is not considered incompatible with trade union interests. The hours question is thus alone nominally standing in the way.

At the time of writing, December 31st, there is in the immediate future the alternate prospect of a spread of the lockout, which, indeed, has, we believe, already taken place by the posting of the hitherto Conference delayed notices, or of the opening of their works to such of the men as choose to return to work on the basis of the agreement come to at the Conference. We hope this latter course will be the one adopted. It would show the employers determination to adhere to the terms they had agreed to, and it would enable many men to return to work who are anxious to do so. The strike will go on, we suppose, all the same. It will become a sort of academic institution. Like some of the City Guilds which have long since lost all touch with the originating cause, the strike may continue drawing funds from America and Germany for an indefinite period. But that, as a practical fact, the strike will go on, we hardly believe. It was bound to fail, being started on a false basis. By Mr. Barnes's own confession, the quarrel was shunted from interference with shop management and the machine question, to the "popular one of the eight hours' day," and the trick failed to gull the public at large.

That curious body, the Fabian Society, compounded of snuff-clothed dramatic critics and æsthetic dames with its pseudo socialism and general dilettantism, has at this late hour given mouth on the question in the shape of a manifesto in favour of the strikers, gratuitously and ignorantly assuming that the desire of employers to use machinery is merely an attempt to reduce a prosperous trade to the level of a sweated one, where collective bargaining has not yet been introduced. Absolute ignorance is all we can say to such drivel. There is no desire to interfere with the proper duties of trades unionism, nor would there have been any move in the direction of complaint about the minimum wage had the A.S.E. done its duty, and seen to it that its members for whom it asked a minimum wage were all competent men. But everyone knows that large numbers of the A.S.E. are not good men. It is a blunder on the part of the A.S.E, for which history will record its sentence, to have allowed itself to be dragged out of its proper path. But the powerful desire to get up a fight has been the dominating factor; funds must be raked in, and men who have had no claims to be called engineers, have been admitted to membership for the sake of funds. It is not trades unionism that is at stake in any sense. It is simply the policy of Barnes or of those who have pushed Barnes into the van, that is now being tried and found wanting. This is the vampire that has sucked the vitals of unionism, and through unionism of English trade. All suffer by it, from Col. Dyer to the last new apprentice.

We confess to sharing the doubts recently expressed in an able article in *Engineering* that much of the freedom allowed for in the sounding clauses agreed to at the Conference amounts to really nothing. Freedom to employ any man is one of these; freedom to be a trades unionist is another. According as a shop falls under the head of union or non-union, so far will certain unwritten laws tend to prevail. The whole thing is a matter of common sense and the application of knowledge of facts. If men would do a fair day's work, their nursing by the trades union would do no harm. Probably the average workman needs some such backset. But he is unfortunately ordered by his executive to do certain things in the way of loafing which he is told are for his good. He has done as he was told, and has simply succeeded in proving to the world that apprentices and labourers can turn out more work than he has been doing. But this is not trade unionism. It is want of knowledge. If the secretary of the A.S.E. had been a man of better education and of observant travelled experience and with a knowledge of commercial facts, he would have carried on the business of the A S.E. in a very different manner, and would have succeeded in getting for his members better pay. We fancy we see Col. Dyer receiving a notice some morning that "he is paying his men too little, and compelling them to the monotony of attending to two machines while capable and desirous of having three." This is the sort of thing a really live and up-to-date secretary of the A.S E. would see to. But we cannot learn that there has ever been anything but restriction; we cannot hear that there has been for many years the slightest attempt to secure that its members were ordinary decent tradesmen and reputable citizens. We do not learn that they have ever taken cognisance of any complaint made against their members for notorious laziness. We hear of no single case of any willingness to render possible the taking of some big contract by agreeing to the *status quo* of wages pending its completion, or of any case of a willingness to work with an employer for the common good. One thing is very certain. Machinery in the end is bound to win. This does not imply that the human workers will lose, or how is it that in the chain trade, to which machinery is so little applicable, the human element is so badly paid? Machinery will win and the skilled tradesman—the fitter—will be so scarce in time that when needed he will command good pay. Skill will consist in an ability to compel so many machines to do so much work, and the old seven years or five years apprenticeships will die out. A machine can be learned quickly. Boys will earn more than they did, and the family man will be sooner relieved of his expenses. The fact has got to be faced. The whole system has got to be changed, and it is scarcely likely that the country will go out of trade to suit minds of the quality Mr. Barnes seems to consider as above the average, to wit, his own (*vide* speech at Enfield). Failing to secure the modern methods forced on her by foreign competition, England will have to go out of trade, but England has no intention of going out of business, and the sooner this fact is realised the better it will be for all who are pursuing an *ignis fatuus*. Workmen have so often claimed that all wealth is the outcome of labour that one marvels to see them demanding conditions that could only be granted them if wealth were other than the product of labour. But the mere manual labourer, working by the strength of his muscles, or with the experienced collaboration of hand and eye, would never produce a fraction of the wealth he is able to produce in conjunction with the brain worker, and the brain worker is entitled to some of the wealth he helps to produce. The present demands of the manual worker amount to a claim by him that he is competent to perform both the manual and the brain work, for if the performance of a machine is to be restrained at the desire of the labourer, why not the whole system of book-keeping, supply, purchase, sales, and finance. If we go to the full end of this line of argument we should find ourselves compelled to place the general-managership of all England in the hands of the coal hewers, who alone are at the root of all power. The A.S.E. are very keen to grasp the duties of those above them, but they are jealous to a fault when those below them, or even on a par with them, interfere with their privileges or encroach upon fields they consider to be their own. Labour can only be turned to wealth by the touch of management, and to interfere with management will be fatal to success. Management may not always be successful. When otherwise it brings its own punishment very quickly. To force trades union ideas of restriction upon management would ruin everything. If it be good to work any machine below its capacity, then must it be good to work it not at all, or at least to build cheaper machines good enough only for the reduced capacity. Backwardation of this stamp would quickly bring us back to the time of no machinery. Trades unionists would not acknowledge that this is what they are aiming at, but if they do not it is because they have not sufficient perspicacity to see to the end of the lane they are following. Neither do they seem to perceive that in stopping production they are reducing the power of the nation to pay them wages. England without work would be a sorry place to live in until the production of its own soil was equal to the demands of its population. It is fortunate that the number of men now idle bears so small a ratio to those at work, and we might remind trades unionists that the other business of the country, when it wants the production of engineers, will not come to a stop because such productions are not to be had of English make. They will simply purchase them from abroad.

In view of what he considers the failure of Unionism, Mr. Tom Mann now proposes that Unionism should be national, and provide its members with simply idle pay, strike pay and funeral expenses, but the old, infirm, or sick will have no claim. Practically, Mr. Mann's proposals amount to the recruiting of a mere fighting army which will bury its dead We do not think that he will find many decent workmen to join his new army. That there is something wrong with Unionism we admit with Mr. Mann himself, but we cannot but smile when Mann says so. It is calm in the very eye of a cyclone, the apparent *fons et origo malis.* Looked on as a cyclonic movement, trades unionism is equally calm in its centre of disturbance, but Mr. Mann is not on strike pay. He can be calm, but he is now feeling anxious for the men to get back to work, for if they are idle much longer, where are the funds to come from wherewith poor Tom struggles so bravely along?

On Friday last the Fairfield Company of Govan posted lock-out notices, which will affect about a thousand members of the A.S.E. The Fairfield Company seems only to have come into line because they are persuaded of the necessity of doing so, for they have stood out of the Federation a long time.

It is reported from Yarrow's Yard that cylinders are now being bored out in three days less time than before the strike. The secretary of the Free Labour Association states that the Association has provided 22,000 men during the strike, of whom no fewer than 8,500 are at work in London alone. We are sorry to learn that the Free Labour Association refuse to entertain men who have been members of the A.S.E. who wish to leave the A.S.E. and get back to work. There must be many who wish to do this, and it is pitiable to think of the straits to which these men and their families are reduced by the long idleness.

The engineering employers of Leeds are responsible for the following statements as to the conditions prevailing in Belgium, where the hours of labour range from 60 to 66 per week.

In Liege, the wages for 60 hours per week for fitters are 18s. 4d. to 22s. 6d.; turners, 18s. 4d. to 28s. 9d.; machinemen, 13s. 9d. to 18s. 4d. At Antwerp, the wages are:—Fitters, 21s. 3d. to 26s. 3d.; turners, 21s. 3d. to 26s. 3d.; machinemen, 18s. 4d. to 18s. 9d. *Overtime counts after 12 hours.* The Clyde wages for 54 hours are for fitters, turners, and machinemen, from 25s. to 35s.

English workmen should endeavour to bring up the European Continent to English levels. Comparing foreign with English wages, it is not possible to urge that the foreigner puts up with less money because his living expenses are less, for it costs more to live there than in England, the purchasing power of money being much more in England than it is abroad.

It is undesirable that English wages should be reduced. Reduced wages only mean a smaller volume of home trade. The endeavour should be to increase the output of the country. It is only by output that England can live, but one has only to refer to the case of Thomas Parker, Limited, reported on page 933 of our last issue, to see how output is deliberately curtailed by unprincipled unionists.

The Trades Union Congress of Saturday last does not help to clear the atmosphere. Confusion of issues is more confounded than ever. Mr. Barnes, who has agreed to certain things at the Conference, and offered to send the men back to work if the 51 hours' week was accepted by the employers, loudly states that the men will fight on until 48 hours is won. But men outside the A S.E., who spoke at the Congress of Saturday, stigmatise the terms of the employers as ridiculous, and as an attempt to destroy trades unionism altogether. Yet Messrs. Sellicks and Barnes agreed to these very terms. Indeed, here is an abstract of their circular to the men:—

"These proposals differ somewhat from those submitted before, and they secure the status of the unions on some of the points covered. . . . . The right of the unions to collective bargaining on behalf of their members is maintained. . . . . On the whole the proposals, as set out, do, to some extent, risk your interests, but your delegates ventured to offer on your behalf a return to work on the basis of a 51 hours' week, which, however, the employers declined."

Clearly if the employers had only acceded to a 51 hours' week, the risk hinted at would have been taken. Clearly a matter of three hours a week cannot make all the difference between smashing and preserving the principles of unionism. On the other hand, it may be argued that the employers, on their side, are not merely concerned with the demand for eight hours. If it had not been for the trades unions themselves, and their restrictions on output, we should have had the eight hours long ago. The employers undoubtedly are fighting for the right to run their machinery under its best and most economical conditions. They object to the eight hours because they want to be first very sure they have got the upper hand in the output question before they risk curtailment of hours. Neither the men nor the masters are really so interested in the hours question as they themselves believe. As regards the men, such of these in London as are in eight-hour shops still come up from their suburban homes by the same trains as formerly. If offered to start work at 8 a.m. only, and with one break per day, they will grumble because they must still come early to save the workman's trains. The employers do not really care so much about the eight hours, and are really fighting for infinitely more than the few hours. From 9 to 8 hours is only about 12½ per cent; but between the A.S.E. loafing rates and cuts and decent work there is anything from 25 to 400 per cent. Of what concern is a paltry six hours in comparison with this? Mr. Barnes at the congress made the usual charges against the employers as the cause of all the suffering, and as disturbers of the peace. Knowing that the lockout would follow on the strike for eight hours, one can only, in a sense, admire the brass of the man who can so deliberately travesty facts. There was a good deal of discord at the congress, and it is curious to note that the money to be collected by the suggested weekly levy on all unionists is to be distributed by the Parliamentary Committee, not by the A.S.E. It seems clear that the A.S.E. is out of favour, the general body of trades unionists resenting the autocratic behaviour of that section. The above 3d. levy was estimated to produce £12,000 a week, which is more than Mr. Barnes asked for. But there seems a doubt as to its forthcoming. He referred to the men having been existing for six months on 7s. to 16s. a week. "God only knew how they did it." Mr. Barnes, if he has the strength of mind to cut down his own diet below the scale of the Westminster Palace Hotel, might try it on for himself for a month. He would learn, then, how they did it, and in the future he would, perhaps, be a little more careful how he led his fellow men into such positions.

Mr. Barnes talks too much by far. His policy is not trusted by other unionists, and is, there seems but little doubt, responsible for the sad condition of the engineers to-day. His speeches teem and also for the purpose of extending the area within which the current can be supplied, have resolved upon the Stuart Street site. It is intended to convey the current from this generating station to convenient sub-stations situated in various parts of the city. A deputation will interview the several local authorities through which the existing tramcar service runs in reference to the Manchester Corporation supplying electric traction beyond the limits of the city. The Town Clerk is to report as to the steps to be taken for acquiring the lines belonging to the Manchester Carriage and Tramways Company within the city.

Motor Vans.—The borough engineer of Wolverhampton, Mr. Bradley, has issued the particulars of the motor vans required by the Wolverhampton Corporation.

Nottingham.—It is understood that a sub-committee of the Tramway Committee is considering what is the best system of traction to be adopted for the tramways instead of horses.

Proposed Electric Railway.—A Bill "for incorporating the City and Brixton Railway Company, and for empowering them to construct an underground railway from the City and South London Railway to Brixton Hill," has been deposited for next Session. The proposed railway, which will be nearly 3⅜ miles in length, will commence by a junction with the City and South London line under the High Street, Borough, and will terminate under Brixton Hill. In connection with the railway it is proposed to widen the City and South London line near London Bridge Railway Station, and also to construct a railway connecting with the Kennington Oval Station of that line. The capital required by the proposed company is £1,200,000, with power to raise a further sum of £400,000 by the creation of debenture stock. The Bill also seeks power to enable the company to acquire by purchase or lease so much of the existing City and South London Railway as lies between their proposed point of junction in the Borough and King William Street in the City.

Proposed Electric Railway from Charing Cross to Paddington.—A Bill to incorporate a company for the purpose of constructing an underground electric railway from Charing Cross to Paddington has been deposited at the Private Bill Office. The proposed railway will commence, says the *Times*, to the north of the Avenue Theatre, at the southern end of Northumberland Avenue, and will terminate on the south side of James Street, near Paddington Station. In connection with this railway it is proposed to construct a subway to the Great Western Railway Company's Paddington Station and another subway to Albert Terrace, Knightsbridge. The capital required for this scheme is £1,500,000, which is to be divided into 150,000 shares of £10 each, with the power to divide them subsequently into "preferred half-shares" and "deferred half-shares." Upon this capital it is proposed to raise a further sum of £500,000 by the creation of debenture stock. The time stated for the completion of the line is five years, during which period it is proposed to pay interest out of capital to an amount not exceeding £70,000. The Bill proposes to authorise the company to enter into agreements with the Great Western and South Eastern Railways. The promoters of the scheme are Sir George Russell, Mr. Henry Cosmo Orme Bonsor, and the Hon. Alfred E. Gathorne-Hardy, who, with "four other duly qualified persons to be nominated by them," are to be the first directors of the company.

St. Helens.—Dr. Hopkinson has submitted his report to the Gas and Lighting Committee with respect to the introduction of electrical traction upon the tramways. He advises that no further extension of the electricity works be made pending the completion of the works for supplying the energy for traction, the committee in the meantime putting up with the risks of any inconvenience that might arise. The committee has resolved that the question of the extension of the present plant be postponed, and that only such additions to the undertaking as may be absolutely necessary be made for the present. It was further resolved that the present machinery for the electric supply of the Town Hall be left in such a condition, that if the necessity should arise, the Town Hall and the Gamble Institute may be connected therewith.

TELEGRAPH AND TELEPHONE NOTES.

Delays in Australian Telegrams.—During the progress of the cricket match played at Melbourne this week, we find among the items of cricket news in the evening papers the following paragraph:—"There has been considerable delay in the transmission of our special cables to-day, and Dalziel's agency is informed by the Eastern Telegraph Company that this is due to irregularity in the working of the land-lines in Australia." As we have previously pointed out, the relation between cricket and telegraphy is not at once apparent; but thanks to the keen general interest felt in the former, the public is enabled to get some insight into the deficiencies of the latter. A business man must needs tolerate in disgust and silence, an inconvenience which those interested in sport would not think of suffering for a moment. In spite of the airy protestations of the Postmaster-General of South Australia, who assures the London Chamber of Commerce in reply to a protest made by them—that the Australian land-lines are rarely interrupted—we find on looking into the matter that during the past year, at the very lowest computation, there have been seven occasions on which the failure of these lines have been sufficiently marked to call for notice in the Australian press. Although in January last the interruption on the South Australian land-line lasted about four days; and although the interruption to the same line last month continued for about four or five days, still we are supposed to derive complete consolation and conviction from an official assurance that such things rarely or never occur, and are not to be anticipated in the future; so thus in dealing with any proposal to furnish a trustworthy means of telegraphic communication with Australia, we are to consider that cause of complaint as regards the existing lines is, officially, a myth! We use the word officially, of set purpose, as in spite of the fact that the various Australian provinces have, officially, bound themselves (with, perhaps, the exception of Queensland), to report any such interruptions to the International Telegraph Bureau at Berne, yet they fail to keep their bargain; and even when specifically challenged by the London Chamber of Commerce, one of the more prominent of these Postmasters satisfies himself by writing an explanation, which cannot possibly satisfy anybody else who knows the truth of the case.

Huddersfield Telephones.—The Huddersfield Chamber of Commerce had a discussion on 31st ult. *re* municipalisation of telephones.

Middlesbrough Telephones.—The Streets Committee has considered the unsatisfactory state of the telephone service in the town, and has resolved to ask the Mutual Telephone Company, of Manchester, who are desirous of extending their services to Middlesbrough, their terms for connecting all the municipal offices in the town.

Pacific Cable.—Sir Sandford Fleming, in a communication made to the Press, urges the Government of Canada once more to take up the project for a Pacific cable. He argues that the proposal of the Eastern Extension Company, which resulted in the suspension of the Pacific cable project at the last conference, would not adequately fulfil the purpose, what is required being an auxiliary system free from liability to interruption. He declares that the Pacific cable scheme was pronounced impracticable, expensive, and in the interests of the Eastern Extension Company only. The Australasian Colonies being politically disunited, Sir Sandford Fleming holds that it behoves Canada to make definite proposals, for which the mother country is waiting: "If we are to be brought within speaking distance of kindred communities in the Southern Seas," he concludes, "the first impulse must come from ourselves."

Telegraph Delays.—A deputation from the Liverpool Chamber of Commerce waited upon the Postmaster-General on 29th ult. for the purpose of complaining of the delays in the transmission of telegrams between Liverpool and the Continent. Mr. P. E. Hemelryk asked the Postmaster-General to urge the French and German Governments to expedite matters on their side. The Duke of Norfolk promised to give the various points raised his most careful consideration, and undertook that a new duplex wire should be made available between Liverpool and Hamburg. He also held out a hope that telephonic communication would, if it were found practicable, be established between Liverpool and Havre.

Telegraph Rates for the West Indies.—The West India and Panama Telegraph Company and associated companies have determined to apply from 1st inst. a large reduction in rates between Europe and Jamaica. The reduction amounts to 2s. 10d. per word between Europe and Jamaica, or from 5s. 10d. to 3s. per word. The same reduction will be extended to the West India and Panama Company's stations east of Jamaica, and will also include Demerara. The tariff with the French Islands of Guadeloupe and Martinique will, however, it is understood, for the present remain without alteration.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1893 ...	...
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Grenada-Trinidad ...	Dec. 29th, 1897 ...	Jan. 4th, 1898
Cape Haytien-Puerto Plata	Dec. 31st, 1897 ...	...
Puerto-Plato Martinique	Dec. 31st, 1897 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Otranto-Vallona	Oct. 11th, 1897 ...	Dec. 31st, 1897
San-Thomé-Loanda	Dec. 13th, 1897 ...	...
Saigon-Thuanan	Dec. 20th, 1897 ...	Dec. 31st, 1897
Ceara-Maranham	Dec. 23rd, 1897 ...	...
Teneriffe-St. Louis (Senegal)	Dec. 24th, 1897 ...	...
Para-Maranham	Jan. 3rd, 1898 ...	...
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Carthagena - Barranquilla (Columbia)	July 4th, 1896 ...	...
Communication with Yucatan	Dec. 25th, 1897 ...	Dec. 30th, 1897
Dominica landlines	Dec. 31st, 1897 ...	Jan. 3rd, 1898
Fao landlines...	Jan. 3rd, 1898 ...	...

Telegraphists' Grievances.—The executive committee of the London branch of the Postal Telegraph Clerks' Association have prepared a list of the grievances of which they complain, and will publish them in the form of a manifesto.

The American Pacific Cable Company.—The Pacific Cable Company, of New York, met some weeks ago and elected the following directorate:—J. Pierpont Morgan, Edmund L. Bayliss, J. Kennedy Tod, Rear Admiral John Irwin, U.S. Navy, and James A.

Scrymser. Mr. Scrymser was elected president, and Mr. Edmund L. Bayliss vice-president and acting treasurer. The company announces that the surveys for the cable between the coast of California and the Hawaiian Islands are highly satisfactory, and that arrangements are being made for the establishment of that section within 18 months. It will require over 9,000 miles of cable to connect the United States with the Hawiian Islands, Japan, China, and Australasia. The proposed Pacific cable between America and Hawaii will be up before Congress this session. A Bill was introduced in the 54th Congress authorising the Pacific Cable Company, of New York, to lay this cable. After being reported favourably by the Committee on Commerce in the House, it was sent to the Postmaster-General for a report. This report has not as yet been given out, but, according to the New York *Electrical Engineer*, it is said will be presented to Congress soon after it assembles. Mr. Edmund L. Bayliss, vice-president of the company, states that the Government had completed a survey of the route as far as the Hawaiian Islands, and if the Bill passed at the coming session the cable would be in running order in 1898.

CONTRACTS OPEN AND CLOSED.

OPEN.

Bilbao.—February 28th. The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Consul at Bilbao, reporting that the provisional board appointed in connection with the electric tramway which it is proposed to lay from Zumarraga to Zumaya, in the province of Guipuzcoa, invite plans and tenders, to be received by February 28th, for the construction and equipment of the line. Further particulars of the conditions of the tenders for the above-named tram line and branch, which together measure 30 miles, may be inspected at the Commercial Department of the Foreign Office any day between the hours of 11 and 6.

Bedford.—January 10th, 1898. The Electric Light Committee want tenders for the supply and erection of a 420 B.H.P. double-acting compound enclosed engine, and a 250-unit alternator with stationary armature. See our "Official Notices" December 10th for particulars.

Bootle.—January 10th, 1898. The Corporation wants tenders for the supply and erection of boilers, engines, dynamos, switchboard, pumps, transformers, wiring, alteration of Town Hall wiring, batteries, mains, street boxes, and the running of the electricity works for three years. Consulting engineer, Mr. T. L. Miller, 7, Tower Buildings, Water Street, Liverpool. See our "Official Notices" December 10th for further particulars.

Bradford.—January 13th. The Corporation are asking for tenders for two steam engines for their electricity works at Valley Road. Further details will be obtained from our "Official Notices."

Bedford.—January 24th. The Corporation want tenders for the supply and delivery of vulcanised rubber cables. See our "Official Notices" this week.

Blackburn.—January 22nd. The Corporation want tenders for a 500-kw. continuous current steam dynamo, and a 120-kw. steam alternator. Consulting engineer, Mr. E. M. Lacey. See our "Official Notices" this week.

France.—January 22nd. The Municipal Authorities of Neuilly-sur-Seine are inviting tenders for the concession for the establishment and working of a central electric station in the town. Particulars from, and tenders to, La Mairie de Neuilly-sur Seine.

Gloucester.—January 18th. The Electricity Committee want tenders for boilers, dynamos, overhead crane, switchboard, accumulators, mains, arc lamps, meters, &c., for electric lighting. Consulting engineer, Mr. Robert Hammond. See our "Official Notices" December 10th.

Guernsey.—Tenders are wanted for the States of Guernsey for the supply of several hundred creosoted telegraph poles, ranging from 22 to 60 feet. Particulars from Mr. A. R. Bennett, 44, Manor Park Road, Harlesden, London.

Guipuzcoa.—February 28th. The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Consul at Bilbao, reporting that the provisional board appointed in connection with the electric tramway, which it is proposed to lay from Zumarraga to Zumaya, in the province of Guipuzcoa, invite plans and tender, to be received by February 28th, for the construction and equipment of the line. Further particulars of the conditions of the tenders for the above-named tramline and branch, which together measure 30 miles, may be inspected at the Commercial Department of the Foreign Office between 11 and 6.

Leicester.—January 31st. The Leicester Corporation invites designs and tender for motor vehicles for the collection of house refuse. Specifications and particulars, with drawings, to be sent to the Chairman of the Sanitary Committee, to the office of Mr. E. Geo. Mawbey, C.E., borough engineer, Town Hall, Leicester.

Newport.—January 24th. The Electricity Committee want tenders for the supply and erection of mains, transformers, switch gear, cast-iron posts and for arc lamps. Consulting engineer, Mr. Robert Hammond. See our "Official Notices."

Roumania.—March 15th. Tenders are being invited by the General Direction of the Roumanian Post and Telegraphs in Bucharest for the supply of 56,000 metres of galvanised iron and steel wire.

Shoreditch.—January 11th. The Vestry want tenders for wiring materials for one year. Particulars can be seen at the Lighting Engineer's Office, Town Hall.

Spain.—January 9th. The municipal authorities of Torrente (Valencia province) are inviting tenders for the concession for the electric lighting of the town during a period of 17 years. Tenders to be sent to El Secretario del Ayuntamiento de Torrente (Valencia).

Tunis.—Tenders are at present being invited (no date being mentioned) by the Société Immobilière d'Hamman-lif, near Tunis, for the construction of an electric tramway, about 10 miles long, between Tunis, Maxula-Rades and Hamman-lif.

CLOSED.

Bo'ness.—The contract for the whole of the electrical equipment of the Bo'ness Docks has been given to the Brush Electrical Engineering Company.

FORTHCOMING EVENTS.

1898.

Saturday, January 8th, at 3 o'clock.—Royal Institution of Great Britain. Sixth (concluding) juvenile lecture on "The Principles of the Electric Telegraph," by Prof. Oliver Lodge. Subject:—"Space Telegraphy."

Monday, January 10th.—Northern Society of Electrical Engineers, Palatine Hotel, Manchester, at 8 o'clock. Presidential Address by Mr. Raworth.

Tuesday, January 11th, at 8 p.m.—The Institution of Civil Engineers. Paper to be read with a view to discussion:—"The Machinery used in the Manufacture of Cordite." By E. W. Anderson, Assoc.M.Inst.C.E. Monthly ballot.

Röntgen Society. General meeting at 11, Chandos Street, Cavendish Square, W. Paper at 8.30 p.m. by W. Webster, F.C.S., "Practical Work with the X-rays."

Wednesday, January 12th, at 7 p.m.—Society of Arts. Second juvenile lecture, by W. Ramsay, Ph.D., F.R.S., on "Fire."

Thursday, January 13th, at 8 p.m.—The Institution of Electrical Engineers. Presentation of premiums. Inaugural address of the President, Joseph W. Swan, Esq., F.R.S.

Friday, January 14th, at 8 p.m.—Institution of Civil Engineers. Students' meeting. Paper to be read:—"Mechanical Draught." By R. Gordon Mackay, Stud.Inst.C.E. Sir Albert J. Durston, K.C.B., M.Inst.C.E., will preside.

NOTES.

Cable Factory Changes Hands.—We learn that the well-known cable factory of the Fowler-Waring Cables Company at North Woolwich has been acquired by the Western Electric Company, of 79, Coleman Street, London, E.C., Chicago, and Antwerp.

Personal.—On the recommendation of the Minister of Trade and of Posts and Telegraphs of France, the President of the Republic has promoted M. Léonard Raymond to the grade of Commander of the Légion d'Honneur. The Presidential decree describes M. Raymond as Administrator of Postes and Telegraphs, with 44 years of administrative service, and as Officer of the Légion d'Honneur since April 14th, 1876. M. Raymond represented the French Government at the International Telegraph Conference of Buda-Pesth in 1896, as chief of the delegation of that country, and won the sympathies of those who had not enjoyed the pleasure of his acquaintance previous to that meeting, and we are sure his numerous friends will rejoice at the distinction conferred on him by his country's Chief of the State.

Electrical Illuminations.—On New Year's Eve many public and private buildings in New York were decorated with strings of electric lights in honour of the extension of the City boundaries. At the stroke of midnight search lights were turned on the flagstaff at the City Hall. An electric current sent a furled flag to the top of the mast and unfurled it.

Blockley.—By means of public subscriptions this village is to be lighted with 28 electric lights, and Mr. H. N. Warburton, electrical engineer, has been instructed to proceed with the work.

Chelmsford.—Last week, Mr. A. H. Pott, representing the Chelmsford Electric Lighting Company, attended the district council meeting with reference to the company's application for a provisional order to extend their system to several villages in the neighbourhood of Chelmsford. The Council afterwards almost unanimously expressed the wish that the wires should be laid underground.

Croydon.—The Electric Lighting Committee, after conferring with Prof. Kennedy, recently advised the County Council to authorise the further extension of the plant by the provision of an additional unit consisting of an engine, alternator, and boiler (the same size as that at present on order), at a cost of £5,000. This was proposed in view of the increasing demand for current, and the length of time required to obtain new machinery. The extension was stated to be absolutely necessary, especially in view of the contemplated extensions to Norwood and Thornton Heath.

Darlington.—The Town Council is asking the Board of Trade to amend its 1890 electric lighting provisional order, so as to include the whole borough with the exception of Oxen-le-Fields.

Doncaster.—An application was recently made by Messrs. Fisher & Allison, electrical engineers, asking that the Corporation will give their consent to their supplying electric light to certain persons in the neighbourhood of their shop to the extent of not more than 4 horse-power. A committee recommended that consent be given only until the Corporation are able to supply electricity in the borough and subject to an agreement.

Dublin.—The *Daily Nation* has been endeavouring to interview several members and officials of the Corporation for the purpose of getting to know something regarding the future of the electric lighting undertaking, but none of these gentlemen are to be drawn.

The Dublin and Manchester Steamship Company have asked the Port and Docks Board for permission to erect poles in connection with a proposed installation of electric light at the place on Sir John's Quay where their steamers are to be berthed.

Eccles.—The Electric Lighting Committee have decided, subject to the approval of the Council, to let tenders for the electric lighting of the borough amounting to £9,392. This sum is £2,000 less than the amount sanctioned by the Local Government Board.

Germany.—The Municipal Authorities of Elberfeld have decided on the construction of a second central station in the west end of the town at an estimated cost of £125,000.

Gloucester.—The City Council has resolved to ask Mr. Hammond to meet the Electricity Committee to go into the question of site and give some information *re* the scheme.

Hammersmith.—On Wednesday the Vestry had before it the report of the Electric Lighting Committee with regard to tenders received.

Ipswich.—The Ipswich Board of Guardians have decided by 13 votes to 12 to adopt a system of electric lighting for the Union Workhouse.

The *East Anglian Daily Times*, in a leaderette regarding the matter, concludes as follows:—"Having worked with both gas and electric light we can have no hesitation as to their relative merits, and it would be difficult to find those who have worked by the new light wishing to return to the old."

Kendal.—A sub-committee recommends the appointment of Messrs. Handcock & Dykes, of London, as electrical engineers to report on electric lighting.

Kingston.—In a review of the year the *Surrey Times* says that the electric lighting business of the Corporation has during the year literally progressed by leaps and bounds, no less than 2,375 lamps having been installed, bringing up the total to 9,200, and a substantial profit on the year's working will certainly accrue.

Kintore.—Some days ago the electric light was introduced into the business premises and dwelling house of Mr. W. Hutchson, baker. The dynamo is driven by a powerful oil engine used in his bakehouse.

Lancaster.—Applications have been received for a supply of electricity to several premises in Moor Lane. The engineer is to canvass the neighbourhood in order to ascertain if others are likely to require a supply.

Leeds.—At a special meeting of the City Council, announced for Wednesday (5th inst.), a report was presented by the Parliamentary Committee respecting the proposed purchase of the undertaking of the Yorkshire House-to-House Electric Light Company. If the report was adopted it was proposed to apply forthwith to the Local Government Board for a provisional order to empower the Corporation to issue irredeemable and redeemable stock for the purpose of purchasing the undertaking.

It is stated that a sub-committee is to arrange a friendly conference with the Yorkshire House-to-House Electricity Company, Limited, in the course of the next few days, *re* the proposed purchase.

Lewisham.—The Lewisham District Board of Works have refused to give their consent to the applications of the Great Western Electric Light Company and the County of London and Brush Provincial Electric Light Company for provisional orders to supply electricity in the district.

Liverpool.—A deputation from the Tramways Committee recently waited upon the Lighting Committee with reference to the lighting by electricity of the experimental line of electric tramway. Central poles are to be placed in Prince's Avenue.

London.—At the Commission of Sewers' meeting on Tuesday, the Solicitor (Mr. Baylis) reported the result of the case in which the Commission was sued by the City of London Electric Lighting Company for the non-payment of a sum of £1,442 on an account for lighting the City. It was stated that it was remarked by the Judge that the Corporation should not have stopped the amount, but paid it, and then sued the company for it. Mr. Turner moved that the Solicitor should be instructed to recover the amount. This having been seconded, Mr. C. J. Harris moved, as an amendment, that the question should be referred to the Streets Committee with power to take the necessary steps. Mr. Tranter seconded the amendment, which was carried.

Llanidloes.—The electric light has been installed at the Railway Foundry by the enterprising proprietor, Mr. John Mills.

Manchester.—There is a feeling among some of the members of the Corporation that a grave error was committed when appointing the new Electricity Committee last November in a number of old members of that committee not being re-elected by the Corporation. It is held that the attendance of some or all of these gentlemen on the Electricity Committee is very necessary just now in view of the large extensions of the works and plant which are under consideration. A proposal dealing with the matter was to come before the Corporation on Wednesday, a resolution being placed on the agenda by Councillor Lambert adding the names of the six members who were omitted in November to the Electricity Committee as it now stands.

The Electricity Committee recommends the Council to purchase land in Stuart Street, Bradford, for the establishment of a new generating station. This step is deemed necessary in order to carry out the electrical working of tramways within the city, and to extend the area of electric lighting.

Middlesboro'.—At the last meeting of the Streets Committee, says a local paper, it was decided on the recommendation of the Electric Lighting Committee "that wherever the Streets Committee were laying down new streets they would put a 2-inch pipe, at the cost of the Electric Lighting Committee, through which to thread the electric wires."

Newcastle-on-Tyne.—The plans of Messrs. Lummis-Peterson & Co., for the electric lighting of Heaton Road Wesleyan Church has been accepted. Tenders were sent in by nine firms.

Peterborough.—An important point respecting the electric lighting question came up at the meeting of the Town Council on Tuesday last week. The Electric Extension Company, Limited, having made proposals for the transfer of the provisional order by the Corporation to such company, the Town Clerk was instructed to reply that whilst the reply of the Local Government Board was pending, the Council could not consider such proposal. At a subsequent meeting it was resolved that a letter be sent to the Board of Trade giving notice of opposition to the application for powers by the Peterborough Electric Light Company. The Town Clerk was instructed to again communicate with the Local Government Board urging that an inquiry into the matter of the application of the Council with respect to electric lighting might be held at an early date. With reference to previous correspondence on the subject of the system proposed to be adopted for the supply of energy under the Electric Lighting Order, 1894, the Secretary to the Board of Trade transmitted, for any observations the Corporation might wish to offer, a copy of a memorandum in the matter by Major Cardew, R.E., the electrical adviser to this department. The memorandum stated that with the proposed electrical pressure between the outer conductors it would be necessary that the intermediate conductor be maintained throughout at very nearly the potential of the earth. The simplest means of arranging for this was to connect this conductor with earth at the generating station, but at no other point; and the Board of Trade had in several cases provisionally approved of such connection under certain conditions. As the negative conductor of the proposed-bare copper mains would necessarily be maintained at a potential of 220 volts negative to earth, there would be a strong tendency to the occurrence of leakage at the insulators, involving possible dangers from electrolytic action, and should this system of mains be used, it would be necessary to provide for rigid inspection of all the insulators. The engineer, having had a consultation with Dr. Fleming, recommended that the following observations be forwarded: (1) If the electrical pressure of 440 volts between the outer conductors is adopted, the middle wire will be connected to earth at the generating station, but at no other point, and the undertakers will comply with any provisions or conditions the Board of Trade may desire. But in making application for permission to use 440 volts between the outer conductors, the undertakers wish to retain the power to use the lower pressure of 220 volts if it should be thought desirable; (2) the system of distribution proposed to be used is continuously-insulated mains, and the bare copper was only mentioned in case it might be considered desirable to use it at any special point. If any bare copper is used, such insulators and means of inspection will be provided as meet with the approval of the Board of Trade. The Town Clerk was instructed to forward these observations to the Board of Trade.—The Town Clerk read the following letter: "Local Government Board, Whitehall, S.W., December 23rd. Sir,—I am directed by the Local Government Board to advert to your letter of the 11th inst. relating to the application by the Town Council of Peterborough for sanction to borrow £15,000 for works of electric lighting, and I am to state that according to the latest information in the possession of the Board the Council's margin of borrowing powers is not sufficient to enable them to borrow the sum of £15,000 in addition to the sum of £4,500 for which they desire sanction to borrow for hospital purposes —I am, yours faithfully, A. D. Adrian, Assistant Secretary."—The matter came before a special Council meeting on Wednesday.

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A Norwood paper says that the tramways system has been taken over by the British Electric Traction Company, who will introduce electrically-driven cars, and Mr. H. A. Durke's services are retained for the management of the new company.

Derby.—The proposed purchase of the tramways by the Council has been making progress in the hands of a committee, and the company has intimated that it is prepared to negotiate for the sale of the undertaking. With a view to making an offer to the company, the committee propose that an engineer be employed to advise them on the matter. The question of electricity is being taken into account.

Dublin.—The extension of the United Tramway system which will connect Rathmines by direct route with the electric tram near Ballsbridge is being pushed forward energetically. Already a large portion of the line is laid down. The length of the new tram line will be close on 2½ miles. The effect of the new line will be to connect the extremities of the southern townships from the eastern side of Rathmines Township at Haroldscross to the Pembroke Township at Ballsbridge, and thence near Haddington Road with Sandymount. The entire work is being carried out by the United Tramway Company's own men, who have laid the rails.

Light Railways.—The proposal of the British Electric Traction Company to construct light railways in the Fenton District is not to be opposed by the Fenton Council.

The proposals to construct light railways between Highgate and Finchley, and Finchley and Hendon, were before the Finchley District Council last week. Mr. Vesey Knox, M.P., barrister, appeared on behalf of the electric scheme, and submitted that the system proposed—overhead electric trolley—was the only one possible for such a rural district, and if there was a fatal objection to the system, that would be fatal to the scheme. They proposed to light the road along the line of route at a price to be agreed upon with the Council; a quick service to Hampstead, and, consequently, a service to the West-end of London and an additional local service to the Great Northern Railway. Owing to the provisions of the Tramways Acts, they proposed a street traction far superior to any existing in this country at present; fares of 1d. per mile (but anticipated four miles for 3d.); the average speed (time table), eight miles throughout, was proposed; repair of 18 inches on each side of the lines, which meant where double lines existed 16 feet; the posts would be of an ornamental character, on one side of the road only; purchase by the local authority at the end of 35 years. The only object they had in going under the Light Railways Act was to save the expense of a Parliamentary Bill. They intended putting on a special service for the working classes. They had power to carry goods, but the passenger traffic was looked to; they did not intend to combine goods and passenger cars.

Lucan Tramways.—The Lucan Steam Tram Company are, says *Freeman's Journal*, at present in communication with the Board of Trade with reference to the inspection of the line from the Conyngham Road to Leixlip. It is expected that the inspection will shortly be made, and that the line will soon afterwards be open for traffic. The line has been completely relaid, new rails put down, and the gauge has been widened from the former one of 3 feet to 3 feet 6 inches. The cost of re-sinking the line is nearly £16,000. The remaking was undertaken with a special view to the line being worked by electricity, and provision has been made for the ultimate carrying out of that intention. The introduction of electricity for traction purposes will involve an additional outlay of about £15,000. Until that work may be undertaken, the line will be worked by steam. It is estimated that the conversion of the line, as it is now constructed, into an electrically equipped line, will be carried out in four months, and that change will involve a stoppage of the traffic for that length of time. The board of directors are in negotiation with a London firm of contractors for this work, and if there is a prospect of the work being completed by the summer, it will be commenced as soon as the contract is signed. Otherwise the summer traffic will be carried on by the steam haulage, and the electrical equipment will be postponed until the close of the summer season. The trams with the steam haulage will run every hour, and with electric traction they will be run every half hour. The system of electric traction to be adopted is the trolley overhead wire. The power house will be erected about midway on the line, near St. Lawrence's Road. The dynamos will be driven entirely by steam, as the board has been advised that the water power would not be sufficient. When the contract is completed, the building of the power house will be first commenced.

Manchester.—The Special Committee of Tramways appointed by the Corporation recently resolved: "That the electrical equipment and the supply of the electric current necessary for the working of the tramways of the Corporation within the city be placed in the hands of the Electricity Committee, and that they be requested to take the necessary steps for the carrying out of the work; the terms of payment for the current to be supplied to be hereafter arranged." The Electricity Committee, with a view to carrying out this resolution,

The Northern Society of Electrical Engineers.—Notice is given that a special general meeting of the members of this society will be held at the Palatine Hotel, Manchester, on Monday, January 10th, 1898, at 7.30 p.m., when the following Amendments to Rules XXII. and XXXVI., agreed to at the special general meeting of the members held on the 22nd inst., will be submitted for adoption on the proposal of the Council:—

That Rule XXII. be altered to read as follows:—

The Council shall, previous to the annual general meeting in each year, prepare a list of members whom they propose as suitable for the offices of President, Hon. Treasurer, and Hon. Secretary for the ensuing year, and also a list of members who shall have been nominated for the four vacancies on the Council. Such nominations shall be effected by any retiring member of Council, or other qualified person, being proposed and seconded in writing by two members and supported by four other members. These nominations, together with the written consent of such nominees to accept office if elected, shall be forwarded to the secretary 21 days previous to the annual general meeting. If, after this date, there shall be no more nominations than vacancies the person so nominated become elected, but if there shall be more nominations than vacancies each member shall be at liberty to make a selection from such list, provided the number of names so selected shall not exceed in any case the number requisite to fill the vacancies. Ballot papers shall be so marked and recorded as may be from time to time determined by the Council.

That Rule XXXVI. be altered by the inclusion of the words shown in italics:—

Every Member or Associate shall have the privilege of introducing two visitors to the ordinary general meetings of the society, but no visitor *who is eligible as a Member or Associate* shall be permitted to attend more than twice in any one session except by permission of the Council.

Obituary.—We regret to announce the death, at Cadiz, on the morning of January 4th, of Mr. W. F. O'Brien. For some years past Mr. O'Brien had not enjoyed the best of health, but he had made, during his short stay at Cadiz, such marked improvement, that the news of the relapse which proved fatal, was received in London as an unexpected shock. A large number of our readers have met Mr. O'Brien either in business connected with telegraphic matters, or socially, and in his capacities, both as a telegraph man and as a friend, his loss will be deeply deplored by the large circle which appreciated his many sterling qualities. His knowledge of telegraph affairs, his grasp of every detail connected with his business, and his devotedness to the work, rendered him invaluable in the position he occupied; while his straightforward character and his constant readiness to attend to the interests of others secured for him many and sincere friendships. Mr. O'Brien, after serving in the Postal Telegraphs for some years, entered the employment of the Japanese Government at the moment when the development of the telegraph was first seriously commenced in Japan. On the termination of his agreement with the Japanese Government he joined, in 1875, the West Coast of America Telegraph Company. On the expiration of his term of service he returned to England, and was attached to the staff of the Silvertown Company, and lent valuable services on many cable expeditions. In 1884 he was appointed traffic accountant to the West African Telegraph Company, and at the time of his death held that position in the South American Cable Company and the Spanish National Submarine Telegraph Company. He served the latter company for fourteen years, and during the last year also acted as secretary. Mr. O'Brien attended, on behalf of the companies he served, the International Telegraph Conventions of Paris and Buda-Pesth. We beg to be permitted to offer his family our most sincere sympathies for the great loss they have sustained.

The Chatsworth Festivities.—Messrs. Drake & Gorham received instructions to carry out a number of illuminations in connection with the visit this week of the Prince and Princess of Wales to Chatsworth. The whole of the building was lit up by a special system of reflected light that was much admired. Jandus arc lamps were employed. A search light was fixed on a platform above the roof, and threw a beam on to each of two fountains. These fountains were each illuminated by means of four projectors worked from water-tight boxes placed in the centre of the fountain itself. An illuminating device, known as the electroflame, patented by the firm in connection with the Jubilee illuminations, was shown to great advantage in the centre of the building.

The Engineers' Strike.—Mr. Alexander Siemens, speaking at the dinner of the Article Club on Wednesday night, said the most important question for the commerce of England was at present the great struggle in the engineering trade. The struggle had been going on for six months, but the masters, whose interests were not much in common, had held together, and he could assure them that they would hold together still. There was not the slightest intention whatever on the part of the masters of going back from the terms they agreed upon at Westminster with regard to the management of works in the future, and they would not yield to the demand for diminished working hours. The masters had been defending the right of liberty. The trades unions would not allow their men to work as they could, and if any man was working particularly well, earning extra wages, and doing more than other men, he was hauled before the District Committee, and told he must restrict his production, or he would be fined, or expelled from the union. The masters wanted to do away with that kind of thing. At the same time they had made it compulsory that collective bargaining should be resorted to. With regard to these rules of management, he would call their attention to a very curious point. At the last sitting of the Conference the delegates of the men agreed to these rules, and said if they were given 54 hours' pay for 51 hours' work, they would accept the rules of management, and tell their men to go back to work on the following Monday. When, however, they found the masters would not give in on the question of hours, the delegates turned round and said the rules of management struck at the root of trades unionism, and they must refer the matter to the vote of the men. If the rules of management were right one moment, why were they wrong simply because the employers would not give way on the question of hours? Mr. Knight, the Secretary of the Boilermakers' Society, had also pointed out that his society had been working under these rules for years, and was flourishing under them, and they did not find them hostile to trades unionism. These rules, too, were not a new invention. They were only such as had been in use at some of the works of the Federated Employers where trade unionists were employed before the commencement of the dispute. Why, therefore, did the delegates say all of a sudden that they struck at the root of trades unionism? He would take that opportunity of saying that the Federated Employers had been resisting the demands of the trades unions quite as much in the interest of the individual workmen as in their own interest. The masters were absolutely united, as much now as they were on the first day during these six months, and, far from anybody having broken away from the Federation, other firms had joined and posted notices. That showed that they had a good cause, and they meant to fight for it to the end.

Congratulations.—In the list of New Year honours appears the name of Mr. Spencer Walpole, the secretary to the Post Office, who is made a K.C.B., also of Mr. James Dredge, whom the Queen, on the recommendation of the Secretary of State for Foreign Affairs, has appointed a C.M.G. in the Order of St. Michael and St. George. This honour is bestowed in recognition of services rendered in connection with the Brussels Exhibition. We have pleasure in congratulating Mr. Dredge.

Erratum.—In the article in last week's issue on "Localisation of Breaks and Partial Earth Faults in Submarine Cables," on p. 919 (December 31st, 1897) Formula B should read as follows:—$x = B_1 - (B_2 - B_1)$ ohms, *instead* of B_1 $(B_2 - B_1)$ ohms.

Fire.—During a cinematograph exhibition at Bolton last Saturday, a fire occurred in connection with the electrical apparatus. There was a panic among the audience, and the operator and others were slightly burned.

London Fogs and Artificial Light.—London fog absorbs 11·1 per cent. of the luminous rays from an ordinary gas flame, while 20·8 per cent. of the light from an incandescent mantle are lost in it. This is of course due to the fact that the first-mentioned light contains far more red rays than the other, and that fog permits the passage of red rays to the exclusion of the blue is evident from the deep red colour which the sun assumes when seen through mist.—Cosmos.

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Collision.—On 26th ult. an electric tram collided violently with a motor car at Haddington Road, Dublin. The ends of both cars were considerably damaged. The cause of the accident is believed to be the failure of the motor brake to act.

Croydon.—A correspondent of the *Bullionist*, referring to the proposed purchase of the Croydon Tramways Company's undertaking by the British Electric Traction Company, says that the terms of the sale are "manifestly unfair to the ordinary shareholders." The meeting, he says, was held with doors closed to the press, and he is taking steps to see whether it is too late to prevent the sale on the terms proposed.

A Norwood paper says that the tramways system has been taken over by the British Electric Traction Company, who will introduce electrically-driven cars, and Mr. H. A. Durke's services are retained for the management of the new company.

Derby.—The proposed purchase of the tramways by the Council has been making progress in the hands of a committee, and the company has intimated that it is prepared to negotiate for the sale of the undertaking. With a view to making an offer to the company, the committee propose that an engineer be employed to advise them on the matter. The question of electricity is being taken into account.

Dublin.—The extension of the United Tramway system which will connect Rathmines by direct route with the electric tram near Ballsbridge is being pushed forward energetically. Already a large portion of the line is laid down. The length of the new tram line will be close on 2½ miles. The effect of the new line will be to connect the extremities of the southern townships from the eastern side of Rathmines Township at Haroldscross to the Pembroke Township at Ballsbridge, and thence near Haddington Road with Sandymount. The entire work is being carried out by the United Tramway Company's own men, who have laid the rails.

Light Railways.—The proposal of the British Electric Traction Company to construct light railways in the Fenton District is not to be opposed by the Fenton Council.

The proposals to construct light railways between Highgate and Finchley, and Finchley and Hendon, were before the Finchley District Council last week. Mr. Vesey Knox, M.P., barrister, appeared on behalf of the electric scheme, and submitted that the system proposed—overhead electric trolley—was the only one possible for such a rural district, and if there was a fatal objection to the system, that would be fatal to the scheme. They proposed to light the road along the line of route at a price to be agreed upon with the Council; a quick service to Hampstead, and, consequently, a service to the West-end of London and an additional local service to the Great Northern Railway. Owing to the provisions of the Tramways Acts, they proposed a street traction far superior to any existing in this country at present; fares of 1d. per mile (but anticipated four miles for 3d.); the average speed (time table), eight miles throughout, was proposed; repair of 18 inches on each side of the lines, which meant where double lines existed 16 feet; the posts would be of an ornamental character, on one side of the road only; purchase by the local authority at the end of 35 years. The only object they had in going under the Light Railways Act was to save the expense of a Parliamentary Bill. They intended putting on a special service for the working classes. They had power to carry goods, but the passenger traffic was looked to; they did not intend to combine goods and passenger cars.

Lucan Tramways.—The Lucan Steam Tram Company are, says *Freeman's Journal*, at present in communication with the Board of Trade with reference to the inspection of the line from the Conyngham Road to Leixlip. It is expected that the inspection will shortly be made, and that the line will soon afterwards be open for traffic. The line has been completely relaid, new rails put down, and the gauge has been widened from the former one of 3 feet to 3 feet 6 inches. The cost of re-sinking the line is nearly £16,000. The remaking was undertaken with a special view to the line being worked by electricity, and provision has been made for the ultimate carrying out of that intention. The introduction of electricity for traction purposes will involve an additional outlay of about £15,000. Until that work may be undertaken, the line will be worked by steam. It is estimated that the conversion of the line, as it is now constructed, into an electrically equipped line, will be carried out in four months, and that change will involve a stoppage of the traffic for that length of time. The board of directors are in negotiation with a London firm of contractors for this work, and if there is a prospect of the work being completed by the summer, it will be commenced as soon as the contract is signed. Otherwise the summer traffic will be carried on by the steam haulage, and the electrical equipment will be postponed until the close of the summer season. The trams with the steam haulage will run every hour, and with electric traction they will be run every half hour. The system of electric traction to be adopted is the trolley overhead wire. The power house will be erected about midway on the line, near St. Lawrence's Road. The dynamos will be driven entirely by steam, as the board has been advised that the water power would not be sufficient. When the contract is completed, the building of the power house will be first commenced.

Manchester.—The Special Committee of Tramways appointed by the Corporation recently resolved: "That the electrical equipment and the supply of the electric current necessary for the working of the tramways of the Corporation within the city be placed in the hands of the Electricity Committee, and that they be requested to take the necessary steps for the carrying out of the work; the terms of payment for the current to be supplied to be hereafter arranged." The Electricity Committee, with a view to carrying out this resolution,

The Northern Society of Electrical Engineers.—Notice is given that a special general meeting of the members of this society will be held at the Palatine Hotel, Manchester, on Monday, January 10th, 1898, at 7.30 p.m., when the following Amendments to Rules XXII. and XXXVI., agreed to at the special general meeting of the members held on the 22nd inst., will be submitted for adoption on the proposal of the Council:—

That Rule XXII. be altered to read as follows:—

The Council shall, previous to the annual general meeting in each year, prepare a list of members whom they propose as suitable for the offices of President, Hon. Treasurer, and Hon. Secretary for the ensuing year, and also a list of members who shall have been nominated for the four vacancies on the Council. Such nominations shall be effected by any retiring member of Council, or other qualified person, being proposed and seconded in writing by two members and supported by four other members. These nominations, together with the written consent of such nominees to accept office if elected, shall be forwarded to the secretary 21 days previous to the annual general meeting. If, after this date, there shall be no more nominations than vacancies the person so nominated become elected, but if there shall be more nominations than vacancies each member shall be at liberty to make a selection from such list, provided the number of names so selected shall not exceed in any case the number requisite to fill the vacancies. Ballot papers shall be so marked and recorded as may be from time to time determined by the Council.

That Rule XXXVI. be altered by the inclusion of the words shown in italics:—

Every Member or Associate shall have the privilege of introducing two visitors to the ordinary general meetings of the society, but no visitor *who is eligible as a Member or Associate* shall be permitted to attend more than twice in any one session except by permission of the Council.

Obituary.—We regret to announce the death, at Cadiz, on the morning of January 4th, of Mr. W. F. O'Brien. For some years past Mr. O'Brien had not enjoyed the best of health, but he had made, during his short stay at Cadiz, such marked improvement, that the news of the relapse which proved fatal, was received in London as an unexpected shock. A large number of our readers have met Mr. O'Brien either in business connected with telegraphic matters, or socially, and in his capacities, both as a telegraph man and as a friend, his loss will be deeply deplored by the large circle which appreciated his many sterling qualities. His knowledge of telegraph affairs, his grasp of every detail connected with his business, and his devotedness to the work, rendered him invaluable in the position he occupied; while his straightforward character and his constant readiness to attend to the interests of others secured for him many and sincere friendships. Mr. O'Brien, after serving in the Postal Telegraphs for some years, entered the employment of the Japanese Government at the moment when the development of the telegraph was first seriously commenced in Japan. On the termination of his agreement with the Japanese Government he joined, in 1875, the West Coast of America Telegraph Company. On the expiration of his term of service he returned to England, and was attached to the staff of the Silvertown Company, and lent valuable services on many cable expeditions. In 1884 he was appointed traffic accountant to the West African Telegraph Company, and at the time of his death held that position in the South American Cable Company and the Spanish National Submarine Telegraph Company. He served the latter company for fourteen years, and during the last year also acted as secretary. Mr. O'Brien attended, on behalf of the companies he served, the International Telegraph Conventions of Paris and Buda-Pesth. We beg to be permitted to offer his family our most sincere sympathies for the great loss they have sustained.

The Chatsworth Festivities.—Messrs. Drake & Gorham received instructions to carry out a number of illuminations in connection with the visit this week of the Prince and Princess of Wales to Chatsworth. The whole of the building was lit up by a special system of reflected light that was much admired. Jandus arc lamps were employed. A search light was fixed on a platform above the roof, and threw a beam on to each of two fountains. These fountains were each illuminated by means of four projectors worked from water-tight boxes placed in the centre of the fountain itself. An illuminating device, known as the electroflame, patented by the firm in connection with the Jubilee illuminations, was shown to great advantage in the centre of the building.

The Engineers' Strike.—Mr. Alexander Siemens, speaking at the dinner of the Article Club on Wednesday night, said the most important question for the commerce of England was at present the great struggle in the engineering trade. The struggle had been going on for six months, but the masters, whose interests were not much in common, had held together, and he could assure them that they would hold together still. There was not the slightest intention whatever on the part of the masters of going back from the terms they agreed upon at Westminster with regard to the management of works in the future, and they would not yield to the demand for diminished working hours. The masters had been defending the right of liberty. The trades unions would not allow their men to work as they could, and if any man was working particularly well, earning extra wages, and doing more than other men, he was hauled before the District Committee, and told he must restrict his production, or he would be fined, or expelled from the union. The masters wanted to do away with that kind of thing. At the same time they had made it compulsory that collective bargaining should be resorted to. With regard to these rules of management, he would call their attention to a very curious point. At the last sitting of the Conference the delegates of the men agreed to these rules, and said if they were given 54 hours' pay for 51 hours' work, they would accept the rules of management, and tell their men to go back to work on the following Monday. When, however, they found the masters would not give in on the question of hours, the delegates turned round and said the rules of management struck at the root of trades unionism, and they must refer the matter to the vote of the men. If the rules of management were right one moment, why were they wrong simply because the employers would not give way on the question of hours? Mr. Knight, the Secretary of the Boilermakers' Society, had also pointed out that his society had been working under these rules for years, and was flourishing under them, and they did not find them hostile to trades unionism. These rules, too, were not a new invention. They were only such as had been in use at some of the works of the Federated Employers where trade unionists were employed before the commencement of the dispute. Why, therefore, did the delegates say all of a sudden that they struck at the root of trades unionism? He would take that opportunity of saying that the Federated Employers had been resisting the demands of the trades unions quite as much in the interest of the individual workman as in their own interest. The masters were absolutely united, as much now as they were on the first day during these six months, and, far from anybody having broken away from the Federation, other firms had joined and posted notices. That showed that they had a good cause, and they meant to fight for it to the end.

Congratulations.—In the list of New Year honours appears the name of Mr. Spencer Walpole, the secretary to the Post Office, who is made a K.C.B., also of Mr. James Dredge, whom the Queen, on the recommendation of the Secretary of State for Foreign Affairs, has appointed a C.M.G. in the Order of St. Michael and St. George. This honour is bestowed in recognition of services rendered in connection with the Brussels Exhibition. We have pleasure in congratulating Mr. Dredge.

Erratum.—In the article in last week's issue on "Localisation of Breaks and Partial Earth Faults in Submarine Cables," on p. 919 (December 31st, 1897) Formula B should read as follows:—$x = R_1 - (R_2 - R_1)$ ohms, *instead* of $R_1 (R_2 - R_1)$ ohms.

Fire.—During a cinematograph exhibition at Bolton last Saturday, a fire occurred in connection with the electrical apparatus. There was a panic among the audience, and the operator and others were slightly burned.

London Fogs and Artificial Light.—London fog absorbs 11·1 per cent. of the luminous rays from an ordinary gas flame, while 20·8 per cent. of the light from an incandescent mantle are lost in it. This is of course due to the fact that the first-mentioned light contains far more red rays than the other, and that fog permits the passage of red rays to the exclusion of the blue is evident from the deep red colour which the sun assumes when seen through mist.—COSMOS.

Electric Launch for the Czar of Russia.—At the time of the great Naval Parade in New York Harbour, in 1892, the Grand Duke Alexander, in command of the Russian warships, was so pleased with the electric launch of the U.S. cruiser *New York*, that he purchased it from the Navy Department for his own use. The performance of this boat, built by the Electric Launch Company, of New York, came under the notice of the Czar of Russia, and the result has been, says the New York *Electrical Engineer*, that the latter, a short time ago, ordered one for his own use, which is now under construction at the works of the Electric Launch Company, at Morris Dock, N.Y., under the personal supervision of Mr. J. C. Chamberlain, president of the company, in connection with Capt. D. T. Mertvago, naval attaché of the Russian Legation at Washington. The dimensions of the gig will be as follows:—Length over all, 37 feet; length on load water line, 35 feet; beam, extreme outside of planking, 7 feet 3¾ inches; draught of hull, 2 feet 8 inches; length of cockpit, or seating space, 14 feet 9 inches; greatest width of same, 6 feet 5 inches; displacement, without passengers, not to exceed 5·2 tons. The storage batteries, furnished by the Electric Storage Battery Company, will be of the most improved and modern type, all contained in hard rubber cells, with tight-fitting covers, and placed under the flooring and seats. The number and grouping will be such as to adapt them to be charged from a 110-volt circuit. The motor built to conform to the hull will be of special marine type with self-contained ball-bearing thrust fitted under the floor in its compartment, and directly connected with the propeller shaft. The controller for regulating the speed of the motor will be placed under the forward deck, and operated by a shaft extending through the steering wheel bearing. This controller will be capable of effecting five variable speed rates, from slow starting to spurting speed, and also adapted for reversing the motor with three variable speeds. The gig is to have a speed of eight miles an hour for three hours, or seven miles an hour for six hours, but the controller is arranged to admit of a spurting speed up to 11 miles per hour if desired. The gig is to be delivered and placed in commission by the builders' representative, who is also to instruct the crew in its care and operation.

Motor Cars.—A letter, evidently "writ sarcastic," appears in the *Engineer* from one "J. G. S.," who wants a motor carriage of some kind. He can find no advertisers of these vehicles, and asks are makers full of orders, and overflowing? We think not. There are, we believe, some genuine makers of motor carriages, but we fancy that many of the much-puffed companies which were started to make motor cars were left by their philanthropic promoters with insufficient capital to properly carry on the manufacture and the exploitation of the new industry. But all were not imaginary, and from time to time vehicles appear in the streets of London which seem to evidence the fact that there is a motor car industry.

NEW COMPANIES REGISTERED.

Wm. Coates & Son, Limited (2,172).—Registered in Dublin December 22nd, with capital £25,000 in £10 shares, to carry on a or any of the following businesses, either wholesale or retail, and either jointly or solely with others, electrical engineering in all its branches, plumbers, gas or steam fitters, &c. The subscribers (with one share each) are:—W. T. Coates, 1—11, Fountain Street, Belfast, merchant; W. C. Macann, 1—11, Fountain Street, Belfast, merchant; E. S. Dashwood, 1—11, Fountain Street, Belfast, electrical engineer; G. D. Coates, 5, Chilworth, Belfast, bank manager; R. Hamilton, 37, University Road, Belfast, secretary; T. G. Megaw, 1—11, Fountain Street, Belfast, cashier; T. J. Moore, 1—11, Fountain Street, Belfast, salesman. The number of directors is not to be less than three nor more than five. The first are W. T. Coates, W. C. Macann, and E. S. Dashwood; qualification, 200 shares; remuneration as fixed by the company. Registered by Crawford & Lockha, 8, Anglesea Street.

City of Mexico Electric Power Syndicate, Limited (55,438).—Registered December 30th, with capital £5,000 in £50 shares (40 preference), to acquire any rights and grants for producing electricity for lighting, motive, and other purposes in Mexico or elsewhere, and to carry on the business of electrical engineers and contractors. The subscribers (with one share each) are:—H. K. Baynes, 15, Chapel Street, Belgrave Square, S.W., solicitor; F. S. Courtney, C.E., 39, Alleyn Park, Dulwich; J. T. Toomer, C.E., Queen Anne's Mansions, Westminster; T. P. Wilson, C.E., Holmhurst, Belvedere, Kent; A. P. Friend, Ouseley House, Erith, Kent, engineer; R. J. Price, M.P., 104, Sloane Street, S.W.; C. F. Sillem, Broad Sanctuary Chambers, Westminster, engineer. The number of directors is not to be less than three, nor more than five. The first are J. Price, H. K. Baynes, and J. F. Toomer. Registered by Goldring & Hargrove, 99, Cannon Street, E.C.

CITY NOTES.

Kelvinside Electricity Company.

The annual meeting of this company was held at 28, Renfield Street, Glasgow, on the 29th inst., Mr. J. B. Fleming presiding.

The Chairman, in moving the adoption of the report, said they had not to report a very flourishing concern. They had no dividend to give, but it was perfectly obvious they had turned the corner, and were not far away from success. Several elements had led to that. Mr. Sharpe had induced a good many people to become users of the light, and he believed that his work would become more apparent in the future. The number of consumers was gradually and steadily increasing, but these were not coming in so rapidly as he could wish.

Mr. Reckett seconded the motion.

In answer to questions, the Chairman said they could supply three times the amount of light they were doing at present. The people of Partick were anxious to get the light, and, in addition to householders on the top of the hill, many shopkeepers were desirous of having it. If they had the light in Partick, he was convinced that the company would be a paying concern. He thought they were likely to get the provisional order for Partick, as he did not think the opposition of Glasgow would count for much. He further stated that the revenue this year had been £1,573 11s. 6d., an increase of £151 17s. 8d. over the previous year. The number of units used was 63,562, as compared with 63,467 last year. Although that was only an increase of 95, there was this fact that it included a larger number of private houses, for the cyanide works, which had used a considerable quantity of light in 1895, and rather less last year, would be off this year. The number of units of light sold to private houses was 52,586, against 35,545 in the previous year, showing an increase in that department of nearly 50 per cent

The report was adopted.

Messrs. J. B. Fleming and Reckett were re-elected directors.

Babcock & Wilcox, Limited.

At an extraordinary general meeting of this company, held on 29th ult., at the Cannon Street Hotel, Sir W. Arrol, M.P., presiding, the resolutions passed on the 14th inst., for increasing the capital of the company to £320,000 by creating 8,000 new ordinary shares of £10 each, to rank *pari passu* with the existing ordinary shares, and to rank for dividend as from the 1st inst., were confirmed as special resolutions, on the motion of the chairman, seconded by Mr. M. Rumley. The chairman, in answer to a question, stated that notices to the shareholders would go out in a day or two, and every preference and ordinary shareholder would be entitled to his fair proportion of the new shares.

London Electric Supply Corporation.—According to the *Daily Mail*, when the accounts of this company are made up for 1897 it is proposed to take the concern out of the receiver's hands, to reconstruct the company, and to reduce the capital by writing off £2 or £3 from the ordinary shares. This would place the corporation on a sound basis. The company is doing a big business, and rapid strides are being made. The dividend on the preferences was earned last year, while there was also a small amount left for the ordinary, so that in future preference holders may expect to receive their 6 per cent. in full.

The City of London Electric Lighting Company, Limited.—Warrants for interest due on 31st ult. on the £400,000 5 per cent. debenture stock have been duly posted.

Electric Construction Company.—The transfer books for the first mortgage debentures will be closed from 8th to 14th inst inclusive.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending January 2nd. 1898, were £1,050; week ending January 3rd, 1897, £1,077; decrease, £27; total receipts for half-year, 1898, £1,050; corresponding period, 1897, £1,077; decrease, £27.

The Liverpool Overhead Railway Company. The receipts for the week ending January 2nd, 1898, amounted to £1,357; corresponding week last year, £1,374; decrease, £17.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending December 31st, 1897, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,384.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation, Dec. 29th.	Closing Quotation, Jan. 5th.	Business done during week ended Jan. 5th, 1898. Highest.	Lowest.
137,400*l*	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	...	101 —105	100 - 104 xd	...	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	5½ — 6½	5½ — 6½	...	...
923,920*l*	Anglo-American Teleg., Ltd.	Stock	£2 2s.	£2 9s.	£2 13s.	60 — 62	61 — 63	60½	60¼
3,038,020*l*	Do. do. 6 % Pref.	Stock	£4 4s.	£4 18s.	£5 6s.	108½ - 109½	110 —111	111	108
3,038,020*l*	Do. do. Defd.	Stock	...	...	...	13½— 14	13½— 14	13 13/16	13 9/16
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	7 %	...	16 — 16½	16 — 16½	16½	16⅛
75,000*l*	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	...	114 —118	112 — 116 xd	...	...
44,000	Chili Teleph., Ltd., Nos. 1 to 44,000	5	2½%	4 %	4 %	3 — 3½	3 — 3½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	183 —188	182 —187 xd	...	...
653,586*l*	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	105 —107	104 —106 xd	107	105¼
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	1½%	2 %	1/16 — 3/16	1/16 — 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	8½ - 9½	8½ - 9½	9¼	9
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	18½ - 19½	18½ - 19½	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 11	10 — 11	10⅜	10⅛
30,000*l*	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	4½%	103 —106%	102 -105% xd	...	...
60,710	Direct United States Cable, Ltd.	20	2 %	2½%	2½%	10¼— 10¾	10¼— 10⅝	10⅝	10½
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	6½%	17 — 17½	17 — 17½	17½	17 1/16
70,000	Do. 6 % Cum. Pref.	10	6 %	6	6%	18 — 19	18 — 19	18⅜	18⅛
89,900*l*	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5%	101 104	2 1 5	...	...
1,302,615*l*	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4%	130 - 133	130 - 133	133	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	18¼ 18⅝	18¼ - 18⅝	18⅝	18½
25,200*l*	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5%	101 —105	99 - 103 xd	...	...
100,500*l*	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5%	102 —105	100 - 103 xd	100½	...
320,000*l*	Do. 4 % Deb. Stock	Stock	4 %	4 %	4%	132 —135	132 - 135	132	...
51,100*l*	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5%	101 - 105	99 - 103 xd	100	...
69,200*l*	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5%	102 —105	100 —104 xd	102½	...
300,000*l*	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4%	103 —106	103 - 106	...	...
200,000*l*	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4%	108 —111%	108 —111 %	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	4½%	11½ — 12	11½— 12	11⅞	11⅝
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6%	17½ - 18	17½ - 18	17⅞	17 9/16
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜%	10 %	10 %	25½ - 26½	25½ - 26½	26 1/16	...
160,000	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	102 —105	102 —105	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	52 — 55	52 — 55	55½	...
100,000*l*	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6%	107 —110	107 - 110	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 %	5½%	5½%	6½ - 6¾	6½ - 6¾	6¾	6⅝
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	15 - 17	15 — 17	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	14 — 16	14 — 16	15¼	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6 — 6½	6 — 6½	...	...
130,766	Do. do. Nos. 119,235 to 250,000, £5 paid	5	...	...	...	4¾— 5¼	5¾— 6¼	...	...
1,329,471*l*	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	104 —109	102 —107 xd	105½	105
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	4½%	5 %	5 %	9/16 11/16	9/16 - 11/16	...	...
100,000*l*	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	107 110	105 —108 xd	...	...
11,839	Reuter's Ltd.	8	nil	5 %	5 %	7½ - 8½	7½ - 8½	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	136 - 141	136 —141	139½	...
58,000	United River Plate Teleph., Ltd.	5	3 %	4 %	...	3¾— 4¼	3¾— 4¼	...	...
146,733*l*	Do. do. 5 % Debs.	Stock	5 %	5 %	...	102 —107	100 —105 xd	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	nil	4 %	nil	4½ - 5½	4½ — 5½	...	...
213,400*l*	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	103 —106	103 - 106	...	...
64,256	Western and Brazilian Teleg., Ltd.	15	3 %	3 %	2 %	9¾ - 10¼	9¾— 10¼	10 3/16	9¾
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	7½— 7¾	7½ — 7¾	7½	7⅜
33,129	Do. do. do. Def. Ord.	7½	1 %	1 %	...	2¾ - 3¼	2¾— 3¼	...	...
382,230	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	106 —109	104 —107 xd	105¾	105
88,321	West India and Panama Teleg., Ltd.	10	½%	⅞%	1 %	½— ¾	⅜ — ⅝	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	7¾— 8¼	7½— 8	8	7 13/16
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	5 — 7	5 — 7	...	...
80,000*l*	Do. do. 5 % Debs. No. 1 to 1,600 ...	100	5 %	5 %	5 %	107 —110	105 —108 xd	...	...
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7%	105 —110	105 —110	...	...
160,100*l*	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6%	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	1894.	1895.	1896.	Closing Quotation, Dec. 29th.	Closing Quotation, Jan. 5th.	Highest.	Lowest.
30,000	Charing Cross and Strand Electy. Supply	5	4½%	5 %	6 %	12½ — 13½	12½— 13½	13	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	...	...
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	5 %	10½— 11	10½— 11	10 15/16	10¾
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	4½%	4½%	113 —116	112 —114 xd	..	...
40,000	City of London Elec.Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	5 %	7 %	26 — 27	26 — 27	26¾	26⅜
10,000	Do. do. Prov. Certs.	5	...	...	...	25½— 26½	25½— 26½	...	...
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17 — 18	17 — 18	...	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	131 —136	129 - 134 xd	...	...
30,000	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—30,000	10	...	nil	nil	13½ — 14	13½— 14	13⅞	13⅝
20,000	Do. do. do. 6% Pref., 40,001—60,000 ...	10	...	6 %	6 %	15½— 16	15½— 16	15⅞	15 9/16
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5	...	...	...	9 — 10	9 — 10	9½	...
10,000	Do. do. 7 % Cum. Pref. ...	5	...	...	...	11 — 11½	11 — 11½	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	3 %	4 %	5 %	18½— 19½	18½— 19½	18 15/16	18½
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem. ...	10	...	...	...	18 — 19	18 — 19	18¼	...
230,000*l*	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½%	119 — 123	117 —121 xd	117¾	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	1 %	2 %	4 %	17½ — 18½	17½— 18½	...	...
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	6½%	7½%	10½%	17 — 18	17 — 18	17½	17⅜
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	10 — 11	10 — 11	10⅜	...
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	...	103 —106	101 —104 xd	...	...
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2⅝— 2⅞	2⅝— 2⅞	2 13/16	2 11/16
79,900	Westminster Electric Supply Corp., Ord., 101 to 80,000 ...	5	5 %	7 %	9 %	16 — 17	16 — 17	16⅝	...

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	896.	Closing Quotation, Dec. 29th.	Closing Quotation Jan. 5th.	Business done during week ended Jan. 5th, 1898. Highest	Lowest.
30,000	British Electric Traction	10	...	...	...	16¾— 17¼	16½— 17	17⅛	16½
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	2½%	...	...	1⅞— 2⅛	1⅞ - 2⅛	$2\frac{1}{16}$	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	...	...	2⅛— 2⅜	2⅛— 2⅜	$2\frac{5}{16}$	2¼
125,000*l*	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	...	...	109 —113	109 —113	...	...
50,000	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	103 —105	100 —103xd	...	...
19,126	Central London Railway, Ord. Shares	10	...	...	...	9¾— 10¼	9¾— 10¼xd	10	$9\frac{13}{16}$
143,106	Do. do. do. £6 paid	10	...	...	...	5½— 6	5½— 6xd	5⅞	5¾
58,830	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1 — 1½	1½— 1¾xd	1½	$1\frac{7}{16}$
61,777	Do. do. Def. do. £5 pd. ...	...	...	...	...	4½— 4¾	4 — 4¼xd	...	...
630,000*l*	City and South London Railway	Stock	1½%	$1\frac{3}{16}$%	$1\frac{9}{16}$%	66 — 68	67 — 69	69	67
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	*nil*	...	2 — 2½	2 — 2½	...	...
99,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 99,261	5	5 %	5 %	5½%	2½ — 3	2½— 3	...	...
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5 %	5½%	4½ — 5½	4½ — 5½	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	5 %	6 %	2⅜ - 2⅝	2⅜— 2⅝	$2\frac{9}{16}$	2½
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 ...	2	7 %	7 %	7 %	3⅛— 3⅜	3⅛ — 3⅜	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	...	...	½— ¾	½— ¾	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	...	...	½— ¾	½— ¾	...	...
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	10½%	...	9 — 11	9 — 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	6 %	8 %	10 %	20 — 21	20 — 21	21	20½
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½ — 19½	18½— 19½	19¼	18½
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	4½%	4½%	110 —115	110 - 115	112	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	23 — 24	23½ - 24½	24	23½
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	103 —107	103 —107	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	1½%	2⅞%	2⅞%	11½ — 11⅝	$11\frac{7}{16}$— $11\frac{9}{16}$	...	...
10,000	†Do. do. Pref., £10 paid	10	5 %	5 %	5 %	16 — 16½	16 — 16½	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	15 %	36 — 39	36 — 39	38½	37½
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	101 —104xd	105	...
54,000*l*	Waterloo and City Railway, Nos. 1 to 54,000	10	...	...	...	12½ — 13	12½— 13xd	12¾	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50 °/₀ for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0°/₀§; 1891—7°/₀§ 1890—8°/

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

* Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 11.

Electric Construction Corporation, 6 % Debentures, 104—106.

House-to-House Company, 4½% Debentures of £100, 109—111.

Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 15—15½; 1st Preference Cumulative 6 %, £5 (fully paid), 8¼—8¾. Dividend, 1896, on Ordinary Shares 7 %.

London Electric Supply Corporation, £5 Ordinary, 2½ -2⅝.

* T. Parker, Ltd., £10 (fully paid), 12½.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8—8½. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount 3 per cent. (October 14th. 1897).

THE APPLICATION OF VECTOR ALGEBRA TO ALTERNATING CURRENTS.

By W. G. RHODES, M.Sc., Royal Technical Institute, Salford.

INTRODUCTION.

1. Any physical quantity which requires for its complete specification data regarding (1) its *magnitude*, (2) its *direction*, and (3) its *sense* along that direction, is called a vector quantity. Quantities which are completely specified when their magnitudes only are given are called *scalar* quantities.

Mass and power are examples of scalar quantites: velocity, accleration, force, electric currents, and electromotive forces are examples of vector quantities.

A vector quantity may be completely represented by a straight line drawn in a particular direction, the sense along the direction being shown by means of an arrow head, and the line containing as many units of length as the quantity to be represented contains units of quantity.

We shall call a line drawn in this way *a vector*, *e.g.*, the vector, O P (fig. 1), may represent an electric current if its direction is represented

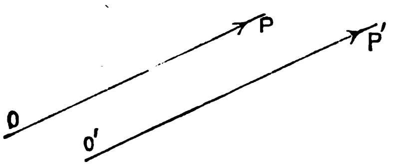

Fig. 1.

by the line O P, its sense from O to P along this direction, and if O P contains as many units of length as the number of amperes in the electric current.

Two vectors are equal if they contain the same number of units of length, are parallel to the same direction, and have the same sense: thus in fig. 1 the vector O P, is equal to the vector $O^1 P^1$, if the length of O P equals that of $O^1 P^1$. The vector P O, we may note, is minus the vector O P.

2. *Composition of Vectors.*—The sum of two vectors, O P and P Q

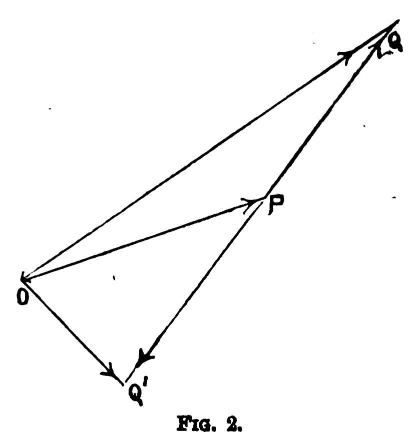

Fig. 2.

(fig. 2), is defined to be the vector O Q. The meaning of the word *sum* is here extended, and if we write

$$OP + PQ = OQ,$$

we should read O P together with P Q are equivalent to O Q. The addition of vectors is thus the same as the addition of forces, for if O P and P Q represent two forces, then O Q represents their resultant. The difference of two vectors, O P and P Q, is defined to be the sum of the two vectors, O P and Q P, and is, therefore, the vector $O Q^1$ (fig. 2), where $P Q^1 = - P Q$.

3. *Algebraic Representation of a Vector Quantity.*—Let O P (fig. 3) represent any vector quantity.

Through O draw any two mutually perpendicular lines, $x\,O\,x^1$, $y\,O\,y^1$. Draw P N perpendicular to $x\,O\,x^1$: the two vectors, O N and N P, are then together equal to the vector, O P. Any vector can thus be resolved into two component vectors parallel respectively to $x\,O\,x^1$

and y O y^1. Now let us agree to represent unit vector along O x by $+1$; unit vector along O x^1 will then be represented by -1, since the sense is exactly opposite. Let us further represent unit vector along O y by k; then unit vector along O y^1 will be represented by $-k$. If, then, O N contains a units of length, and N P contains b units, the vector, O P, is represented by $a + k\,b$ and its magnitude is $\sqrt{a^2 + b^2}$: also its inclination to O x is given by $\tan\theta = \frac{b}{a}$. In the same way $-a + k\,b$ represents a vector lying in the quadrant, y O x^1; $-a - k\,b$, one lying in the quadrant, x^1 O y^1; and $a - k\,b$, one lying in the quadrant, y^1 O x.

If P Q (fig. 3) is another vector whose components parallel to O x

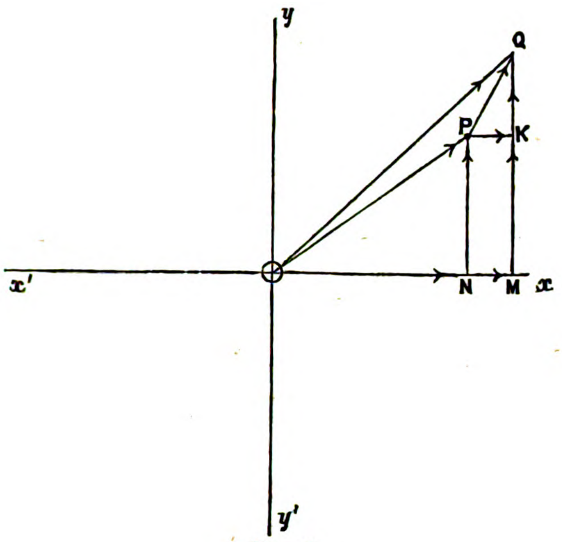

Fig. 3.

and O y are respectively P K = N M = a' and K Q = $b'\,k$, then the vector, P Q, is represented by $a^1 + k\,b^1$, and the vector, O Q, which is the sum of the vectors, O P and P Q, is given by

$$\begin{aligned} \text{OQ} &= \text{OM} + \text{MQ} \\ &= (\text{ON} + \text{NM}) + (\text{MK} + \text{KQ}) \\ &= (a + a') + (k\,b + k\,b') \\ &= (a + a') + k\,(b + b') \end{aligned}$$

This gives the law of vector addition, and inherently contains that of subtraction also, the difference of the vectors, O P and P Q being represented by

$$(a - a') + k\,(b - b').$$

4. *Product of two vectors.*—Consider any two vectors, O P and O Q (fig. 4), and let O P = O N + N P, where N P is at right angles to O Q.

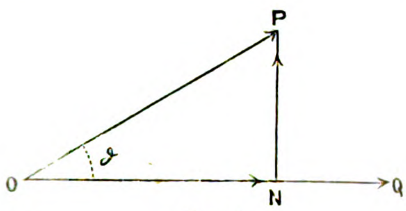

Fig. 4.

There are two products to take into consideration, viz., the product O Q . O N and the product O Q . N P.

To interpret these, suppose that the vector O P represents a displacement, and the vector O Q a force. The product O Q . O N then represents the *work* done by the force in moving its point of application from O to N. This product is essentially scalar.

The product, O Q . N P, represents the *moment* of the force about the point, P, and is a *vector at right angles to the plane*, O P N. We shall not, however, consider this vector product further in the present paper; it is the scalar product, O Q . O N, with which we are at present concerned. By reference to fig. 4, we see that

$$\text{OQ} \,.\, \text{ON} = \text{OQ} \,.\, \text{OP} \cos\theta,$$

so that the scalar product of two vectors is the product of their lengths multiplied by the cosine of the angle between their directions.

5. Let the vector O P be represented algebraically by $a + k\,b$, and the vector O Q by $a' + k\,b'$: then (see fig. 5 and Section 3) the magnitude of O P is $\sqrt{a^2 + b^2}$, that of O Q is $\sqrt{a'^2 + b'^2}$, and the angle, θ, between their directions is

$$\theta = \theta_1 - \theta_2$$

where

$$\tan\theta_1 = \frac{b}{a} \text{ and } \tan\theta_2 = \frac{b'}{a'},$$

therefore,

$$\cos\theta = \cos(\theta_1 - \theta_2) = \cos\theta_1\cos\theta_2 + \sin\theta_1\sin\theta_2.$$

$$= \frac{a}{\sqrt{a^2 + b^2}} \cdot \frac{a'}{\sqrt{a'^2 + b'^2}} + \frac{b}{\sqrt{a^2 + b^2}} \cdot \frac{b'}{\sqrt{a'^2 + b'^2}}$$

that is

$$\sqrt{a^2 + b^2}\,\sqrt{a'^2 + b'^2}\cos\theta = a\,a' + b\,b'.$$

Thus the scalar product of the two vectors $a + k\,b$ and $a' + k\,b'$ is $a\,a' + b\,b'$.

6. *On k as an Operator.*—A vector whose length is a along or parallel to O x is represented by a, whereas a vector of the same length whose direction is parallel to O y is represented by $k\,a$. We

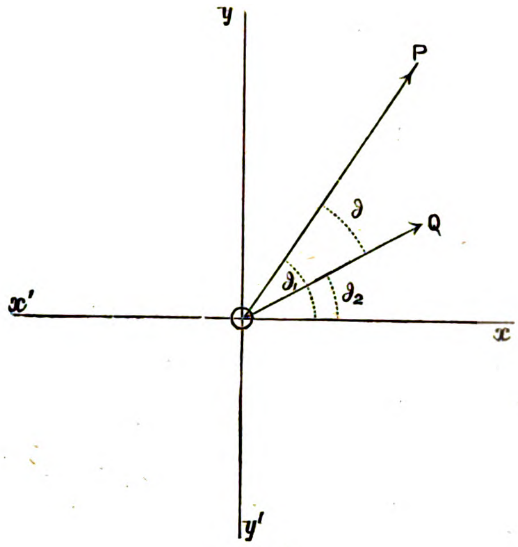

Fig. 5.

may thus regard k as an operator which has the effect of turning a vector along O x, through a right-angle in the positive (counter-clockwise) direction of rotation without altering its length. The effect of similarly operating on $k\,a$ must, therefore, to be consistent, be to turn the vector, $k\,a$, through a right-angle in the positive direction of rotation without altering its length; that is, it becomes a vector of length, a, along O x^1, that is, it becomes $-a$. We thus have

$$k \,.\, k\,a = k^2\,a = -a$$

or

$$k^2 = -1,$$

that is, when using the symbol k in algebraical processes, we must regard it as having the properties of the imaginary $\sqrt{-1}$. If we similarly operate on the vector $-a$, we get $-k\,a$, a vector of length along O y^1, and operating again we get $-k^2\,a$ or $+a$, a vector of length a along O x.

7. Again operating on any vector $a + k\,b$, we get $k\,(a + k\,b)$ or $k\,a - b$, which is the vector $a + k\,b$ turned through a right angle in the positive direction. That is, if O P is any vector, then k . O P is the vector resulting from a rotation of the vector O P through a right angle in the positive direction of rotation. By similar reasoning we can show that $-k$. O P represents the vector resulting from a rotation of the vector O P through a right angle in the negative (clockwise) direction of rotation.

8. *Definition.*—A vector O P is said to lead before, or lag behind, a vector O Q, according as the least amount of rotation necessary to bring O P into the same direction as O Q is in the negative or positive direction.

It is easily seen, then, that the vector, k . O P, leads before the vector, O P, by a right angle, while the vector $-k$. O P lags behind the vector O P by a right angle.

Application to Alternating Currents.

9. Before proceeding to apply the foregoing principles to alternating current calculations, we must first establish three important propositions.

Proposition 1.—The maximum value of the induced electromotive force, due to self-induction in a circuit, is $p\,\text{L}\,i$, where i is the maximum value of the current in the circuit, L is the self-induction of the circuit, and $p = 2\,\pi\,n$, where n is the frequency of the current. Also the E.M.F. of self-induction *lags a right angle behind the current.*

Let the current be $i \sin p\,t$, then the E.M.F. of self-induction is given by

$$\begin{aligned} e &= -\text{L}\frac{d}{d\,t} \,.\, i \sin p\,t \\ &= -p\,\text{L}\,i\cos p\,t \\ &= p\,\text{L}\,i \sin\left(p\,t - \frac{\pi}{2}\right) \end{aligned}$$

which proves the proposition.

Proposition 2.—If two circuits, A and B, have a mutual induction M, the maxima values of the consequent E.M.Fs. in the circuits A and B are respectively $p\,\text{M}\,i_2$ and $p\,\text{M}\,i_1$, where i_1 is the maximum value of the current in the circuit A, and i_2 that in the circuit B, and these induced E.M.Fs. lag a right angle behind the currents i_2 and i_1 respectively.

Let the current in the circuit, B, be $i_2 \sin p\, t$, then the E.M.F. in the circuit due to mutual induction is given by

$$e = -\,M \frac{d}{d\,t} \cdot i_2 \sin p\, t$$
$$= -\,p\,M\, i_2 \cos p\, t$$
$$= p\,M\, i_2 \sin \left(p\, t - \frac{\pi}{2}\right).$$

Similarly for the E.M.F. of mutual induction in the circuit, A. Thus the proposition is established.

Proposition 3.—If a condenser of capacity C is placed in an alternating current circuit, there is a consequent E.M.F. whose maximum value is $\frac{i}{p\,C}$, where i is the maximum value of the current flowing through the circuit, and this capacity E.M.F. *leads before the current* by a right angle.

Let q be the charge on the condenser at any instant when the current is $i \sin p\, t$, then the potential difference at its terminals at that instant is $-\frac{q}{C}$, but we have

$$q = \int i \sin p\, t\, d\, t = -\frac{i}{p} \cos p\, t.$$

Therefore, the capacity E.M.F. is given by

$$e = -\frac{q}{C}$$
$$= \frac{i}{p\,C} \cos p\, t$$
$$= \frac{i}{p\,C} \sin \left(p\, t + \frac{\pi}{2}\right),$$

which shows that e leads a right angle before i, and that its maximum value is $\frac{i}{p\,C}$. The foregoing three propositions will be in constant demand in the sequel so that they should be thoroughly understood.

10. The method of represent alternating currents and E.M.Fs. by by means of so-called clock diagrams has been so fully dealt with by Dr. Fleming, Mr. Kapp, and other writers on the subject, as to render further explanation of the method here unnecessary; suffice it to say, that if the vector, O P (see fig. 3), is drawn of such a length as to represent in magnitude the *maximum* value of an alternating current or electromotive force, and if it is caused to rotate about O with a uniform angular velocity, p, in the positive direction of rotation, then the vectors, O N and N P, will represent the instantaneous values according as the current or E.M.F. is zero, and increasing *positively* when O P coincides in direction with O y^1 or O x.

Circuits Containing Resistance and Self-Induction Only.

11. Now let O P = i be a vector representing the maximum current in any circuit containing self-induction, then by Proposition (1) and Section 8, the vector representing the maximum value of the E.M.F. of self-induction in the circuit in which the current, i, is flowing is $-\,k\,p\,L\,i$, where L is the self-induction and $p = 2\,\pi\,n$, n being the frequency of the current. If the current is caused by a potential difference whose maximum value is represented by a vector, e, then the vector, e, has to supply a component, $r\,i$, in the direction of the

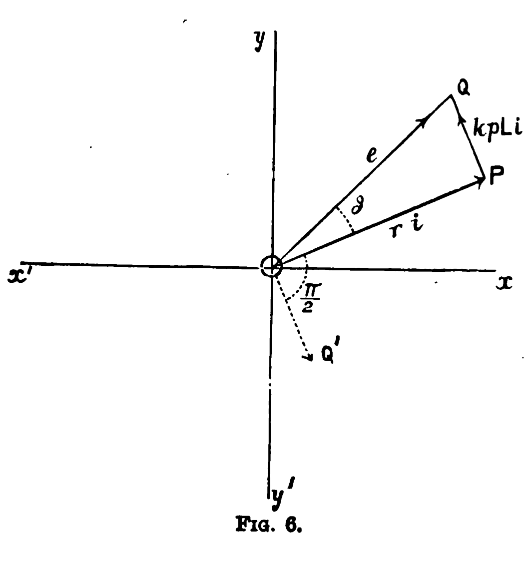

Fig. 6.

vector, i, to drive the current against the ohmic resistance r of the circuit, and also a component $+\,k\,p\,L\,i$ to balance the E.M.F. $-\,k\,p\,L\,i$ of self-induction. We thus have the vector equation

$$r\,i + k\,p\,L\,i = e, \qquad (1)$$

which is essentially a vector equation of E.M.Fs.

If we reduce the lengths of each of these vectors in the ratio, $1 : \sqrt{2}$, we may regard the vectors as representing root mean square values, but this alteration would not produce any change in equation (1), which only depends upon ratios of magnitudes of vectors.

If then a potential difference, e, of frequency, n, is applied between the terminals of an inductive circuit of resistance, r, and self-induction, L, then the vector equation (1) holds good, p being equal to $2\,\pi\,n$.

Let O P (fig. 6) represent the vector $r\,i$, then the vector O $Q^1 = -\,k\,p\,L\,i$ represents the E M.F. of self-induction, and the vector P Q $= +\,k\,p\,L\,i$ is the vector representing the E.M.F. necessary to overcome self-induction: therefore, the vector O Q = O P + P Q is the vector representing the applied potential difference e. Further, the vector O P, which is in phase with the current, lags behind the vector representing e by an angle θ, where

$$\tan\,\theta = \frac{p\,L}{r}.$$

Also (see Section 3) the *magnitude* of e is given by

$$e = \sqrt{r^2\,i^2 + p^2\,L^2\,i_2}$$
$$= i\,\sqrt{r^2 + p^2\,L^2}$$

that is
$$i = \frac{e}{\sqrt{r^2 + p^2\,L^2}} \qquad (2)$$

Equation (2), it must be noticed, is not the same as equation (1); it is one of several deductions from equation (1). Whereas (1) is a *vector* equation, involving directions as well as magnitudes; (2) involves magnitudes only.

The quantity $\sqrt{r^2 + p^2\,L^2}$ is called the impedance of the circuit.

12. Referring again to equation (1), it may be written

$$i\,(r + k\,p\,L) = e$$

or
$$i = \frac{e}{r + k\,p\,L}$$
$$= \frac{e\,(r - k\,p\,L)}{(r + k\,p\,L)\,(r - k\,p\,L)}$$
$$= \frac{e\,(r - k\,p\,L)}{r^2 + p^2\,L^2}$$
$$= \frac{r}{r^2 + p^2\,L^2}\,e - \frac{p\,L}{r^2 + p^2\,L^2} \cdot k\,e, \qquad (3)$$

which is a current vector equation, and states that the current, i, can be resolved into a component $\frac{r}{r^2 + p^2\,L^2} \cdot e$ parallel to the direction of e, and a lagging component $\frac{p\,L}{r^2 + p^2\,L^2}\,(-\,k\,e)$ at right-angles to the direction of e. This is shown graphically in fig. 7, where O P is the

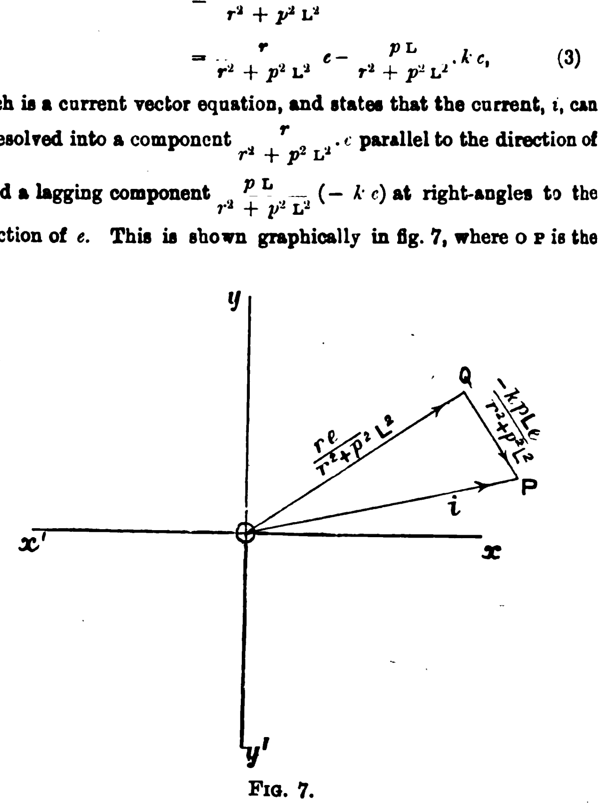

Fig. 7.

current vector, and O Q and Q P its components respectively along and at right angles to the direction of e. It should be noticed that the product $(r + k\,p\,L)\,(r - k\,p\,L)$, which equals $r^2 + p^2\,L^2$, since $k^2 = -\,1$, is not a vector product: the quantities, r, p, and L, are all scalar and have no right whatever to be treated as vectors after the manner of some writers on the subject.

We shall frequently make use of the vector equations (1) and (3) so they should be thoroughly understood. In fact, to proceed further without first mastering them would be useless.

13. Suppose now that any number, n, of inductive circuits are connected in series and it is required to find their equivalent resistance, self-induction, and impedance,

Let $r_1, r_2, r_3 \ldots . r_n$ be the ohmic resistances of the several circuits.

" $L_1, L_2, L_3 \ldots . L_n$ their self-inductions.

" $e_1, e_2, e_3 \ldots . e_n$ the vectors representing the potential differences between their respective terminals.

" i the vector representing the current flowing through the series circuit.

" $p = 2\,\pi\,n$, where n is the frequency of the current.

Then, the vector representing the potential difference between the extreme terminals of the series circuit is given by the *vector* equation

$$e = e_1 + e_2 + e_3 + \ldots . + e_n.$$

But by equation (1)

$$e_1 = r_1 i + k p L_1 i$$
$$e_2 = r_2 i + k p L_2 i$$
$$e_3 = r_3 i + k p L_3 i$$
$$\cdots\cdots$$
$$e_n = r_n i + k p L_n i.$$

Now all the $r i$'s are in the same direction, viz., along the current vector, as also are all the $k p L i$'s, viz., leading a right angle in front of the current vector; they can, therefore, be added together numerically, and we get

$$e = e_1 + e_2 + e_3 + \ldots + e_n$$
$$= (r_1 + r_2 + r_3 + \ldots + r_n) i + k p (L_1 + L_2 + L_3 + \ldots + L_n) i \qquad (4)$$

But if R and L are the equivalent resistances and self-inductions of the complete circuit, we have by equation (1)

$$e = R i + k p L i \qquad (5)$$

Comparing equations (4) and (5) we see that

$$R = r_1 + r_2 + r_3 + \ldots + r_n$$

and

$$L = L_1 + L_2 + L_3 + \ldots + L_n$$

and the impedance, I, is given by

$$I = \sqrt{R^2 + p^2 L^2}.$$

(*To be continued.*)

ELECTRIC LIGHTING PROVISIONAL ORDERS.—SESSION 1898.

LIST of applications for provisional orders deposited with the Board of Trade, on or before December 21st, 1897, under the provisions of the Electric Lighting Acts, 1882 to 1890.

Title of order and description of area.	Name of promoters.	Agents.
Airdrie Burgh Electric Lighting Order. The Burgh of Airdrie.	The Corporation.	Messrs. Martin and Leslie, 27, Abingdon Street, Westminster, S.W.
Aldershot Electric Lighting Order. The Urban District of Aldershot.	The Urban District Council.	Messrs. Blyth, Dutton, Hartley and Blyth, 112, Gresham House, Old Broad Street, E.C.
Aston Manor Electric Lighting Order. The Urban District of Aston Manor.	The Urban District Council.	Messrs. Sharpe & Co., 9, Bridge Street, Westminster, S.W.
Barnes Electric Lighting Order. The Urban District of Barnes.	The Urban District Council.	T. Blanco White, Esq, 59 and 60, Chancery Lane, W.C.
Batley Electric Lighting Order. The Borough of Batley.	The Corporation.	Messrs. Dyson & Co., 9, Great George Street, Westminster, S.W.
Birkdale Electric Lighting Order. The Urban District of Birkdale.	The Urban District Council.	Messrs. Sharpe & Co., 9, Bridge Street, Westminster, S.W.
Bolton Electric Lighting Order. The County and Municipal Borough of Bolton, the Urban District and Township of Astley Bridge, and the Townships of Heaton, Smithills, Darcy Lever, Breightmet, Lostock, Deane - over - Hulton, Middle Hulton, Tonge, and Great Lever, within the Bolton Rural District.	The Corporation of Bolton.	Messrs. Dyson & Co., 9, Great George Street, Westminster, S.W.
Brechin Electric Lighting Order. The Royal Burgh of Brechin.	The Corporation.	Messrs. Clarkson and Toovey, 98, Great Tower Street, E.C.
Bridgwater Corporation Electric Lighting Order. The Borough of Bridgwater.	The Corporation.	Messrs. Torr & Co., 19, Abingdon Street, Westminster, S.W.
Burslem Electric Lighting Order. The Borough of Burslem.	The Corporation.	Messrs. Sharpe & Co., 9, Bridge Street, Westminster, S.W.
Chelmsford Rural District Electric Lighting Order. The Parishes of Writtle, Great Baddow, Broomfield, Springfield and Widford, within the Chelmsford Rural District.	Chelmsford Electric Lighting Company, Ltd.	Messrs. Deacon and Co., 9, Great St. Helen's, E.C.
Chichester Corporation Electric Lighting Order. The City of Chichester.	The Corporation.	Messrs. Baker & Co., 22, Great George Street, Westminster, S.W.
Chislehurst Electric Lighting Order. Portion of the Parish of Chislehurst.	Chislehurst Electric Supply Company, Limited.	Messrs. Baker, Blaker & Hawes, 117, Cannon Street, E.C.
Chorley Corporation Electric Lighting Order. The Borough of Chorley.	The Corporation.	Messrs. Lewin, Gregory & Anderson, 13, King Street, Whitehall, S.W.
Colne Corporation Electric Lighting Order. The Municipal Borough of Colne.	The Corporation.	Messrs. Baker & Co., 22, Great George Street, Westminster, S.W.
Crewe Electric Lighting Order. The Borough of Crewe.	The Corporation.	Messrs. Sharpe & Co., 9, Bridge Street, Westminster, S.W.
Darlington Electric Lighting Order. The whole of the Borough of Darlington, except the detached portion of the Township or Civil Parish of Darlington known as Oxen-le-Field.	The Corporation.	Messrs. Durnford and Co., 38, Parliament Street, Westminster, S.W.
Dartford Electric Lighting Order. The Urban District of Dartford.	The Urban District Council.	Messrs. Baker & Co., 22, Great George Street, Westminster, S.W.
Doncaster Corporation Electric Lighting Order. The Borough of Doncaster.	The Corporation.	Messrs. Sherwood and Co., 7, Great George Street, Westminster, S.W.
East Ham Electric Lighting Order. The Urban District of East Ham.	The Urban District Council.	Messrs. Baker & Co., 22, Great George Street, Westminster, S.W.
East Stonehouse Electric Lighting Order. The Urban District of East Stonehouse.	The Urban District Council.	Do.
Gravesend Electric Lighting Order. The Municipal Borough of Gravesend.	The Corporation.	Messrs. Deacon and Co., 9, Great St. Helen's, E.C.
Greenock, Port-Glasgow, and Gourock Electric Lighting Order. The Burghs of Greenock, Port-Glasgow, and Gourock.	North British Electricity Supply Company, Ltd.	Messrs. Sherwood and Co., 7, Great George Street, Westminster, S.W.
Hamilton Electric Lighting Order. The Burgh of Hamilton.	The Corporation.	Messrs. Grahames, Currey & Spens, 30, Great George Street, Westminster, S.W.
Hastings Corporation Electric Lighting Order. The Borough of Hastings	The Corporation.	Messrs. Bircham and Co., 46, Parliament Street, Westminster, S.W.
Hereford Electric Lighting Order. The City of Hereford.	The Corporation.	Messrs. Andrews and Fawcus, 18, Essex Street, Strand, W.C.
Hornsey Electric Lighting Order. The Urban District of Hornsey.	The Urban District Council	Leonard J. Tatham, Esq., 17, Bedford Row, W.C.
Hove (Aldrington) Electric Lighting Order. The Parish of Aldrington in the town of Hove.	The Hove Urban District Council.	Messrs. Bircham and Co., 46, Parliament Street, Westminster, S.W.
Ilford Electric Lighting Order. The Urban District of Ilford.	The Urban District Council.	John W. Benton, Esq., Clerk to the Council, 3, Cranbrook Road, Ilford.
Ilfracombe Electric Lighting Order. The Urban District of Ilfracombe.	The Urban District Council.	Messrs. Baker & Co., 22, Great George Street, Westminster, S.W.
King's Norton Electric Lighting Order. The Parishes of King's Norton and Northfield in the Rural District of King's Norton.	The Rural District Council.	Messrs. Bircham and Co., 46, Parliament Street, Westminster, S.W.
Kingswinford Electric Lighting Order. The Rural District of Kingswinford.	The Rural District Council.	Messrs. Baker & Co., 22, Great George Street Westminster, S.W.
Leatherhead Electric Lighting Order. The Urban District of Leatherhead.	The Urban District Council.	Messrs. Sherwood and Co., 7, Great George Street, Westminster, S.W.

Title of order and description of area.	Name of promoters.	Agents.
Leigh-on-Sea Electric Lighting Order. The Urban District of Leigh-on-Sea.	The Urban District Council.	Messrs. R. W. Cooper & Sons, 5, Victoria Street, S.W.
Lewes Corporation Electric Lighting Order. The Borough of Lewes.	The Corporation.	Messrs. Renshaw, Kekewich, & Smith, 2, Suffolk Lane, Cannon Street, E.C.
Lowestoft Electric Lighting Order. The Borough of Lowestoft.	The Corporation.	Messrs. Sharpe & Co., 9, Bridge Street, Westminster, S.W.
THE COUNTY OF LONDON:		
Bermondsey Electric Lighting Order. The Parish of Bermondsey.	The Vestry.	Frederick Ryall, Esq., Town Hall, Spa Road, Bermondsey, S.E.
Bermondsey, Rotherhithe, Greenwich, and Lewisham Electric Lighting Order. The Parishes of Bermondsey and Rotherhithe and the Districts of Greenwich and Lewisham.	County of London and Brush Provincial Electric Lighting Company, Limited.	Sydney Morse, Esq., 4, Fenchurch Avenue, E.C.
Bethnal Green, Poplar, and Whitechapel Electric Lighting Order. The Parish of Bethnal Green and the Districts of Poplar and Whitechapel.	County of London and Brush Provincial Electric Lighting Company, Limited.	Sydney Morse, Esq., 4, Fenchurch Avenue, E.C.
Holborn District Electric Lighting Order. Portion of the Holborn District.	Charing Cross and Strand Electricity Supply Corporation, Ltd.	Messrs. Wyatt and Co., 28, Parliament Street, Westminster, S.W.
Holborn and St. Giles Electric Lighting Order. Portion of the Holborn District, the District of St. Giles, Lincoln's Inn, Gray's Inn, Staple Inn, and Furnival's Inn.	County of London and Brush Provincial Electric Lighting Company, Limited.	Sydney Morse, Esq., 4, Fenchurch Avenue, E.C.
Lewisham District Electric Lighting Order. The District of Lewisham.	The District Board of Works.	Templer L. Down, Esq., 3, Pope's Head Alley, Cornhill, E.C.
Lewisham Electric Lighting Order. Portion of the Parish of Lewisham.	Great Western Electric Light and Power Company, Limited.	Messrs. Walter Webb and Co., 23, Queen Victoria Street, E.C.
St. Giles District Electric Lighting Order. The District of St. Giles.	Charing Cross and Strand Electricity Supply Corporation, Ltd.	Messrs. Wyatt and Co., 28, Parliament Street, Westminster, S.W.
St. Marylebone Electric Lighting Order. The Parish of St. Marylebone.	The Vestry.	Messrs. Sherwood and Co., 7, Great George Street, Westminster, S.W.
St. Marylebone Electric Lighting Order. The Parish of St. Marylebone.	County of London and Brush Provincial Electric Lighting Company, Limited.	Messrs. Milner & Bickford, 1, Great Tower Street, E.C.
St. Marylebone Electric Lighting Order. The Parish of St. Marylebone.	Marylebone Electric Supply Company, Limited.	Sydney Morse, Esq., 4, Fenchurch Avenue, E.C.
Maidenhead Electric Lighting Order. The Borough of Maidenhead.	The Corporation.	Messrs. Sharpe & Co., 9, Bridge Street, Westminster, S.W.
Margam Electric Lighting Order. The Urban District of Margam.	The Urban District Council.	Messrs. Baker & Co., 22, Great George Street, Westminster, S.W.
Melton Mowbray Electric Lighting Order. The Urban District of Melton Mowbray and the Parishes of Sysonby, Welby, Eye Kettleby, Burton Lazars, and Thorpe Arnold, in the Rural District of Melton Mowbray.	Melton Mowbray Electric Light Co., Limited.	Messrs. Rees & Frere, 5, Victoria Street, Westminster, S.W.
Middlesbrough Corporation Electric Lighting Order. The Municipal Borough of Middlesbrough.	The Corporation.	Messrs. Durnford & Co., 38, Parliament Street, Westminster, S.W.
Midland Electric Power Distribution and Lighting Order. The Boroughs of Walsall, Wednesbury, West Bromwich, and Wolverhampton, the Urban Districts of Bilston, Coseley, Darlaston, Heath Town, Rowley, Regis, Sedgley, Short Heath, Smethwick, Tipton, Wednesfield, and Willenhall, and the Rural District of Walsall, in the County of Stafford; and the Borough of Dudley, and the Urban District of Oldbury, in the County of Worcester.	Midland Electric Corporation for Power Distribution, Limited.	Messrs. Sherwood and Co., 7, Great George Street, Westminster, S.W.
Michelstown Electric Lighting Order. The Town of Michelstown.	The Michelstown Guardians.	Messrs. W. and W. M. Bell, 27, Great George Street, Westminster, S.W.
Montrose Electric Lighting Order. The Royal Burgh of Montrose.	The Corporation.	Messrs. Clarkson and Toovey, 98, Great Tower Street, E.C.
Norwich (Extension) Electric Lighting Order. The Parishes of Thorpe St. Andrew, Postwick, Sprowston, Old Catton, Hellesdon, Costessey, Bowthorpe, Colney, Cringleford, Intwood, Keswick, Markshall, Arminghall, Trowse Newton, and Bixley, and and the Shirehall and Castle Ditches, Norwich.	Norwich Electricity Company, Limited.	Messrs. Waterhouse and Co., 1, New Court, Lincoln's Inn, W.C.
Nuneaton Electric Lighting Order. Portions of the Parishes of Nuneaton and Chivers Coton.	Nuneaton Electric Company, Ltd.	Cecil F. Twist, Esq., 5, Bedford Row, W.C.
Oldbury Electric Lighting Order. The Urban District of Oldbury.	The Urban District Council.	Messrs. R. W. Cooper and Sons, 5, Victoria Street, S.W.
Ossett Electric Lighting Order. The Municipal Borough of Ossett.	The Corporation.	Messrs. Baker & Co., 22, Great George Street, Westminster, S.W.
Partick Electric Lighting Order. The Burgh of Partick.	Kelvinside Electricity Company, Limited.	Messrs. Burchell and Co., 5, The Sanctuary, Westminster, S.W.
Penarth Electric Lighting Order. The Urban District of Penarth.	Penarth Electric Lighting Company, Limited.	J. C. Ball, Esq., 3, Victoria Street, Westminster, S.W.
Perth Electric Lighting Order. The Parliamentary Burgh of Perth.	The Commissioners of the Burgh.	Messrs. Wm. Robertson & Co., 45, Parliament Street, Westminster, S.W.
Peterborough Electric Lighting Order. The Municipal Borough of Peterborough.	Peterborough Electric Light and Power Company, Limited.	Messrs. Clarkson and Toovey, 98, Great Tower Street, E.C.
Prescot District Electric Lighting Order. The Urban District of Huyton-with-Roby.	British Insulated Wire Company, Limited.	Sidney Morse, Esq., 4, Fenchurch Avenue, E.C.
Preston (Extensions) Electric Lighting Order. The Urban District of Fulwood, and the Townships of Broughton, Lea Ashton Ingol and Cotam, Woodplumpton, Barton, and Penwortham, in the Rural District of Preston.	National Electric Supply Company, Limited.	Francis H. White, Esq., 7, Bedford Row, W.C.
Ramsgate Electric Lighting Order. The Borough of Ramsgate.	Electric Supply Corporation, Ltd.	Messrs. Deacon and Co., 9, Great St. Helen's, E.C.
Rawmarsh Electric Lighting Order. The Urban District of Rawmarsh.	The Urban District Council.	Messrs. Baker & Co., 22, Great George Street, Westminster, S.W.
Rochdale Electric Lighting Order. The County Borough of Rochdale.	The Corporation.	Messrs. Dyson & Co., 9, Great George Street, Westminster, S.W.

Title of order and description of area.	Name of promoters.	Agents.
Rotherham Corporation Electric Lighting Order. The Municipal Borough of Rotherham.	The Corporation.	Messrs. Baker & Co., 22, Great George Street, Westminster, S.W.
Rothesay Electric Lighting Order. The Burgh of Rothesay.	The Corporation.	Messrs. Loch & Co., 36, Great George Street, S.W.
Royal Leamington Spa Electric Lighting Order. The Borough of Royal Leamington Spa.	The Corporation.	Messrs. Sharpe & Co., 9, Bridge Street, Westminster, S.W.
Royal Leamington Spa Electric Light and Power Order. The Borough of Royal Leamington Spa.	Midland Electric Light and Power Company, Ltd.	Messrs. Smith, Pinsent & Co., 6, Bennett's Hill, Birmingham.
Ryde Electric Lighting Order. The Borough of Ryde.	Ryde Electric Light and Power Company, Ltd.	Messrs. Clarkson and Toovey, 98, Great Tower Street, E.C.
St. Albans Corporation Electric Lighting Order. The City of St. Albans.	The Corporation.	Messrs. Rees and Frere, 5, Victoria Street, Westminster, S.W.
St. Anne's-on-the-Sea Electric Lighting Order. The Urban District of St. Anne's-on-the-Sea.	The Urban District Council.	Messrs. Baker & Co., 22, Great George Street, Westminster, S.W.
Shrewsbury Electric Lighting Order. The Borough of Shrewsbury.	The Corporation.	Messrs. Sharpe & Co., 9, Bridge Street, Westminster, S.W.
Smethwick Electric Lighting Order. The Urban District of Smethwick.	The Urban District Council.	Messrs. R. W. Cooper and Sons, 5, Victoria Street, Westminster, S.W.
Stoke-upon-Trent Electric Lighting Order. The Borough of Stoke-upon-Trent.	The Corporation.	Messrs. Sharpe & Co., 9, Bridge Street, Westminster, S.W.
Warrington Electric Lighting Order. The Municipal Borough of Warrington.	The Corporation.	Messrs. Baker & Co., 22, Great George Street, Westminster, S.W.
West Bromwich Corporation Electric Lighting Order. The County Borough of West Bromwich.	The Corporation.	Messrs. R. W. Cooper, and Sons, 5, Victoria Street, Westminster, S.W.
Westgate-on-Sea Parish Electric Lighting Order. The Parish of Westgate-on-Sea.	The Isle of Thanet Rural District Council.	R. E. H. Fisher, Esq., 9, New Inn, Strand, W.C.
Weston-super-Mare Electric Lighting Order. The Urban District of Weston-super-Mare.	Weston-super-Mare Electric Light and Power Syndicate.	Messrs. Robbins, Billing & Co., Surrey House, Victoria Embankment, W.C.
Weymouth and Melcombe Regis Electric Lighting Order. The Borough of Weymouth and Melcombe Regis.	The Corporation.	Messrs. Dyson & Co., 9, Great George Street, Westminster, S.W.
Whiston Rural District Electric Lighting Order. The Rural District of Whiston.	The Rural District Council.	Sydney Morse, Esq., 4, Fenchurch Avenue, E.C.
Willesden Electric Lighting Order. The Parish of Willesden.	The Urban District Council.	Messrs. Holmes, Greig & Greig, 18, Abingdon Street, Westminster, S.W.

ON THE EXTERNAL FIELD OF HELICALLY MAGNETISED RINGS.*

By W. M. MORDEY.

On the subject of some experiments by the present writer relating to ring on armature conductors, enclosed or nearly enclosed in iron, Prof. H. du Bois contributed an article in the *Electrotechnische Zeitschrift* of August 19th last, in the course of which attention was particularly directed to a phenomenon of ring magnets. Prof. du Bois writes:—"*A ring-magnet experiences a side thrust when in an external field whose lines of force are in the same plane as the ring; and conversely it exerts a thrust in the opposite direction upon the supporter of the external field.*" "This deduction," he adds, "so astonishing at first sight, I have proved to be verified by experiment." As its author gives the emphasis of italics to this passage, it may be well to submit what appears to be the explanation, as the present writer chanced to come across the effect in question a good many years ago. It is, as Prof. du Bois says, rather astonishing at first sight, but the explanation seems to be quite simple. The external field is caused by the advancing or longitudinal constituent of the helix. Magnetically a helix traversed by current acts as a series of rings, but, in addition, it has a minor magnetising effect, at right angles to that of the rings, due to the advance of the conductor from end to end of the helix. Thus, a helix bent into a ring or wound about an annular core, forms an endless or ring-magnet when traversed by current. But in addition to this main effect, the faces of the ring, regarded axially, present N. and S. polarity respectively, the whole closed helix acting externally (so far as this subsidiary effect is concerned), and as regards external fields, as a simple loop or ring of conductor carrying current. This may be illustrated by a lines-of-force figure, taken from a ring helically wound with a single layer of winding. In such a figure, the lines of force radiate from the centre or axis of the ring at right angles to the axis of the spiral—they represent portions of closed lines of force which enclose the axis of the spiral. In a helix wound with two layers, one forward, the other back, the external magnetising effect due to this cause is *nil*. In a single layer (or simple) helix, this external effect may be neutralised by returning the wire along the axis of the helix.

A simple straight helix acts externally as a straight conductor.

A flat spiral acts like a disc or wheel, or as a number of radial conductors in one plane traversed by current passing from or to the centre.

* From the *Philosophical Magazine* for December, 1897.

UNIONISM IN 1851.

Engineering has been raking up records of the old unionism which it has lately been the habit to extol as something very superior to the new unionism. Our contemporary shows clearly that in the year 1851 matters were much as they are to-day. A manifesto of December 24th, 1851, is quoted. It might have been penned by Mr. Barnes. Interference with, or dictation to employers, is specially disclaimed, but overtime and piecework is demanded to be abolished, and there are the stock arguments as to the injury to health and the interference with the intellectual and moral growth of the men.

There was a lockout in 1852. This was the immediate outcome of a Masters' Federation, resulting from an attempt to compel an Oldham firm to abolish piecework, and to stop the working by one man of more than one machine, and also to stop unskilled labour. The lockout was announced for January 10th, 1852, the strike having taken place on January 1st.

In every detail the dispute proceeded on all fours with the present one, save that the Employers' Federation only re-engaged men who would forswear the union, and the union was fairly well smashed, the lockout lasting until April. All its funds had gone, but it lost few members, only some 200 between January and June of 1852, though by the end of the year its members had fallen off by about 2,000, or, say, 20 per cent. The same demands by the men, and the same examples of interference, seemed to characterise this earlier strike, and the special vigour of the attack upon employers caused them to combine. But what was the final result? In 1855 the A.S.E. was again as strong as ever, but the Employers' Federation had perished of atrophy, its units reverting to their state of selfish isolation. Thus it was that in 1872 the plan of crushing employers in detail was enabled to secure victory.

Our contemporary quotes "The strong man armed keepeth his goods in peace," and the unionists know this, and have kept the fact in view for 50 years, keeping their eye for ever on the goal, undiverted by victory or defeat. In 1851 they snatched for a prize and missed it. In 1872 they got their prize. They have probably missed their game this time, but if the employers disband, they will surely try again. But things to-day have one great difference. Foreign competition is now with us. Previously it has been an entirely negligible quantity. It is so no longer, and it is to foreign competition acting on the employers that federation has been brought about. The objections in the past to the men's interference have been based on the difficulty of securing correspondingly increased prices for manufactures. But the increased price had to be paid, and was paid. To-day the increased price cannot be asked, but the foreigner will get the work. Hence the Federation, and the certainty that no longer can the policy of dawdling over work be carried on. The operation and details of the present strike may resemble those of 1851-2, but the environment is now changed, and though eight hours will come about in its proper time, it will not be before workmen understand the necessity of maintaining output—not of keeping it down.

A NEW TRANSMISSION DYNAMOMETER.*

By W. E. DALBY, M.A., B.Sc., Assoc.M.Inst.C.E.

In transmission dynamometers in which the deformation of a spring was used to measure the work being transmitted, the mechanism might be divided into two parts: (1) The measuring-springs, and the apparatus fixing them to the several parts of the dynamometer; and (2) the apparatus used to measure the deformation of the spring. The paper treated of a new device for measuring the deformation of the spring.

* Institution of Civil Engineers, December 21st, 1897.

The deformation of the spring was in general communicated to two pieces of the dynamometer, causing relative angular displacement between them. Thus, if one end of the spring was fixed to a pulley and the other end to the shaft on which the pulley was mounted, the relative angular displacement would be between the pulley and the shaft. To measure this whilst the pulley and shaft were rotating, a sprocket-wheel was fixed to the pulley and another of equal diameter to the shaft. Over these an endless band was placed, arranged to form two loops, the parts of the band forming one loop leading the one to the sprocket-wheel and the other to the opposite side of the other sprocket-wheel. In these loops were placed guide-pulleys, mounted in frames, constrained by a slide to move in the direction of the band. A relative angular displacement of the sprocket-wheels was necessarily accompanied by a relative linear displacement of the guide-pulleys in the loops proportional to the torque acting between the shaft and pulley, and by suitably calibrating a scale to measure their distance apart this torque, or change in torque, might be read off directly.

To obtain a good fit, and yet at the same time avoid any sticking of the slide, the frame carrying the guide-pulleys had only six properly arranged points of contact with a group of three bars forming the slide, and to control the motion of the pulleys in any position and constrain them to follow the motion of the loops, a spring was arranged to act on a cord connecting the two frames in such a way that the guide-pulleys were always compelled to sit in their respective loops, the tension on the spring causing them to do so, being constant.

Two dynamometers had been made on these principles for the engineering laboratory at Cambridge. One was arranged on a main driving shaft, the dynamometer being formed by connecting a pulley driving a dynamo to the shaft by means of a spring, a sprocket-wheel was fixed to the shaft, and another of equal diameter was fixed to the pulley-boss. An endless steel band passed over the sprocket-wheels so as to form the loops described was used to operate two guide-pulleys mounted in frames, free to slide in the direction of motion of the band. This, the apparatus for measuring the torque, was placed several feet below the shaft in a convenient place for observation. A second dynamometer was made on the same principle, but arranged to be self-contained. Any machine could be driven through it, and the power given to the machine directly observed. The dynamometer was used to measure the power given to a dynamo. Measurements were made of the work required to overcome the belt friction, journal friction, of the work lost in hysteresis and eddy currents, and of the efficiency of the dynamo at different outputs.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1897.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents*, 322, *High Holborn, London, W.C., to whom all inquiries should be addressed.*]

30,065. "Improvements in key switch holders for incandescent electric lamps." J. M. Huisman and H. C. Gover. Dated December 20th.

30,085. "Improvements in electrical contact devices." B. Doyle and H. V. Thirkell. Dated December 20th.

30,089. "An improved process for preparation of an electric paste accumulator." E. Kosel. Dated December 20th.

30,135. "An improvement in vehicles driven by oil engines in connection with electric motors actuated by accumulators." A. L. Fyfe. Dated December 20th.

30,157. "Improvements in and connected with the manufacture of electrical cable or conductor conduits." A. Musker and F. J. P. Cheesbrough. Dated December 21st.

30,205. "Improvements in coin-controlled mechanism for electric and other meters." W. F. Browne. Dated December 21st. (*Complete.*)

30,211. "Improvements in and relating to insulating blocks for electric conductors." W. P. Thompson. (J. Jungbluth, Germany.) Dated December 21st. (*Complete.*)

30,221. "An improved electric fuse and machine for the manufacture thereof." N. Schmitt. Dated December 21st. (*Complete.*)

30,246. "Improvements in arc lamps for projection." L. Stuart and J. H. Barton. Dated December 21st.

30,247. "An improved centreing motion for arc lamps and lime-light jets." J. Stuart and J. H. Barton. Dated December 21st.

30,253. "An improved electro-chemical explosive device." H. H. Lake. (G. Cornara, Italy.) Dated December 21st.

30,256. "Improvements in electrical resistances." A. J. Marquand and F. G. Treharne. Dated December 21st.

30,259. "A method or methods for controlling a mechanism or mechanisms by means of electric or electro-magnetic waves of high frequency." E. Wilson and C. J. Evans. Dated December 21st.

30,264. "Improvements in and relating to windings for polyphase machines." The British Thomson-Houston Company, Limited, and H. M. Hobart. Dated December 22nd. (*Complete.*)

30,275. "Improvements in dynamo-electric machines." T. E. Weaver. Dated December 22nd.

30,277. "A porcelain insulator disc for capped incandescent lamp-holder." W. D. Hassall. Dated December 22nd.

30,295. "The automatic locking lever and lifting lever combination for electrical lifts, cranes, or other machinery." C. E. B. Holt. Dated December 22nd.

30,299. "Improved means for making electrical connections upon railway trains." J. E. Duckworth. Dated December 22nd.

30,341. "Improvements in and relating to electric smelting furnace." W. Antrobus. Dated December 22nd.

30,347. "Improvements in electrical arc lamps." E. P. L. Moss and L. C. A. Pottier. (Date applied for under Patents, &c., Acts, 1883, Sec. 103, November 3rd, 1897, being date of application in France.) Dated December 22nd.

30,364. "Improvements in phase transformers for electric currents and the application of the same to monophase electric motors." E. B. Wedmore. Dated December 22nd.

30,393. "An electro-mechanical dancing marionette figure in combination with rubber rotating sphere for advertising purposes and such like." J. G. Knight. Dated December 23rd.

30,441. "Improvements in primary and secondary galvanic batteries." C. L. R. E. Menges. Dated December 23rd.

30,445. "Apparatus for simultaneously connecting a number of pairs of electric conductors." Siemens Bros. & Co., Limited, and E. Holmes. Dated December 23rd. (*Complete.*)

30,447. "Improvements in supplying electrical energy to railways worked by alternating currents." Siemens Bros. & Co., Limited. (Siemens & Halske, Actien-Gesellschaft, Germany.) Dated December 23rd.

30,470. "An improved electricity meter shelf-fixing, or box and main connection board or box combined." F. W. E. Jones. Dated December 24th.

30,476. "Improvements in and connected with electric traction." H. W. Handcock and A. H. Dykes. Dated December 24th.

30,494. "Improvements in the armatures of induction motors." W. L. Wise. (The Maschinenfabrik Oerlikon, Switzerland.) Dated December 24th.

30,544. "Improvements relating to the electric welding of tubes and to apparatus therefor." O. Parpart. Dated December 24th.

ELECTRICAL PATENTS OF 1884, EXPIRING IN JANUARY, 1898.

We are informed by Messrs. W. P. Thompson & Co., that about 90 applications for electrical patents were filed in the month of January, 1884. Only two of the patents granted for these applications have been maintained to run their full length of term, viz., 14 years, and being of some interest we give short abstracts below.

551. "A new or improved process and apparatus for the extraction of metals from their chlorides or fluorides." L. A. Groth. (R. Cratzee, Hanover, Germany.) Dated January 3rd, 1884. The object is to obtain metals from their chlorides or fluorides. The metallic melting pot used contains an insulating case with which it communicates by means of holes; this case contains the positive electrode while the melting forms the negative. Rods of the metal, to be reduced with carbon, are placed beside the positive electrode in the insulating case, an inert or reducing gas is brought to the pot, which is provided with an outlet. The chlorine or fluorine passes out of the insulating case through a pipe near the top. 2 claims.

2,285. "Improvements in holders for incandescent electric lamps." C. Darnfeld. Dated January 28th, 1884. Consists of the construction of holders for incandescent electric lamps, the object being to enable the lampholders to be conveniently screwed on to gasoliers, chandeliers, &c., to fit the conducting wires in the lampholder in a commodious way, to protect the same from contact or any external disturbance, as well as to fix the lamp itself into the holder in the simplest way ensuring contact with the conductor. 3 claims. This patent was amended on February 6th, 1890.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free*, 9d. (*in stamps*).]

1896.

16,270. "Improvements in secondary electric batteries." M. O. A. Garreau. Dated July 22nd, 1896. The plates or electrodes consist of a grid or framework, each rectangular space in which is filled with strips of lead alternately of a flat and corrugated shape. These strips are united across their centre by autogenous soldering. The plates are wrapped in parchment paper and mounted on insulating legs.

17,906. "Improvements in crossings of electric conductors for electric railways and tramways." A. T. Snell, C. E. Grove and A. F. Hills. Dated August 12th, 1896. Relates to the arrangement of conductors at cross-over roads on lines using a three-wire system. An insulated conductor at the crossing is placed above or below the working conductors, and electrically connected permanently, or through switches, with one side of the system, and the current is taken to the locomotive or motor vehicle through additional brushes and switches thereon.

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CONTENTS:

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THE STRIKE.

ONE is apt to lose sight of the heart of a matter which is daily encumbered with so many side issues. The recent Conference proved a deplorable failure, but it has been of service. It has shown the general public who are at all interested in the question that the engineering employers have all along meant what they said when they declared they would not budge on the question of hours and of management. The public have also been made aware that the men's representatives accepted everything except the 54 hours, and would have ordered the men back to work if the hours had been made 51. The public are thus face to face with the plain fact that the only point at issue in the opinion of the men's executive is a matter of three hours a week. From what we can gather the public knows that foreigners work more than nine hours a day; they know that in America the Saturday half-holiday does not exist, and they are not credulous of the working man when he calls his employer a tyrant. For many years the British workman has been the butt of the comic papers, and has been chiefly in touch with the public in the form and guise of the common plumber. All householders know the plumber and his devious ways. Now, would it surprise the general public to know that the plumber is no worse than any other class; that he is the exact counter part of the great democracy of which, say, Mr. and Mrs. Sidney Webb write in such glowing terms. The plumber is simply a workman who spends as much time as he can upon his work, and thus he forms a very valuable comparison to lay before the outside public as a sample of the type of man which obeys the orders of trades union bosses and restricts production.

We commend, therefore, the plumber in all his parts to the sympathisers of the down-trodden and tyrannised men as a sample of the quality of working against which the employers have had at last to strike. The position is now plain. Trades unionism is trying to strengthen itself by drawing on its members all over the country, as well as accepting the help of foreign workmen who hope to get all the work. Employers have not in the past been prone to federate. In doing so they have been compelled by the men, and the result has been disastrous to the men, who should pause before they give any pretext to the employers to similarly extend the area of their federation over other than the trades at present involved. We are not of those who wish to see too much federation of capital, but we are equally averse to see a federation of ignorance, and that is what the present practice of trades unionism has come to imply.

It is said that outsiders see most of a game, and when viewed from a distance, no doubt the present struggle is seen in clearer perspective than it appears to those of us in the midst of it. In the *Engineering and Mining Journal*, a writer, whom we believe to be a man of considerable attainments in all commercial and economic matters, looks on the employers' demands under the head of freedom of employment, as the recitation of the alphabet of liberty, and when he reads that this is "diametrically opposed to the first principles of trade unionism," he throws in his vote with the London *Times* in denouncing these principles as opposed to common sense. Similarly, also, he perceives the folly of trades union objections to the payment of men according to their ability. Yet he is told that this also is opposed to the sacred principles of unionism

He sees in this attitude of unionism the compulsory discharge of the aged, the infirm, and the cripples, just as we have often pointed out—the abolition, in fact, of the natural kindly sentiment we all recognise in the presence of the one-armed gatekeeper. We well recollect in our own apprenticeship days the face and figure of the old fellow whose name we have forgotten, who sat all day on a block of wood fishing with a magnet in a tray of gunmetal turnings extracting the iron. What it cost to clean this gunmetal was never counted, but it would have paid the firm to throw it away and discharge the man.

The American writer sees that trades unionism is to-day foreign in its aims and purpose from its original inception. He sees how unionism has encroached upon the rights of free contract, and has violated the economic law. He sees that its demands have only stopped short of direct stoppage of business, and that employers have been assumed to be capable of affording all they have conceded to extortion. He states plainly that trades unionism is undermining the prosperity of Great Britain by its short-sighted selfishness.

Commenting upon the truculent statement of the men that if they do drive away English trade they will follow it abroad, he says if they follow it to America they will have to be very different in their behaviour to secure steady employment. They will be glad to work 56 or 60 hours a week, and will speedily be walked out (they say fired out in America) of the shop if they stick at attending several tools at once, while if they loaf about filing or scraping they will not be asked too often if they intend to work all week on a two hours' job. He concludes that the strikers have run against three great first principles which can be warranted to stand the shock, namely:—

(1) Whoever demands more than justice will ultimately fail, and may even as a penalty of failure get less than justice. (2) Destroying the trade of a country is not the way to improve the condition of its operatives. (3) There are two sides to the labour question; and it is high time to consider not merely what the employer pays, but also what he gets for his money.

Mr. Benjamin Taylor, who writes on "The Blight of Trades Unionism," thoroughly denounces its aims and practices. In an article in *Cassier's*, in which he reviews British labour conditions, he give a concise *résumé* of the history of trade disputes during the past few years. "Whom the gods wish to destroy they first make mad" was never so applicable as to the practices of trades unionism. Most of the disputes of late years have been cases of civil wars between different unions on questions of demarcation of work. Furies themselves could scarcely compare with the fury of an engineer who finds a sinful boilermaker with a file in his hand. The different trades unions have fought among themselves over these paltry matters without any thought to the poor employer at all, and one is forced to the conclusion that all the trouble arises from the officials, who are jealous of each other, and endeavour to keep all the work possible for their own members in order to prevent other unions becoming more rich at their expense.

There is an important fact, but one sadly overlooked, that of the workmen as a whole only about one-sixth belong to the unions. We do not learn that the five-sixths are in receipt of less wages than the one-sixth. Yet on the basis of "he who is not for us is against us," we may conclude that the majority do not love the unions, and get along all right with their employers. How, then, can the employers be the tyrants they are represented to be. The real tyrant is the trades union spirit as now understood by the leaders and blindly accepted by the men.

Apart from any smashing of unionism, it is doubtful if the time has not now arrived to utterly annihilate the bogus affair which passes for unionism, and make a clean sweep of the whole crew who mismanage the union business, waste their funds, and bring their members to starvation. If the employers as a result of this present struggle only learn not to hold a candle to the devil by giving way upon any points which are opposed to sound business principles, we think good will arise. Employers in the past are largely to blame for the present condition of affairs. They have given way on an infinity of small points, perhaps none of them in itself of any serious weight, but aggregating to an immense total, and becoming, like Sindbad's old man of the sea, too burdensome to carry further.

Trade union tyranny has become a grinding tyranny; its members have, as a mass, lost all sense of honour and manliness. For exclusiveness, they have excelled the old guilds, whose tactics ruined the great cities of the middle ages. In a free country there is, and ought to be, perfect freedom to combine for lawful objects; but it is contrary to the principles of freedom for a combination to limit the freedom of the outside individual, and to set up lines of demarcation, or use immoral methods of suasion. There must be something rotten in present day unionism, when the ordinary police are unable to preserve every man in safety who is endeavouring peaceably to earn his living. If trades unionism cannot exist without such immoral means, the sooner it is destroyed the better will it be for all. The sober and industrious will profit in larger wages. The drones of the hive will perhaps be driven to mend their ways, and so far will also profit. The only losers will be the fanatics who lead the men in the ways of destruction, and run them against the rocks of the unshakeable principles of truth.

Wattage of Lamps.—The *Canadian Electrical News* draws attention to the wattage of lamps as a matter in which a saving might be effected by central stations. Lamps can be obtained of 60, 54, or 50 watts each. In an average 1,000 light plant probably an average of 6,000 lamp hours per night are supplied. The difference between using 50 watt lamps and 54 watt lamps is 24,000 watt-hours nightly, which is almost 50 horse-power-hours. Putting this at its coal equivalent shows that 50 watt lamps will save about 23 tons yearly over 54 watt lamps, and at $3 this means $69 yearly. In order to use 50 watt lamps it is absolutely necessary to have a very close voltage regulation, and this can be effected by a liberal use of copper and careful attention. Five per cent. interest on $1,400 is $70, and this liberal use of copper will not cost $1,400, so that a net saving will result, not to speak of the increased lamp capacity of the machine.

SOME NOTES ON SINGLE-PHASE MOTORS.

By A. C. EBORALL.

The position of the single-phase motor has very greatly improved within the last two years. Three years ago there were very few motors available, and these had many defects, both in starting and running. This is no longer the case, several types, whose performance leaves little to be desired, being on the market at the present time. That being so, it has occurred to the present writer that the publication of some recent notes of his, bearing on this subject, might possibly be of interest.

The single-phase motors now on the English and Continental markets may be conveniently divided into the following broad divisions:—

I.—*Constant magnetic field motors.*
II.—*Alternating magnetic field motors, and*
III.—*Induction motors.*

I.—Constant Magnetic Field Motors.

The ordinary reversed alternator, which is a typical example of this class, is, from the nature of its design and operation, of but very limited application. The complication of the exciter, and the necessity of bringing the motor up to speed, and synchronising it with the line current before switching-in, precludes its use in most situations where electric power is required. Of course, once having got it running on the load, such a reversed alternator makes a splendid motor for large powers, superior probably to any other, as it possesses the best of regulation, high efficiency, and high power factor, combined with an ability to stand any usual overload. Such a synchronous motor also possesses the very valuable property of acting as a "phase-rectifier," the power factor of the line being improved by simply regulating the motor fields—giving it more excitation than it actually needs for the load, and which is equivalent to the effect of a condenser of large capacity in the circuit. Of course, the over-exciting of such a motor must naturally not be pushed too far, else it may have the effect of causing the motor to run out of step, even when underloaded.

In accordance with what has been said above, synchronous motors of this character have been little used, owing to their difficult operation. In America, one or two installations have been laid down, principally for mill driving, and there are also several on the Continent. The methods of starting usually employed are:—(1) Running up the generator and motor together, giving the latter a start by hand, and exciting the fields from a few accumulators, or (2) running the direct coupled exciter as a motor from a storage battery of small dimensions, and which may also temporarily excite the fields, thus bringing the main unit up to the necessary speed; or, lastly (3), running up motor and exciter by means of one of the self-starting single-phase motors presently to be described. In each case the main unit must start on a loose pulley—and in each case complication and expense.

It may be remarked in passing, that all the later installations of this class have been laid down with polyphase machines, as their performance is in every way as good as that of the single-phasers, while at the same time less copper is required in the line, they are easier to start, and considerably cheaper. Their phase-rectifying properties are also good—in this connection two important Swiss power installations may be instanced in which these properties are satisfactorily utilised—one, on the Hochfelden-Oerlikon transmission, the other the Bremgarten-Zürich line, in each case three-phase synchronous motors running light and much over-excited, helping to annul the inductive drop produced by asynchronous motors running on the same circuit. In the last example the motor is of 250 H.P.—but its use is only rendered necessary by reason of the poor regulation of the generators.

Seeing that single-phase reversed alternators make such good motors when once running, it is not surprising to find that many attempts have been made to make them self-starting without the aid of external devices. These attempts have invariably taken the form of laminating the fields, and passing the supply current both through them and the armature at starting, thus causing the motor to run up to speed as an ordinary series or shunt-wound motor. Synchronism having been attained, the line current would be switched on the armature, and the fields excited by means of a direct current derived from a small commutator placed on the end of the shaft, and which is in electrical connection with the supply leads.

Probably the first commercial motor of this type was one made by Messrs. Brown, Boveri & Co., four or five years ago, and the principle of which is indicated in fig. 1. The

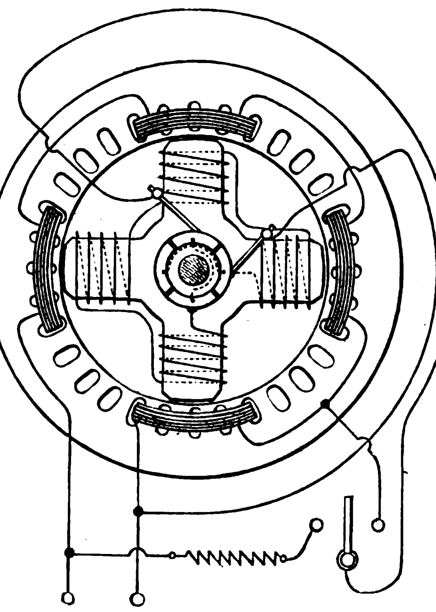


Fig. 1.

stationary armature is hole wound with rectangular coils connected in series, producing N. and S. poles round its inner periphery. The rotating field magnet is built up of star-shaped stampings, the windings being on the arms of the star. These windings may be either connected in series or in two parallels, the two free ends being brought through the shaft to an overhung commutator on one end of it. This commutator has four segments, but opposite segments are connected together (they are one casting, in fact), so that it is virtually a two-part one. Two brushes on a rocker at 90° apart lead the current to it.

The mode of starting up is as follows:—A resistance being in circuit with the fields, the latter are put in parallel with the armature, and the combination switched on the mains. The motor brushes are then shifted right forward through 90°—this being done in order to have the field current in the correct phase with regard to the armature current. The motor will now start to run up, operating as an ordinary shunt motor, and emitting a peculiar note, which changes in tone as the speed approaches synchronism. When very near a synchronous speed, the tone will change to unmistakeable beats. On these being heard, the field resistance is cut out, and the fields put in parallel with one armature coil, when the motor will run right into step and can now be loaded up. The fields are now, of course, receiving a direct current from the commutator. As to the position of the brushes—they are right back at this synchronous speed—they having been gradually shifted back as the motor ran up.

The operation of starting as described above is not nearly so complicated as it sounds, one switch shifting all the connections. In order to avoid an excessive current consumption at starting, such motors were usually started with an auto-transformer, or equivalent device.

It may be of interest to enumerate the many defects of this type of motor, and their causes.

Let the case be considered of the motor starting—an alternating current is running through both fields and armature. Now the self-induction of these is widely different, and hence the lag in the armature circuit is quite different to that in the field circuit. It follows from this that the torque exerted between the two is necessarily insignificant, because the armature current may have its maximum strength at a time when the magnet's field is quite weak. Hence the motor must start on a loose pulley.

If the brushes on the commutator are not in the right position, the motor will not start at all, for the reason given before. They must be right forward, and as the motor comes up to speed, gradually shifted back. This is done to the accompaniment of a great deal of sparking, which, however, practically ceases when the motor is running synchronously on the load.

Again, owing to the considerable air-gap required by such a field magnet, and also to the form of the latter, there is considerable magnetic leakage at all loads, but especially at

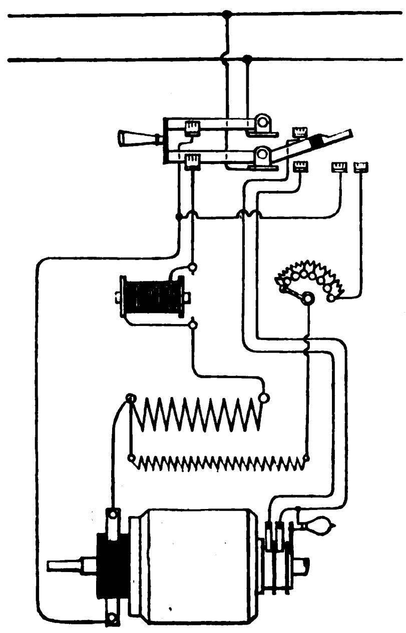


Fig. 2.

starting and heavy loads. As a result the power factor of such a motor is never high, and sometimes a very small quantity indeed.

Overloading a motor of this type to any extent is an impossibility, as it falls out of step, principally owing to leakage.

To sum up the disadvantages of this type of motor:—

1. It must start on a loose pulley.
2. It has dead points at starting.
3. The brushes must be manipulated during starting.
4. There is considerable sparking at all stages of the starting operations.
5. It is very liable to burn out.
6. Its power factor is low.
7. It cannot be overloaded to any extent.
8. It could not be commercially operated at any frequency greater than 60 ~.

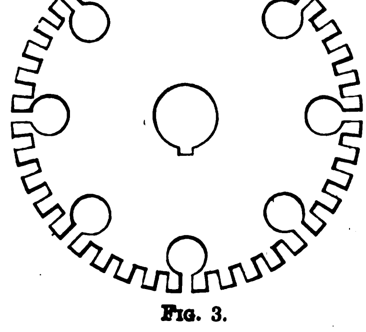


Fig. 3.

The efficiency of these motors can be made high, and this is about the only virtue they have. Owing to their many defects, Messrs. Brown have long since given up their manufacture, but motors identical in design are used for driving the Ferranti rectifiers, and possess all the faults mentioned above to a larger or smaller extent.

Messrs. Ganz & Co., of Buda-Pesth, and the Fort Wayne Company of America, have also worked at the problem of making a synchronous motor self-starting, and have met with a considerable amount of success. The motor of the latter company well merits description, as, taking it all round, it is certainly one of the best single-phase high frequency motors on the English market at the present time. Fig. 2 is a scheme of the windings and connections, and fig. 3 shows the pattern of core disc used for the armature.

(*To be continued.*)

ELECTRIC RAILROADING.

A good deal of nonsense has been uttered from time to time in connection with the development of electric traction for heavy railroad work, and (even ignoring the preposterous dreams of ordinary newspaper men who gaily throw steam locomotives on the scrap heap, and clamour for 150 miles an hour on our present railway tracks) those who presumably ought to know better, have too often been guilty of claims for which no sound basis can be shown—notably by emphasising the so-called fuel economy of stationary compound condensing engines as compared with results obtained from the average steam locomotive. They forget that the coal bill isn't the only or the chief part of a railroad's expense account.

There is, however, on the other hand, no reason why electrical engineers should go out of their way to find fault with electric traction because it apparently cannot, all at once, replace the use of steam locomotives; plenty of people—outsiders—will be ready to discount the advantages of electricity without any help or encouragement from those presumably engaged in advocating its use. We do not, therefore, quite see the object of Dr. Cary T. Hutchinson in his recent remarks before the New York Railroad Club upon the engineering side of the application of electricity to standard railroading; at any rate, his remarks would certainly not apply in this country with the force that they may have in the States.

He thinks that the application of electricity to trunk-line service is no nearer than it was at the time of Edison's first locomotive! By this, of course, he does not imply that electrical appliances have not improved, but that the conditions of railroading have continuously become more onerous; freight trains are heavier, express trains are faster and more frequent, &c.

As stated, this may hold for lines and railway systems like those in the States, where single track is common, and trains are all sandwiched in together on the one track. With us it is becoming a matter of necessity to have a four-track line, with separate tracks for goods or slow passenger, and express services. The more frequently, therefore, that expresses run under such conditions, the more economical would be the use of electric traction for such a service. Moreover, except for the first cost of motor plant, there seems no reason why still greater economy should not follow from the employment of electricity for heavy goods service also. It is because the average goods engine has a considerable amount of shunting and odd jobs of a similar kind to perform, that it manages to burn so much coal in comparison with its straightaway train mileage.

Therefore, if the goods service were also operated by electricity, the greater part of the generating plant would be taken up in providing current for work of this kind, going on for considerable periods. The demands of express traffic would only come on at infrequent intervals, but, as a whole, the power plant should have a very good load factor.

It really seems that electric railroading is very like electric lighting in regard to its application; that is, the greatest economy ensues in the latter when the *whole* of a district or area is supplied with current, and every householder uses it for all his lights. The slow development of such a satisfactory state of things has not deterred the electric light engineer from doing good pioneering work, nor should it in the case of electric traction for railroads. No one expects the North Western, the Great Western, or the Midland, to discard offhand all their fine steam locomotives, and increase the capital accounts by many millions to provide for power houses, third rails, motor cars, and electric locomotives; nor yet has anyone ever proposed to light the whole of one big city simultaneously by means of a single enterprise. The analogy is confessedly not exact, but there is much truth in it, and a step-by-step progress to maximum results may just as conceivably follow from care in choosing the best railway lines for immediate equipment, as in choosing the best areas for lighting.

NEW MODELS OF THE LALANDE OXIDE OF COPPER BATTERY.

The Lalande battery is well known to our readers,* and its inventor is continually making fresh improvements upon it.

The new models, which are simplified and reduced in price, constitute a very important improvement on the old types which were much appreciated; they enable us to avail ourselves in all security and without risk of accidents of the remarkable advantages of this battery, which only consumes its products in proportion to the work furnished; viz., enormous electrical capacity, great output and long duration, perfect constancy.

The oxide of copper is contained in cylindrical jars of perforated sheet iron enclosed in a porous substance without any appreciable resistance; the result is that the metallic deposits on the zinc are almost entirely suppressed, short circuits being thus absolutely avoided.

The zincs, which are simplified in form, are cylindrical in shape, and are hung from the sides of the glass jars. The

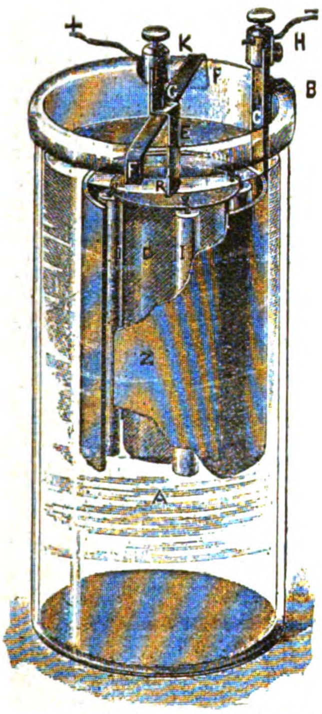


Fig. 1.—Improved Element, 1897, Large Type.

glass jars of the large and medium types are moulded by the Appert process, and are very strong.

The charges of potash for the different types are contained in tins with hermetically-sealed lids, which ensures their preservation for an indefinite period. Moreover, the dissolution of the potash is effected very easily and quickly, without any manipulation and without risk. To obtain it, we pierce with some sharp instrument, one or two little holes in the bottom of the tin opposite the lid; we remove this lid by prising up the projecting rim with a screwdriver, or some other instrument, and replace it by a perforated lid (accompanying each tin), which is fixed in place by a few blows with a hammer. The vessel containing the battery having been filled with the proper quantity of water, the tin of potash is put in upside down, being held to the top by a rod of any kind, a pencil, for instance, which is passed through the ring that is soldered on to the bottom of the tin, and rests on the sides of the glass vessel. The water enters the box through the perforated lid, driving out the air through the holes in the bottom, and soon dissolves the potash which sinks to the bottom of the vessel. When the dissolution is finished, the tin is taken out and thrown away (first shaking it to make sure that it is empty); the liquid is then very carefully stirred by means of a rod. Then, when the electrodes are put in position, the battery is ready to work.

In order to provide against accidents that might be caused in rooms, for instance, by the breaking of the glass vessel containing an element, a protective case of tin may be used, into which the glass vessel can be slipped. Then, in case of breakage, the potash is retained without the function of the element being interrupted.

The large type element (fig. 1) (total height, ·37 m.; diameter, ·18; capacity, 600 ampere-hours; internal resistance, ·03 ohm; continuous normal output, 5 to 6 amperes; forced output, 15 to 20 amperes), comprises a glass vessel, A, a cylinder of amalgamated zinc, Z, which is suspended to the sides of the vessel from a hook, B, fixed to the conducting plate, C, and a depolarising cylinder of oxide of copper, D. The latter has a conducting plate, E, which is bent double, and on which is fixed a round plate of metal, R, supporting four porcelain insulators, I, I, I, I.

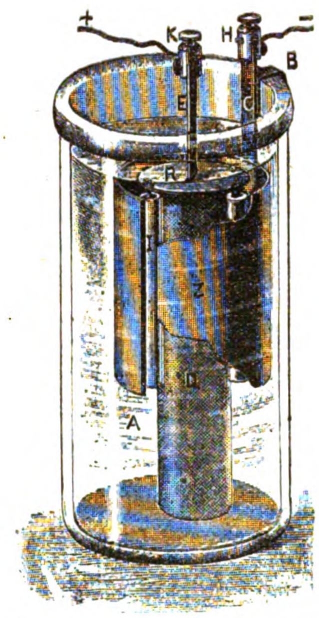


Fig. 2.—Improved Element. 1897, Medium Type.

The cylinder, with its insulators, is supported by a metal cross-piece, F F, provided with a point, G, which passes into a hole in the conducting plate; the insulators keep the electrodes equally distant from one another. The current is taken from the terminals, H and K. The medium model (fig. 2) (total height ·325 m., diameter ·15 m., capacity 300 ampere-hours, internal resistance ·05 ohm, continuous normal output 3 to 4 amperes, forced output 8 to 10 amperes), has a zinc electrode, Z, similar to that of the large model, and like it suspended to the sides of the glass vessel, A. The depolarising cylinder, D, is also placed in the centre of the zinc, Z, from which it is separated by three insulators, I, I, I; this cylinder rests on the bottom of the vessel.

The small type model (fig. 3) (total height ·2 m., diameter ·115 m., capacity 75 ampere-hours, internal resistance ·25 ohm, continuous normal output 1 ampere, forced output 2 to 3 amperes), has a zinc electrode, Z, consisting of a portion of a cylinder, and also the oxide of copper cylinder, D, opposite to it, suspended to the sides of the glass vessel. The zinc is provided with a conducting wire, H, and the cylinder of oxide with a terminal, K.

For the elements to be properly mounted it is necessary that the solution of potash should be mixed with great care, and that it should cover the electrodes of the battery to the depth of 2 or 3 centimetres.

* See *L'Electricien*, 2nd series, Vol. i., 1891, p. 409.

It is advisable, especially for elements intended to last a long time, to cover the liquid with a layer of thick oil to the depth of half a centimetre. The battery requires no other attention; its consumption is only in proportion to its work. The long duration of the elements, which are capable of producing about ten times as much work as other batteries, renders its use really economical.

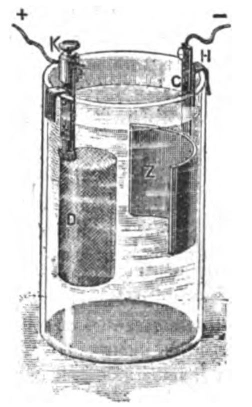


Fig. 3.

The electromotive force of the various elements is from ·8 to ·9 of a volt. Two elements have to be used in place of a bichromate or a Bunsen element.

When the battery is exhausted, its various parts, the zinc, the cylinder of oxide of copper, and the potash being calculated so as to become exhausted simultaneously, must be replaced. The other parts only can be used again after cleaning.

The oxide of copper battery is especially suited to all applications that require a large output and long duration. Amongst the most important may be mentioned the use of the battery for working the induction coils of gas and petroleum engines. Four elements can work the coil of an engine running 10 hours a day, for about a year for the large type and six months for the medium type. Some coils only require three or even two elements. — Un Praticien (*L'Electricien*).

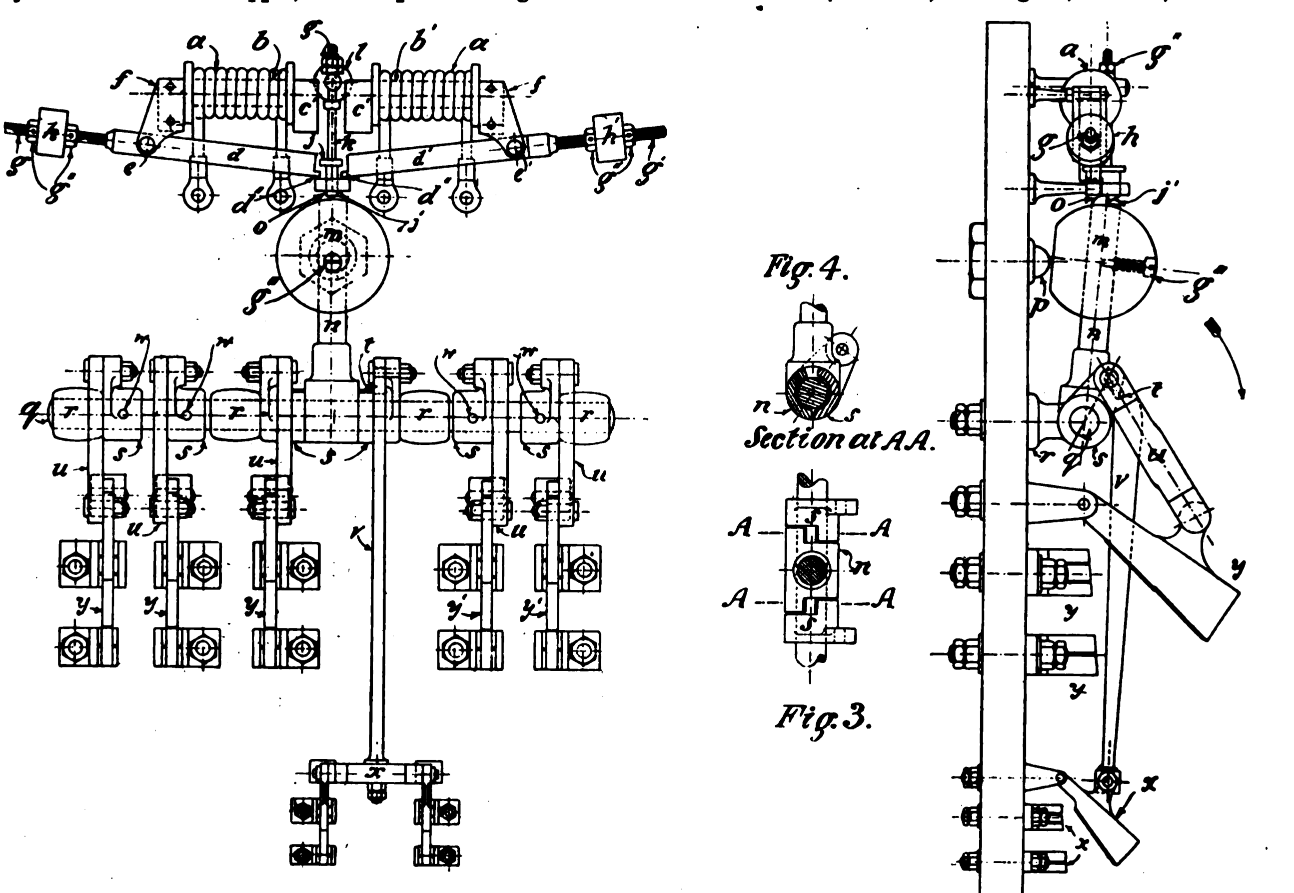


Fig. 1. Sub-Station Transformer Switch Fig. 2.

SUB-STATION TRANSFORMER SWITCH.

To reduce as much as possible the serious item of sub-station expenditure, and risk of the attendant not being on the spot when required, the automatic transformer switch, which is illustrated, has been designed by Mr. A. H. Walton, acting engineer of the Metropolitan Electric Supply Company, Limited. From the illustrations it will be seen that this apparatus has in all six switches—one double-pole switch for the primary, mounted on an independent marble base; two single-pole switches for short-circuiting the solenoids after the switch is brought into action, and three for connecting the transformer on the low tension side of a three-wire system. Its action will be obvious.

Fig. 1 is a front elevation of the automatic switch, showing the full details of the apparatus as arranged for transformers working on a three-wire system, the coils, a a', being in the main circuit, one on each of the outer wires. Fig. 2 shows a side elevation of the same.

Fig. 3 shows point at which the weight operates. Fig. 4 is a section on line A A, fig. 3.

a and a' are electro-magnets, magnetised by the aforesaid electrical energy requiring adjustment, having laminated cores, b and b', with projecting pole-pieces, c and c', suitably shaped for attracting the armatures, d and d', which armatures are pivoted to the pieces, e and e', of the bases, f and f', of the electro-magnets.

The armatures are counterweighted and adjusted by the regulating screws, g and g', which regulate the position of the balance weights, h and h', these weights being locked in any desired position on the screws by the nuts, g'', as shown.

The armatures, d and d', are tongued, as at d'', in order to engage (when being drawn up to the pole-pieces) with the collar piece, j, attached to a spindle, k, whose freedom of motion through the pillar, l, is limited by the collar and nuts, g'', as shown; at the same time the armatures, d and d', are inoperative until they reach the collar, j, thus preventing the uncertain working of the apparatus, and also relieving the armatures, d and d', from any friction, and making the pull of the magnets perfectly constant.

m is an adjustable weight sliding on the tongued bar, n, and locked by the set screw, g''', as shown.

This weight is thrown slightly forward, beyond its centre of gravity, by the India-rubber stop, p, fig. 2.

The object of the tongue, *o*, on bar, *n*, is such that while engaging with the tongue, *j*, it prevents the weight falling further forward by gravity, whilst the current is gradually energising the electro-magnets up to the pre-arranged maximum at which the switch or switches is, or are, set to act.

The bar, *n*, works on a spindle, *q*, running through bearings, *r r r r*, to which spindle the arms, *s s s s s s*, are connected by pins, *w*, keys, or other suitable means.

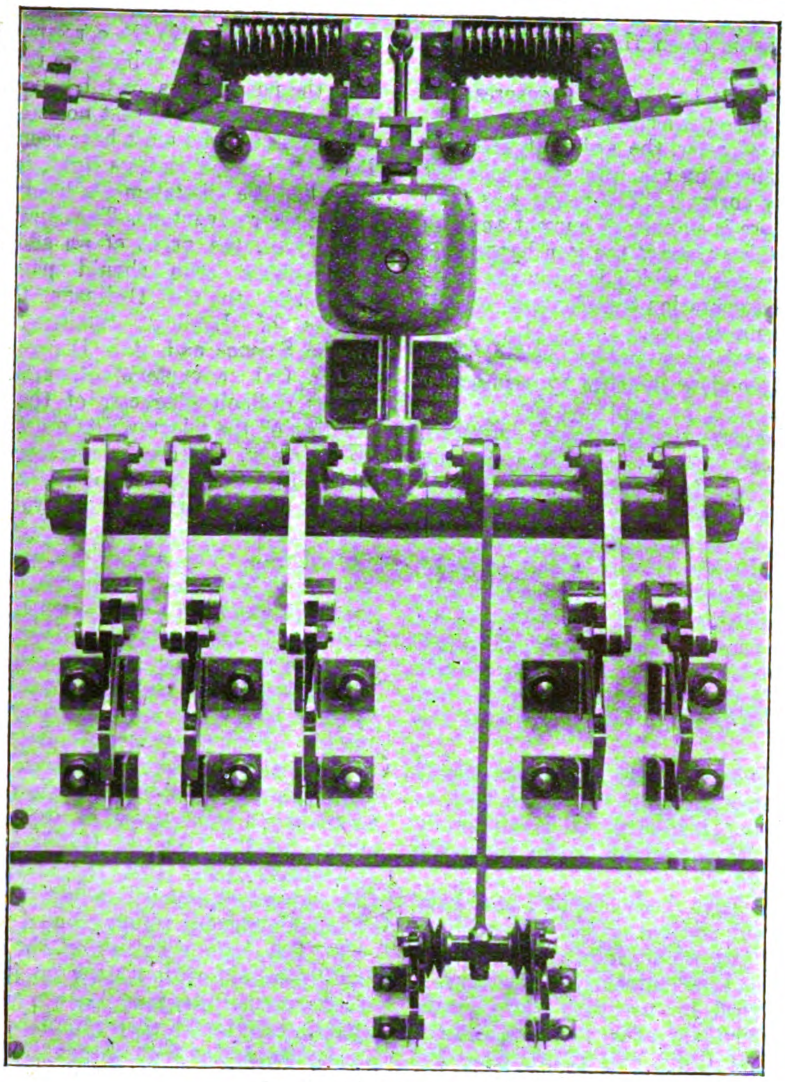
The arm, *n*, is free to move on the spindle, *q*, for a certain distance, so that it may gain sufficient momentum before the moment of actuating the body of the arms, *s s*, on either side of it.

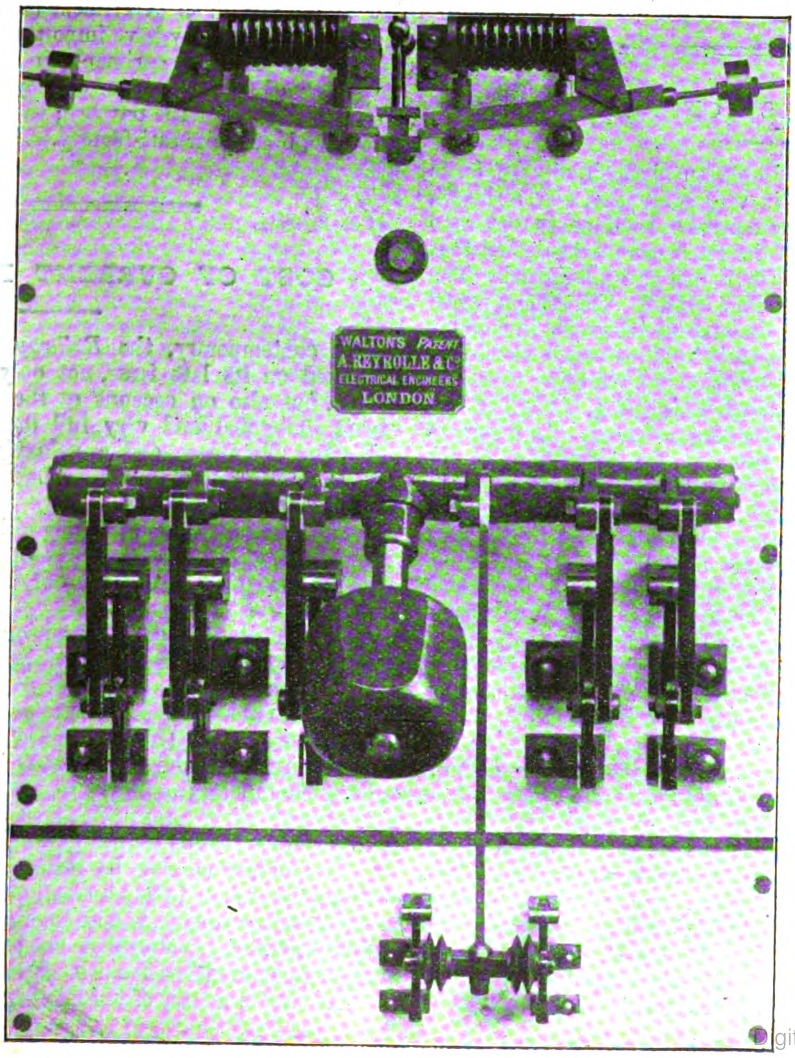
The method of actuating these arms is shown in fig. 3 and fig. 4, in which part of each side, *n*, is cut away, thus showing engaging parts of the arms with *s s*, which are similarly treated. To one of the arms, *s*, is attached a link, *v*, having a slot, *t*, shown dotted in fig. 2; the object of this slot is to enable the link, *v*, to close the small switch shown at *x* in figs. 1 and 2, for closing the primary of the transformer after the larger switches, *y y y y' y'*, have been closed.

The three switches, *y y y*, when closed, introduce the secondary of the next transformer or group of transformers as previously arranged.

The two switches, *y' y'*, are for the purpose of short-circuiting the coils, *a* and *a'*, after they have completed their work, thus saving any loss of energy in same.

It may thus be seen that on any predetermined





amount of current passing through the coils of the electro-magnets, *a* and *a'*, their armatures, *d* and *d'*, are drawn up immediately, thus releasing the weighted arm, *n*, which turns freely for a limited distance on the spindle, *q*.

On the prongs of the clutch, see fig. 3 and fig. 4, engaging the spindle, *q*, at once turns, and being attached by pins, *w*, to the arms, *s s s s s s*, closes first the five larger switches, and then by the means of the pin and slot, *t*, the small switch, *x*, attached to the link, *v*.

In opening the switches the action is the same, and the larger switches open first and the smaller switch opens last.

The chief object and advantage of this arrangement is that owing to the secondary of the transformer being closed first, the rush of current which would occur if the primary were switched in first, is prevented by the iron being magnetised by the secondary coil, and also sparking is greatly reduced when transformers are taken out of circuit.

The links, *w*, figs. 1 and 2, are insulating pieces.

The link, *v*, being metal, is insulated from the small switch at the point, *x*, fig. 1, by means of an insulating bar.

We have had an opportunity, through the courtesy of Mr. Walton, in witnessing the operation of this switch, and it appears to possess many distinct advantages; among them may be mentioned the following:—

1. The action is simple and definite. Once the switch begins to act, it does so thoroughly,

and there is no hunting, as is often the case with automatic apparatus.

2. The short-circuiting of the two solenoids ensures that no energy is absorbed when once the switch is put on.

3. In switching in a transformer, the switch first closes the secondary coil, thus magnetising the iron synchronously with the incoming primary current. The primary is then closed, and by this means there is no rush of current and rise in pressure, which so often takes place if the iron happens to be magnetised the wrong way, and which is often the cause of the breakdown of large sub-station transformers, especially where the working pressure is high.

4. The switch being essentially a gravity switch, good contact is ensured for the secondary switches by adjustment of weight as required.

5. Owing to the particular arrangements already described, the working of the magnets is certain, and the moving armatures, d d', are relieved from friction.

By its use one man can look after many sub-stations; all that he requires to do being to switch the transformers "off" after the load has fallen. In the case of a fog suddenly arising, the central station engineer may rest assured that as many transformers are switched in as are necessary, and all he has to do is to send round and switch them off at his leisure. Nor can the attendant err by leaving in too few transformers for the load, for then each transformer in turn will be automatically switched in by its predecessor until the required load is reached.

It will be noticed that this switch does not automatically cut-out, and no doubt all practical men will agree that, to ensure the sub-station being inspected, it is absolutely essential that there should be something to do when the inspector visits the sub-station.

Several of these switches have been erected, and have been in daily use, in the sub-stations of the Metropolitan Company for many months, and we are informed that their working up to the present has been eminently satisfactory.

The switch shown is designed for use with a 30-kilowatt transformer. The manufacturing of these switches is in the hands of Messrs. Reyrolle & Co. We congratulate Mr. Walton on devising so ingenious and practical a piece of apparatus, and trust it may obtain the success which it merits.

THE POST OFFICE.

The progress which this important branch of the State makes from year to year is very gratifying, and although there may doubtless be very much to be done in order to satisfy the ever exacting public, yet it cannot be denied that such progress as has been made is real and substantial. The reduction in the ordinary postage rate, in the express parcel rate, in the charge for the delivery of telegrams in country districts, &c., have been wholesale reforms which should be much appreciated. The abolition of certain vexatious restrictions have also given much satisfaction, though in this respect there is still room for improvement. In regard to telegraphic and telephonic progress, the completion of the transfer of the telephone trunk lines, hitherto owned by the National Telephone Company, took place early in the year (1897), so that at the present time the whole of the very large network of trunk wires is now exclusively controlled by the Department, and the disadvantage of a divided maintenance is avoided. The extension of the telephone system generally has been continuous, and is still progressing, and this, in conjunction with the work in connection with the telegraph system, must have severely taxed the energies of the very capable staff forming the engineering branch of the Department.

On April 1st the recommendation of the Tweedmouth Commission on Post Office Establishments came into effect, but the dissatisfaction which was expressed by a large body of the staff resulted in a special committee being appointed, which committee recommended certain modifications in the original report, and these have been carried into effect. The modifications, however, did not include any change in the scales of pay which the Tweedmouth Committee had recommended. Whether these scales are really adequate or not we do not express an opinion upon, but in the correspondence which took place in our columns on the subject we think it became quite evident that the public press had been quite misled as to the real facts of the case, and that no attempt whatever was made by the agitators, who must have seen that the public were being led astray, to put matters right, as they doubtless would have done had the misstatements been to their disadvantage, and not to their advantage. The concession of the "double increment," *i.e.*, the grant of an additional increment to those telegraphists who should pass technical examinations equivalent to the Ordinary Grade of the City and Guilds of London Institute, and the Pass Grade of the Science and Art Department, has doubtless been taken full advantage of, and, considering the by no means difficult character of the examinations, a very large number of the telegraphists must have received the increase to their pay. As usual, however, discontented grumbles are heard in various directions, if we are to believe the statements made in the official organ of the telegraph staff. Many of the complaints are obviously absolutely without foundation. The authorities, who very properly insist that the condition under which the additional increments are to be given shall be a real possession of technical knowledge, require the applicants to produce elementary certificates from the City and Guilds and Science and Art Departments (the certificates not dating back more than five years), or, in the absence of these to pass an equivalent Departmental examination. Such conditions can certainly not be considered to err on the side of severity, especially in view of the fact that the reward is an addition to the yearly salary, and not simply a £3 or £5 prize, which is the coveted desire of those who enter for the City and Guilds examinations. All sorts of threats are made that the matter will be brought before Parliament, which will doubtless be asked to sanction the double increment being granted without any examination at all. But, seriously speaking, the general action of the telegraphists, although it may be justified to some extent, is, if the true facts were known, much more likely to excite public indignation than sympathy.

In connection with the engineering work of the Department, the construction of the underground line with paper insulation between London and Birmingham will be watched with interest. The experiment (if it may be called such) is a bold one, but may have important results.

An interesting experiment in connection with the conveyance of mails is the employment of steam, oil, and electrical vans for the purpose; the experiments so far appear to have been quite satisfactory.

COST OF CURRENT FOR TRACTION.

Our contemporary, the *Railway World*, is to be complimented on its last issue, not only for its excellent appearance, but also on account of the contents, which include a well illustrated and very full description of the Clontarf Electric Tramway, and a valuable and well-timed article upon "Tramway Power from Lighting Stations: What is a Fair Price to Charge?"

Some criticism of the latter will be opportune at the present time, and we hope may be appreciated by our readers, seeing that the subject is one of increasing interest all over the country.

After stating the general position—the whole matter being, of course, simply one of bargaining, of buying and selling—the local authorities or lighting companies naturally desiring to obtain the highest possible price per unit, whilst the tramway companies are correspondingly anxious to pay no more than current would cost if they generated it themselves—our contemporary proceeds to state the case for each side, afterwards summing up with a strong tendency on the whole to a verdict for the tramway companies.

The objection may be raised that this is no more than might be expected from a traction journal, but it falls within our province to pose as a disinterested judge in the matter; and we certainly think that no judicial summary and comment upon evidence could be clearer or more fair.

As a mere matter of chronicling figures, our contemporary first of all gives costs of producing current per unit sold in different places, which may be tabulated somewhat as follows:—

I.—*Local Authorities*—

	No.		Average cost (pence).
(*a*) Selling over 1,000,000 units per annum	4	...	1·63
(*b*) Selling from 500,000 to 1,000,000 units per annum	4	...	1·95
(*c*) Selling less than 200,000 units per annum	20	...	3·51

II.—*Companies*—

	No.		Average cost (pence).
(*a*) Selling over 1,000,000 units per annum	1	...	2·44
(*b*) Selling between 500,000 and 1,000,000 units per annum ...	3	...	2·28
(*c*) Selling less than 200,000 units per annum	12	...	4·26

Following on this we have a long statement from the manager of a large electric lighting company, whom we have not much difficulty in identifying, and who, even apart from that, might readily be put down as being engaged in negotiations for the sale of current to one or more tramways, and, therefore, particularly anxious to keep up the price. His reasoning is clever, but we think also very superficial and hardly fair, as he appears to choose out for emphasis the conditions or factors that favour his own side, without allowance for those that tell against him. Perhaps one can hardly expect impartial judgment from those vitally concerned in maintaining high prices, yet we cannot too strongly urge upon the electric lighting interests that they should give all possible assistance to electric traction, inasmuch as they should have everything to gain and nothing to lose by its introduction. To choke off by prohibitive tariffs any efforts to instal electric tramways, will, to our mind, resemble the killing of the goose that lays the golden egg.

The electric lighting manager alluded to is made to say that with a tramway plant the load factor in proportion to the total capacity is, as a rule, not more than 50 per cent., whilst in a lighting station, taking load to *plant capacity running* it is not impossible nor even uncommon to get 80 per cent. utilised. Allowing a reserve of half the plant for a tramway station (though we don't see why any greater reserve is necessary there than in a lighting station) he considers that the load factor on the whole machinery in working order may for tramway work be as low as 25 per cent.

Even assuming that these figures are correct, it is decidedly one-sided to bring them forward in this way without, at least, some mention of the time element. We have always understood that the term "load factor" implied the ratio of average output to maximum output spread over the whole day of 24 hours; but, apparently, the expression has also a more limited meaning than this. The comparison would surely be in any case more fairly stated by saying that, with a lighting station, an average load factor of 80 per cent. may be realised for a few hours only per day, whilst in a tramway power house the load factor, even presuming that it is no more than 50 per cent., at any rate implies a steady consumption of current for 12 or 16 hours a day. It is, we need hardly point out, more economical, as a rule, to run 16 hours a day, even at half load, than for three or four hours only at three-quarter load, so far as wear and tear of plant is concerned, as well as general working expenses.

The net advantage is really, in this respect, most emphatically on the side of traction plants, as the *Railway World* article points out in stating the case for the tramway companies through the mouth of a prominent traction company, that may also be recognised without much trouble. The Wright system of charging at Brighton for electric supply is very suitably brought forward to prove the statement that electric tramways are exceptionally good customers for current, requiring from half to two-thirds full load for perhaps 16 hours a day. Thus the cost per unit, at 7d. for the first hour, and 1½d. for subsequent hours, works out to not more than 1·8d. per unit for the whole 16 hours.

Moreover, the further point is made that for traction work the supply of current paid for is measured *at the station*, and therefore should not be subject to any allowance in cost for losses in distribution. The percentage of current sold to that generated appears to average about 75 to 80, so that a considerable allowance ought to be made in this respect, if the tramway company is to bear distribution losses.

Winding up the discussion, our contemporary expresses a belief that we have not yet seen the end of possible economies in the production of electricity on a large scale, spread over the greater part of the day; and it instances some examples from America where the cost of power varies from a little over ¼d. to ½d. per car mile, including fuel and supplies, labour and repairs.

We are thoroughly in accord with our contemporary in considering such tariffs as 3d. and 4d. per car mile or per unit for tramway current to be simply prohibitive under average conditions; the maximum rate fairly chargeable ought not, so far as we can at present say, to exceed 2d. in view of the long hours of demand coupled with steady use of current. The momentary variations from zero to maximum which are sometimes characteristic of a line with sparse traffic doubtless affect the instantaneous governing powers of the engines, but can hardly be said to make much difference to the steady jog-trot of the recording watt-meter that helps to draw up the bill for current delivered. Nor should they necessarily imply the provision of expensive duplicate plant with greater capital outlay and consequent higher cost, in so far as that is concerned, of current delivered.

THE NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

(*Annual General Meeting, January 10th, 1898.*)

ABSTRACT OF PRESIDENTIAL ADDRESS

By Mr. John S. Raworth, M.Inst.C.E., Member of the Institution of Electrical Engineers.

Gentlemen,—My first impulse is to acknowledge with my best thanks the spontaneous and almost embarrassingly sudden invitation to accept the presidency of this Society, which your good nature has forced upon me.

As at the time of its receipt I was not even a member of Council, I had no expectation of receiving such an honour; nor am I yet satisfied, knowing as I do from my experience on the Council of the Institution of Electrical Engineers, how onerous are the duties of a president, that I shall be able to fulfil them to your satisfaction.

The war of the future will be an industrial war, in which the resource and dogged perseverance of the English race will be as much in request as they were at Waterloo. We are up to our ankles in it already, and yet our engineers, the advanced guard of our industrial forces, having heard so much about the might, majesty, and magnificence of the British Empire, have thought it a small matter to desert the trenches for six months, vainly to discuss the breadth of the proposition contained in the declaration of the Centurion of old: "I say to this man 'go,' and he goeth, and to another 'come,' and he cometh, and to my servant 'do this,' and he doeth it."

But, gentlemen, *we* know that the muscle and sinew of the engineering trade is true at heart; we know that we have the right stuff at our backs, and that when the specious agitator shall have descended to his proper place, and when danger shall have become apparent even to those who do not sit in the conning tower, then there will be no desertion, then every man will do his duty, and none will dare to speak to the man at the wheel.

The history of electrical engineering, apart from telegraphy, is so short that we have probably no member who does not carry the whole of it in his memory; it is, therefore, quite unnecessary for me to break out into reminiscences. I cannot, however, refrain from reminding you that when I started electrical engineering in Manchester 20 years ago, there existed in Mill Street, Ancoats, a factory devoted entirely to the production of dynamos, arc lamps, and projectors; we have every reason to be proud of our townsman, Mr. Henry Wilde, whose fame, though world-wide, is surpassed by his modesty; and it must be a source of satisfaction to every member of this society to know that Mr. Wilde's genius and foresight brought him a substantial fortune.

After the era of Mr. Wilde's activity, Manchester in matters electric moved but slowly; now, however, under the inspiring influence of Mr. Alderman Higginbottom's faith and fervour, it is rising to an appreciation of its possibilities, and in all probability will very soon again set the pace for the rest of the world.

The one thing we want is faith—it is quite as important in mechanics as in religion: for as by faith the walls of Jericho fell down, so will the walls of prejudice and incredulity, which at present bar your path to the promised land of fame and fortune, collapse at the first brush with the dynamics of faith.

The time for hesitation and half-heartedness is past, money is plentiful, and the investor has full confidence in "Electrics." I propose, therefore, to look ahead a little, in the hope that I may at least succeed in stimulating you to apply your minds most seriously to the problem that lies before us.

The problem is: How can we possibly supply the demand that is about to break upon us?

When we entered upon this business we had practically only one commercial outlet—viz., lighting—and we were unable by any amount of sophistry to make the public believe that electric light was cheaper than gas; now the conditions are changed, and Mr. Arthur Wright informs me that in Brighton the working-man and the fried-fish shop are his best customers. He is actually realising Mr. Preece's oft-derided statement, that the electric light is the poor man's light.

I beg you to think what the result will be so soon as the great British public shall awaken to the fact that electricity, with its enormous advantages, can be bought for actually less money than its equivalent in gas; and it may awake any moment; probably your next president may be in the happy position of having to congratulate you thereon.

I said, a moment ago, that when we entered upon this business we had practically only one commercial outlet; even to-day that same outlet is our mainstay, but other developments are growing so rapidly that one finds it impossible to keep pace with them; take, for instance, electro-chemistry; old in conception, new in economic application.

This great work has begun: who can tell when it will end, or what demand it will make on our national capacity of production?

Again the melting and welding processes are being gradually introduced into engineering workshops; intrinsically expensive, they justify their existence by electrifying into life most costly corpses—an almost infinitesimal deficiency is made good, a blow-hole is filled, a crack is welded up, hundreds of pounds are saved by the expenditure of a few shillings. At present none but the enlightened use this process, but it is only a matter of two or three years before every engineering establishment in Great Britain shall be so provided.

I have now to call your attention to the subject of locomotion, and in so doing I do not intend to discuss the question of electrical transmission of power for main lines of railways. I leave that to my successors. I would rather direct your thoughts to the more pressing question of tramways and light railways. Hitherto, we have done next to nothing, and the small experiments which have been undertaken have been carried out almost entirely with American machinery. Even under these conditions the results have been satisfactory. We must not, however, lose sight of the fact that we possess several home-made electric tramways, including Mr. Holroyd Smith's Blackpool line, which, although constructed 12 years ago in the face of difficulties not encountered in the case of any other electrical tramway in England, has nevertheless given satisfaction and paid its shareholders. We have also the Liverpool Overhead Railway, the Isle of Man tramways, and the South Staffordshire lines, as standing proofs of our native ability to deal with problems of the most varied and exacting character.

The total mileage of electrically-worked tramways in Great Britain is now 93. The projected lines, however, amount to no less than 340 miles in length, and the capital required for their equipment will certainly not be less than £3,000,000.

But even this large amount of prospective business represents only the beginning of the demand. Very soon horse traction will be superseded by electricity on the whole 1,000 miles of tramway now existing; and in addition to this, London will be honeycombed with subterranean electric railways, and provincial towns will adopt systems of surface tramways far more elaborate and extensive than those which now exist, even if they have to widen their streets to accommodate them.

There is already sufficient indication of what is coming in the attitude of Manchester, Leeds, Sheffield, and Glasgow. The fact is, that electric trams pay both the owner and the user; wherever they run no one can afford to walk, except for exercise, for the saving of time is enormous. Even in England, where the eight miles an hour rule is in force, there does not appear to be any difficulty in getting over the ground. I cannot explain this in detail; you must see it for yourselves.

What we want is to get rid of the horse in cities. He is all right in the country, but in town he is a nuisance. Consider, for one moment, what we could do if he were kept outside. Firstly, we should make our streets of hard asphalte, as smooth as a billiard table; secondly, we should keep them quite clean; thirdly, our electric motor carriages would run with so little friction, that even our present batteries would fulfil all the conditions.

The only difficulty arises out of the time necessary for making the change; if it could be made in a night, then Manchester might start on the new system to-morrow, and even Alderman Higginbottom would not recognise his native city, so delightful would it appear. But although it cannot be done in a night it will be done by a long and painful process, in which the electrical engineer will have to overcome the obstruction of bad roads and supplant the horse on his own ground; then, ultimately, the civil authorities will alter their roads to suit the new conditions.

What a pity it is that we electrical people cannot start afresh, and build a new city, embodying all the latest improvements.

I fear our electric city is a long way off, so in the meantime we must make the best of those we have, and no one will deny that there is room for improvement.

In the first place, we must abolish smoke.

Which idea brings me at one step right into the middle of a subject—the most pressing and important subject with which it is possible to engage the attention of a Lancashire audience. I refer to the driving of machinery for manufacturing purposes by electrical distribution of power, including the total abolition of line shafts, counter shafts, wheels, ropes, pulleys, and belts.

The day for tinkering with this problem is over; every man in this room knows that it can be carried through with absolute certainty, with satisfaction to the manufacturer, and with an enormous saving both to himself and the community. But the manufacturer does not yet know that the shaft of his machine can be fitted with a three-phase motor without commutator or brushes, and less complicated than his present double pulley and strap fork. When you have succeeded in impressing him with this fact, the remainder of your task will be an easy matter, but it must be undertaken methodically. The first step is to appoint a commission to settle uniform periodicity and voltage; the second is to equip an electrical manufactory capable of turning out 500 cheap motors per week; the third is for machine makers to attach the motor in place of their present pulleys, so that when a manufacturer buys a machine, he buys it all ready for attachment to his power circuit.

Having reached this point, it is obvious that the manufacturer will no longer desire to buy coal; he will be quite satisfied with watts, which may be produced at the pit's mouth, and sold retail for less than they can now be supplied mechanically to the machine axis.

The whole question of external supply of power turns on this question of economics, and your manufacturer's eyes will gleam with rapture if you can prove that you can save him a thousand a year.

Happily your task is an easy one so far as argument is concerned, and if illustration be required, I am not sure that we members of this Society could spend our savings to better advantage than by taking a representative deputation of Lancashire and Yorkshire manufacturers through Switzerland and Germany, to show them how the old order is giving place to the new; how the millwright is disappearing in favour of the electrician; how 25,000 mechanics are struggling to keep pace with the demand for electrical machinery, of which about three-fourths is required for power purposes.

Some of it, of course, is for the transmission of water-power; but even in Switzerland water-power is seldom so well placed that it can produce electrical horse-power cheaper than we can produce it by steam at the pit's mouth; that is to say, at about £4 per annum—constant service, or £38 for factory hours.

When we consider that the present cost of steam power for a cotton mill is about £3 per annum per indicated horse-power, and that the electrical horse-power required in its stead would not be more than 65 per cent., you can easily see what a large margin there is for profit to the producer and for saving to the consumer; for it must be remembered that the load curve would be practically a parallelogram, or rather two parallelograms, one for the day and a smaller one for the night.

But, gentlemen, great as would be the saving to the spinner, and the large manufacturer whose steam power costs him £3 per horse-power, it would be vastly greater to those thousands who employ small steam engines which run up the cost of power to £10 or £12 per annum. The aggregate annual saving to Manchester and Salford alone would be immense, quite beyond my power of calculation; but you must not suppose that because our imagination fails to grasp the figures involved, that the change which is coming will be long delayed on that account. Some friends of mine who have lately visited the Continent of Europe report as follows:—"Evidence was afforded us that not only are new factories all over the Continent laying down electric power throughout, but that works already equipped with steam power are pulling it out and substituting electric."

In America the same process is going on, so it follows as a matter of course that we must either quicken our pace or drop out of the running altogether.

Happily the coal pits around Manchester are so close to the city that there will be no new difficulties in transmission, and a very moderate voltage will suffice.

It is obviously outside our province to discuss the various possible methods for raising the capital. My own impression is, that when the profitable nature of the investment comes to be understood, there will be no difficulty in raising a million to put down a pioneer plant of 50,000 horse-power, with an earning capacity of close on £200,000 per annum.

Gentlemen, when I look round this room and appreciate the fact that you are the men who must carry out all these great works, then I understand the honour that is placed upon me in being called to be your president; then I feel thankful that you are all young and eager for work—there is plenty of it waiting for you—but I am not so pleased that we are few in number, for it is not possible to manufacture an electrical engineer either in five minutes or five years, so in the very nature of things our ranks will swell but slowly.

Many of you doubtless wonder, and wonder in sorrow, why our progress in this country has been so slow compared with the rapid strides which have been made on the Continent. I have seen and heard many explanations, all partially true, but the real and predominating reason is the low price of gas in this country, whereas on the Continent gas is usually so high in price that the investor did not feel any hesitation in backing electric light to beat it. Consequently, supply works and manufacturing works were developed at a great rate, and are still increasing in size and output at a speed which would frighten us in this country; and yet I have no hesitation in saying that if all our makers of dynamo-electric machinery were forthwith to proceed to double their capacity, they would not be in time to cope with the demand which will come upon them.

I have indicated to you several sources, of which three are principal ones, from any one of which sufficient demand may arise to swamp all our works; I say may arise, but the whole three may with almost equal probability be tapped at the same time, and then where shall we be? Already large quantities of machinery are being imported from the Continent and from America, simply because we are not prepared to make them here, and yet the blind leaders of the blind think this a fit time to restrict the output of our machinery. It is like shutting up the gun factories in the middle of a war. Our only hope is that the six months' discipline may atone for the six months' loss.

This brings me to the consideration of a subject which, though not strictly electrical, is nevertheless very intimately bound up with our lives and fortunes: I refer to the steam engine.

Our electrical brethren in Switzerland and in some parts of America can get along well enough without the steam engine, but it is not so with us. It is fortunate, therefore, that we have plenty of coal with which to feed him. But this abundance of coal has tended to make us less careful of it than our less fortunate neighbours. The result is, that although we make good steam engines, in spite of American comments to the contrary, we have not made economy our first consideration; we have, moreover, been confirmed in this practice by the belief that economy of coal could only be obtained by increased capital expenditure and troublesome complications. But that view is totally and fundamentally erroneous. I have already proved in my paper on the generation of electrical energy for tramways, read before the Institution of Electrical Engineers in 1897, that a high mean pressure is not uneconomical per electrical horse-power; and consequently that the gain by using large engines with very early cut-off is only apparent when the indicated horse-power is taken as the basis of comparison; further, I can give you this solid fact: that the large engines at the Wandsworth electricity station are producing an electrical horse-power at practically the same steam consumption at full load as at half load, thus showing that, taking all the losses into account, the saving effected by extreme expansion is cancelled out.

Therefore we arrive at this fact, that existing engines might easily drive more spindles without increasing the cost per spindle, although there would be an increased cost per indicated horse-power. This seeming paradox will not cause you any trouble, though it may puzzle the cotton-spinner. But, gentlemen, our friends on the Continent have gone a step further: they have improved their engine and improved their steam by superheating to such an extent, that I have actually seen a 500-horse-power engine, driving an average of 300 horse-power, fed by a single-flued boiler 5 ft. 9 in. diameter by 26 ft. long. This impressed me more than the professorial tests, which gave 8·8 lbs. of steam per indicated horse-power. To the saving in coal we must add the saving in boilers and other subsidiary apparatus.

My firm belief is that the economy now being realised in Germany by Wilhelm Schmidt and Company is obtained at a lower capital cost, and with less complication, than we find with our Lancashire engines.

Gentlemen, you are fully aware by bitter experience that the demand for steam engines in this country altogether exceeds the supply, and that in consequence of this state of affairs engines are being introduced from America, which, although well built, will not comply with English specifications as to economy; and consequently we are in the position that, however we may exert ourselves to fill the coming demand for electrical plant, we shall be either without the means of driving it, or dependent on American engineers for our steam engines.

This is not a delightful prospect, but we must face it, even if it be to the tune of two or three millions of additional capital in engineering works.

Gentlemen,—The keynote of the few words which I have had the honour of addressing to you this evening is *faith*—faith in yourselves, faith in electricity, faith in the new dispensation which is dawning on the world.

Your faith will be faith founded on knowledge; and exactly in proportion as you turn it to account by making preparation to gather in the harvest ripening under your eyes, so will be your share of the fruit. You must copy the example of the capitalist and financier, and obtain some monetary interest in every good scheme you may be connected with.

There remains for me nothing but to congratulate you on the fact that, after years of hard work, quite inadequately remunerated, the goal of your ambition is glittering before you. In a few months you will be in the position of our forefathers, the mechanical engineers, who reaped their reward almost before they had earned it. It behoves you, then, to be ready, be constantly on the watch for the little cloud no bigger than a man's hand, and wait not for the prophet to say to you: "Prepare thy chariot and get thee down, that the rain stop thee not."

ENGINEERS' STRIKE.

The present appearance of this quarrel now is that the employers are extending the area of lock-out and throwing more men upon the funds of the unions, and pressure is being brought to bear upon foremen to abandon their connection with the unions as being altogether opposed to honest service of their employers. We have all along set ourselves against any attempt at "smashing of the unions," but we are bound to say that our sympathies with trades unionism are very quickly evaporating in face of the exceedingly foolish action of the men in prolonging the dispute at the bidding of their executive in face of every just and reasonable consideration. We have upheld trades unionism, not because we have thought the men required it from want of intelligence, but because we have looked on the working man as a person as being often unable to look after his financial interests as he should do. We are more than ever convinced that he is incapable of doing so, but we are equally convinced that his employers would far better be trusted to do this for him than those who have taken the work in hand, and, in doing it, have landed the men in their present dilemma. As regards the modern form of trades unionism, we honestly believe it better that there should be no trades unionism at all than the modern form of it should any longer continue to work its wicked ways. To judge by the letters which pour into the daily press, the public are beginning to see the truth of the matter. A correspondent of the *Standard* points out that this six month's strike has put a stop on the cry of a "living wage" so much heard lately, for men have clearly demonstrated that a mere fraction of their regular wages has proved quite enough to live upon. The same correspondent points out that even when the strike is over there will be, for a long time, a heavy drain on the union funds as so many men will be unable to find work at first. He has also discovered the fact that for every hundred pounds of profit lost by the masters the men are losing five hundred pounds. Mr. T. A. Brassey writes to the *Times* suggesting that a shorter day and two shifts would probably be as productive of work as a nine hours' day on the present three shifts per day. We find that men are very averse to a two shift day. They talk about their working men's railway ticket and do so much grumbling that where the idea has been suggested it has not been carried out. But one of the best letters of the week is that of Mr. W. McDermott to last Friday's *Times*. Like ourselves, he thinks there is too much tenderness with the trades union idea. The trades union are trying their best to smash the Employers' Federation. Why has not the Federation an equal right to smash the union? The Federation does not wish to do so, but Mr. McDermott is perfectly correct when he states that the benefits which have arisen from trades unionism have been much overrated. The working men have not, he considers, benefitted by them. Wages have gone up because, formerly, British trade was ahead in every manner of mechanical appliances, and trades unionists benefitted with every one else. But now that other nations are using all the machinery possible, and English trades unionism is doing all it can to oppose machinery, it is certain that high wages can no longer be possible. It is, says Mr. McDermott, merely a coincidence that the results of machine using have been contemporary with the action of trades unionism, and the benefits credited to the latter are really due to the former. In restricting output, the men's leaders are, at any rate, striking at the root of all past success, however derived. If the men's leaders be truthful when they deny that their policy has been to restrict output, then must it be that the workmen have themselves deteriorated. They can no longer be considered fit competitors of Americans, Frenchmen, or Germans, and the sooner capital avoids the engineering trades the better will it be for capital. But Mr. McDermott only advances this contention to support the fact that it is the men's leaders who are responsible for all the mischief. He states that an English company owning works in Chicago and in England have of course to pay American workmen about third more than they pay in England to cover the difference of living. Yet the labour cost on the production of the English shop is higher than it is in America. This is not a question of race for the American workmen are largely Englishmen, who work as hard over there as Americans. They are simply freed from the paralysing influences of trades union leaders, few of whom ever did a decent day's work in their lives. The result as far as McDermott's Company is concerned is, just that the work is being done in Chicago, carried 900 miles to New York, and then to London, whence it is often sent abroad. This is simply taking work out of the country. Now, if the men who have been idle for six months, and have had the use of all the papers in the public free libraries and could have read up all that has been written in the time, and do not yet see the facts of the case, they must be blind and unthinking beings, incapable of taking their proper place in the world, and fitting dupes of their leaders. Like ourselves, Mr. McDermott does not think so much of the hours question. It is the personal matter which frets his soul, the idling, the dishonest acceptance of wages for work slovenly or half done, the mean and spiteful treatment of their non-union fellows, and their general ignorance of the plainest facts. There were reports spread a few days ago as to secessions from the Federation, but they were denied by Col. Dyer, and the only foundation from which they could have arisen seems to have been the action of one or two firms in offering to re-open on the terms agreed to at the Conference, but without success. A Carlisle firm tried it, and obtained one or two men, who left through picketing. The *Daily Chronicle* which has throughout the strike manifested a singular ignorance of facts, has made all possible out of the above, and also out of the case of Messrs. Fowler, of Leeds, who are said to have tried to come to terms with the allied trades, though members of the Federation. In the meantime another large firm in Leeds joined the Federation, and more lock-out notices have been posted in Nottingham and Preston. Sir Benjamin Dobson, at Bolton, reported the Federation solid as ever, or more so. The Bishop of Norwich rather shines out above the ruck when he states that the employers ought to be considered in their contention that trade cannot be continued if the men's demands are conceded. He falls back on prayer, but we sadly fear he knows not the British workmen. They believe not Moses nor the Prophets, though the country is overrun with foreign machinery.

The *Telegraph* is responsible for the statement that some of the strike leaders have become alive to the fact that the public are not with them. It has taken them a long time to find this out, and it will, perhaps, take them as long to realise that the public have also begun to learn that the income of the engineers on strike was much above that of the public, which is expected to subscribe. The people called on to subscribe are those who work up to 16 hours a day, are often poor clerks who have no voice in the conduct of business which they are really in a better position to understand than is a working man to meddle in shop management, and the thousand and one men in the street who don't get paid for overtime. The men's leaders are slow of thought and yet they are reported as doubting whether the

3d. levy proposed at the Memorial Hall conference will be raised. They are now hoping to drag on the strike until Parliament opens, as though Parliament—that refuge of those destitute of self help—could make a losing trade pay a fixed wage. The men have the whole business in their own hands if they would use their plain senses to see it. They have only to do a fair day's work to make engineering so busy in England that the wages of the good men would go up considerably, and employers would be well able to afford it.

If our good bishops and dons really feel an interest in the subject of the strike, why do they not join hands and employ a reputable firm of chartered accountants to examine the books of a few firms and see for themselves the proofs that apprentices and labourers are easily outworking the supposed skilled unionists? They could do this. We feel sure the books of several firms could be opened to them under the published headings of a letter, as *a*, *b*, *c*, &c. There would be some sense in this. If, having found out the truth for themselves, they then elected to pray for the conversion to a right frame of mind of the men or the masters, whichever they found to be wrong, their prayers might avail much, but, to leave it all to Heaven, savours too much of faith without works, which we all know to be very dead. Six months has shown the employers that they can do without the A.S.E., and in support of this it is pointed out that iron keeps its price and must be going into consumption. The Free Labour Association has alone supplied 24,000 men to different employers. No employer seems to be reducing wages, but all are going on in a way that ought to be very satisfactory to any real honest trades union. The fact seems every day more apparent that the men on strike are pursuing a chimera. They are standing idle on the shore and watching the tide of industry sweep past them, and on the shore they will have to remain. We cannot but help being glad that in every nation there are certain disadvantages which help to counterweigh the advantages. Were England alone in this we should speedily be ousted from the World's markets. The *Engineer* has pointed out how in America, where they are steeped to the lips in that most ignorant of superstitions—a protective policy, they have free trade in labour, and labour does very well unless upset by tariff mongering. In England we have free trade and do very well, but to the American we appear to be an ignorant and stupid set of worn out fossilised conservatives because we have not got free trade in labour. If we had free trade in both items we need not fear America. Englishmen are as inventive and as capable as any American, but of what use is it inventing a 50 per cent. better machine to be butchered by a stupid trades unionist.

Speaking at Edmonton on Sunday, Mr. Barnes had something to say about the aim of toilers to secure a more equitable distribution of the world's good than hitherto. He seems to go a curious way to attain this—putting his members on starvation diet for six months and compelling them to accept nothing of the world's good except as paupers. Then he talked about American workmen being paid more hour for hour than English workmen. This is not true in spirit. English workmen are paid hour for hour more than Americans if the purchasing value of money be taken into account. But, apart from this consideration, and in mere coin by weight, Americans are not paid one-half—often not one-tenth—of what Englishmen are paid for the same amount of work done. Further, if English workmen would do as Americans do, and would help machinery and not hinder it, their financial position would be better in every way than that of the American. Again, one stands aghast at the impudence of a man who can bring forward American workmen as a comparison when the relative attitudes to machinery are considered. However, enough of Mr. Barnes's tergiversations. A crushing reply to anything that can be truthfully advanced by the trades union is to hand in extracts from the shorthand reports of the Conference, from which it is plainly to be seen that everything was agreed to at the Conference except the change of hours. It is a good thing these notes have been published, as they will assist to prevent the public from being led away by misstatements. The reported defection of Messrs. Fowler, of Leeds, from the Federation has been shown to be false. The men themselves asked the firm to meet them for a friendly conference. Perhaps the men are a bit tired of Barnes. Mr. Fowler has stated that there is no thought of making any compromise.

There are now nearly 700 firms in the Federation, and some 60 or 70 fresh lock-out notices have been posted since the Conference concluded. We observe that Mr. Barnes has a complaint about the age of workmen being on an average under 40. We do not believe Mr. Barnes, so far, at least, as the engineering trades are concerned. He calls it murder, and so on. We suppose he is referring to long hours. He refers then to those "splendid fellows in Germany" who have been sending more money. Those splendid fellows have to work a good deal longer hours than Barnes' dying lambs, who do not die of too much work, nor do they die from too little to drink. *Verbum sap.*

Mr. Yarrow is returning from America. He has been studying American methods, and he says of the workmen, "They take a greater interest in their output.

"Each man tries to do all he can, in marked contrast to the English system.

"I am surprised at the management of automatic machinery in American engineering works.

"One man here has charge of several machines; in England this is against the union rules, consequently a mechanic is idle a considerable part of his time.

"The lower prices of raw material in the United States," continued Mr. Yarrow, "have put American engineers in direct competition with English, and I believe that competition will continue to grow keener.

"Materials for the great Central Railway of London are being supplied by Americans, who are shipping steel billets to England, boiler plates to Holland, and deck beams to Belgium, which English firms formerly supplied."

It is reported that the number of men applying for reinstatement at Messrs. Denny & Co., of Dumbarton, is becoming greater.

Several employers have given written engagements to their men who have stood by them during the strike, so that their services must be retained after the strike. The Federation have issued a poster containing their conditions. We can only say that, terms or no terms, collective bargaining or not, there has got to be a change in England, and we believe it will come in the way of more honest work, and that England will not go out of business, as she certainly must do, if trades unionism be allowed any longer to work ruin, and encourage rank robbery and idleness.

CORRESPONDENCE.

Tests for Faults in Submarine Cables.

I have read with much interest a letter from Mr. W. J. Murphy, of the c.s. *Amber*, which appeared in the columns of a contemporary of the 31st ult., wherein he comments on several points in Mr. Schaefer's test—entitled "A New Method of Localising Total Breaks in Submarine Cables"—which appeared in the same journal under date October 15th, 1897. Any new method or improvement on those already known for localising faults is naturally of so great interest to all, and more especially sea-going electricians, that I have ventured to make a few remarks on the subjects mentioned in Mr. Murphy's letter.

I cannot wholly endorse Mr. Murphy's statement that "it would be rather misleading, in my opinion, to give quantitative comparison of the results by different methods of tests taken for the localisation of the same fault or break." For example, in the case of fractured conductors, there are a number of similar tests which one can apply with perfect confidence in the results, and I know of no better criterion of the merits, or otherwise, of a new test, which claims to have advantages over another—both being designed for the same character of faults—than to compare results obtained on the same fault taken under the conditions stipulated by the authors. It is simply a question of proving the test before adopting it. Under these circumstances, I consider it would be quite correct to draw comparisons between the following tests, say—Kennelly's two methods; Schaefer's, Rymer-Jones's and Cann's modification of Kennelly's, and any such tests which are practically based on Kennelly's. These being taken from one end only, *i.e.*, in the case mentioned of a fractured conductor, the personal equation of an assistant does not enter. We can, therefore, classify the above-mentioned methods under one heading, as being applicable to the same character of faults.

On the other hand, when dealing with partial earth faults of high resistance—the conductor being continuous—which necessitate tests being taken from both ends, I am quite in accord with Mr. Murphy when he remarks "that special considerations such as the faults distance, strength and variability of the electric current, condition of cable, apparatus available, the personal equation of the man at the other end, &c., renders one test in particular preferable." That *one* test cannot of course be particularised, because this again becomes a matter of individual opinion. In partial earth faults, and more especially when the fault resistance is high and variable, the personal equation of the assistant at the distant station becomes a factor of the highest importance, and when his electrical knowledge is slight, or, to say the least, very elementary, the results obtained from his end will not as a rule be very reliable, and, therefore, the lot of the electrician responsible for the localisation is not a happy one. In such a case where no skilled assistant is available, it would be far better to use the most simple tests applicable—having regard to the character of the fault—and which would give a near approximation of the distance, than to employ another method necessitating more knowledge of electrical connections, &c., and greater exactitude in key manipulation and reading—which, with skilled assistance, might rightly be considered to give more accurate results—but with only unskilled co-operation might only lead to hopeless confusion, loss of time, and, at the best, unreliable figures.

Again, in cases where the testing current is limited by the company's rule to a certain maximum voltage—owing to the general weakness of an old cable—this is greatly against some tests, and very often practically excludes their use.

With regard to the relative merits of *false* and *scale* zero tests, my experience generally has been when localising faults by the Kennelly methods that there existed but little difference in the results—if any—when employing the two tests as a check against each other on the same fault. It is in balancing to false zero that the personal equation enters more largely than in scale zero testing, especially when the fault resistance is high and changing rapidly under the action of the testing battery. Each method has its own particular merits, under certain conditions, but the scale zero method is undoubtedly the test, *par excellence*, for repairing ships, if only for one reason—though, of course, possessing other advantages—that the practical execution of the test occupies about one-third, or even less time, than when balancing to false zero, very often a matter of vital moment when the ship is hanging on to the cable, and every minute is of grave importance.

With reference to another point, "the application by Mr. Schaefer of the scale zero method to break testing is a special case, because by its use the difficulties introduced by polarisation and capacity are overcome, &c." These difficulties have already been overcome by Kennelly's tests. Again, I fail to see the soundness of Mr. Schaefer's "earth current" correction; it appears to be unreliable in principle, and not to be depended upon for many earth faults, especially those having, comparatively speaking, high and variable resistance, and with polarisation changes occurring rapidly. With a large surface exposure fault, the cable current being also steady, the results obtained may work out approximately correct. More information on the subject of this test would be useful.

As I have already trespassed too much on your valuable space, I feel I must not enlarge on any more points, but will simply remark, in conclusion, that I trust Mr. Murphy will ere long give the profession an account of the new method of locating high resistance faults which he speaks of in concluding his letter. With his varied experience of fault testing, the subject matter cannot fail to be both instructive and interesting.

Herbert E. Cann.

January 7th, 1898.

A Defence of Germany.

When next Herr R. Von Fischer-Treuenfeld takes upon himself to write in the strain of his effusion of December 28th ult., which appears in your issue of the 7th inst., perhaps he will endeavour to make himself acquainted with facts. It is all very well to speak of the German Emperor as the head of a friendly nation, but it is well known that his animosity against this country is intense, and that at the time of the Transvaal trouble he did his best—or worst—to injure England, and for years the whole press of Germany —under the surveillance of the State—for press freedom is hardly existent in Germany, has teemed with abuse of ourselves, and wild statements as to destroying England's power and commerce. Englishmen have no jealousy of fairly conducted trade rivalry; but attempted highway robbery is not commerce. Further, at the time of the Emperor-Kruger flirtation, Germans resident in Great Britain, making their living here out of our British tolerance and justice to all foreigners, made no secret of their desire to help Germany against the land which sheltered them. Your correspondent tries to make a point of Dr. Ludwig Mond's present of £100,000 to the Davy-Faraday Laboratory. Well, what of that? Did not Dr. Mond make this money, and a good many other hundred thousands, not to say millions, at Northwich in Cheshire?

Herr Treuenfeld talks of war between England and Germany as though England had fomented it, when he must know the present bad feeling has arisen entirely since his Emperor's telegram.

If Germany's Colonial expansion is to consist in grabbing England's colonies and inciting rebellion in States under England's suzerainty, the sooner we get to war the better. But we hope all Germans are not of your correspondent's persuasion, and still have some ideas of common honesty remaining. Let Germany mind her own business and leave ours alone, and let German residents in England have the decency to be loyal to the land which gives them food and shelter. So far, they have not been so. Germans are naturally a quarrelsome people; hence the 30 years' war of which Herr Treuenfeld speaks, caused, I believe, by too much fussing about this king and the other. And now that the present German Emperor makes it the first object of his life to injure England, we have Herr Treuenfeld worrying his little self because he is treated to a little ridicule by the people whose throats he is so anxious to cut.

W. H. Booth.

London, *January 8th*, 1898.

Mr. R. von Fischer-Treuenfeld protests too much; he may be more briefly answered. He has two grievances (1) our criticisms of the German Emperor; (2) the causes which lead to these "rhapsodical recitations."

With regard to the first of these, it may at once be said that if Our Gracious Queen were to make herself as absurb as her grandson sometimes does, the refined German press would be the first to point it out. Presumably Mr. R. von Fischer-Treuenfeld hesitates to show his own sense of the Imperial humour from a wholesome fear of prosecution for *lèse-majesté*—or dare we suggest that he is a convert to the New Evangelism (for ever and ever)?

As regards the second, the English do not expect a monopoly of the world's trade, nor do we begrudge Germany a commercial success. But we *do* object to English marks being put on German goods, and as all our ports and colonies have always been thrown open to German subjects and commerce on equal terms with our own, after we have prepared the way with our blood and our money, we most strongly resent the ingratitude and impudence with which the Germans continually treat us.

Mr. R. von Fischer-Treuenfeld cites emigration figures; does he take into account the great and frequent additions which have been made to the German army of late years? He talks of colonies; does he seriously suppose that German emigrants would not rather stop in the Fatherland than go to German colonies? Will he tell us that there is more money per head of population in Germany than in England? Does he not know that those who emigrate from England are largely composed of the dregs of other countries? Finally, when there are floods in Germany, who is it who gets up Mansion House funds to assist the sufferers? Do we ever go begging to Germany in our misfortunes? Would money be offered gratuitously?

All this Mr. R. von Fischer-Treuenfeld, as a German with 25 years' residence in England, knows or should know, unless his association with a German firm here has blinded his sense of thinking for himself. As he is so anxious to contribute to a mutual understanding, let him begin at home, and teach his countrymen how much they owe to England.

Audi alteram partem.

[We do not think that any interests are served by a continuation of this discussion.—Eds. Elec. Rev.]

Steam Boilers.

My attention has been drawn to a leader in your paper criticising a paper I had the honour of reading before the Northern Society of Electrical Engineers. As you thought fit to criticise, perhaps you will kindly allow me the privilege of a reply. You commence your criticism by stating "but our readers will be disposed to attach very little weight to the arguments it is meant to convey, if they judge everything by one very glaring claim." Perhaps your readers might have understood your sarcasm if you had stated what claim you referred to. Then you state: "He also claims that the water-tube boiler has the same temperature all over." If you will be good enough to read my paper again, you will find I do not say this, but "One strong point in favour of the water-tube boiler is its very perfect circulation, which means that practically all the water in the boiler is at very nearly the same temperature."

I should, of course, have been quite wrong if I had stated that the boiler had the same temperature all over because the water forced into the boiler is comparatively cold. In the case I have been experimenting with it was about 100° F.; therefore it will be quite clear that the water in the back tubes was at a considerably lower temperature than 359° F., and the fact that the back of the boiler contains the coldest water is undoubtedly the reason the exit gases are so reduced in temperature.

Then you make the statement:—"The author makes a deplorable error in his reference to the steam jet adding to the heat by its conversion into water gas as it passes through the fire." One would have expected you to be certain of your facts before criticising in so determined a manner, and I think, upon further consideration, you will admit you are wrong.

You will, I have no doubt, agree that steam blown under the fire contains a considerable amount of heat, and in passing through the fire takes the heat from the bottom of the fire during its conversion to carbon monoxide and hydrogen which readily burn upon the top of the fire, and the heat thus given off helps very considerably in the combustion of the gases which are leaving the furnace, and in that way adds considerably to the heat of the furnace. I did not for a moment think or wish to convey the idea that by blowing steam under the fire, water gas was produced without considerable heat at the bottom of the fire being absorbed; but from actual tests with water-tube boilers, I have been convinced that the transference of the heat from the bottom to the top of the fire helps the combustion very considerably.

You then make the statement: "Steam is burnt hydrogen, and cannot be burnt again unless first dissociated by the employment of exactly as much heat as it gives back again on recombination." Had I made this statement, I should have considered you would have been justified in using a much stronger expression than "deplorable error," and I cannot understand your making such a statement.

Do you suggest that if high pressure steam is allowed to condense in an air-tight vessel, the result would be anything but water H_2O, or do you suggest that the ordinary method of manufacturing water gas, as adopted by many gasworks, is impossible, because this is clearly what you imply? Steam is not burnt hydrogen, but is vaporised water H_2O, and only requires more heat and the presence of carbon to be converted to H_2CO (water gas).

In your criticism of my remarks upon steam fittings, you have, I think, overlooked a very elementary point in connection with steam practice, and my reason for advocating a large steam valve, so that the steam may leave the boiler slowly, is based upon the fact that if a stop valve upon a boiler be partially closed, allowing the steam to leave the boiler at a great velocity, water is always carried with the steam; whereas, if the steam leaves the boiler slowly, the provision of an anti-priming pipe, which is, of course, fixed in most modern boilers, prevents priming.

Evidently my remarks upon the drainage of steam pipes were more clearly understood by referring members of the Society to the diagrams, but I should have thought any engineer interested in the subject would have been conversant with the American method of draining pipes I described in my paper, and certainly the editor of such an important paper as the ELECTRICAL REVIEW.

A. B. Mountain.

[If the circulation in a steam boiler be so good, it is hardly likely that the temperature of the back tubes would be so very low for the circulation in them must be rapid. In any case there is little chance of a single row of tubes reducing the gases to the point claimed. It is lower than obtains after the gases from a Lancashire boiler have passed by 100 4-inch economiser tubes. This repeated claim for water-tube boilers is mischievous and cannot be upheld by any reason, for if the furnace temperature be 2,500° and the final be only 350°, how is it we don't get evaporations of 13 to 14 lbs. per pound of coal? Where does all the heat go? There is so little to account for in the waste gases. As regards the steam jet the words seemed to convey the impression that the steam was useful other than as now explained. We do not understand Mr. Mountain's question as to steam being other than H_2O. We did not state that water gas as made in producers was impossible, but arguments as to water gas have no bearing on boiler furnace combustion. Steam introduced in a producer is dissociated and goes to form CO and H, and possibly hydro-carbons. It simply utilises part of the exothermic production of CO to split up water to its combustible constituents. Dissociation of water is an endothermic action, and if this were not carried out the producer gases would simply go away to the condenser pipes much hotter than they do when the heat has been partially utilised to split up water. Here water becomes a means to economy because it absorbs heat otherwise wasted. In a boiler furnace it cannot have such an effect, because the gases as produced on the grate are burned at once. No good can arise from steam, except so far as it helps the draught, or is necessary to the proper combustion of hydro-carbons to which its presence seems to be needful.

As regards the arguments as to steam valve, we really cannot see how, in a boiler properly fitted with anti-priming pipe, the degree of opening of the steam valve can have the slightest effect. The valve must of necessity be opened enough to let out all the steam made. If the valve is partly closed the rapidity of flow must be checked; and this is all it can do where there is an anti-primer. Without this pipe there might be some reason in advocating a large *valve opening*, but with it, the smallest valve that will pass all the steam is the best.—EDS. ELEC. REV.]

In your issue of the 24th ult. you say the author of the above paper "makes a deplorable error in his reference to the steam jet adding to the heat by its conversion into water gas as it passes through the fire," but you follow this by an assertion of your own "that moisture in a furnace may assist combustion, for it seems to be proved that its presence is necessary to combustion, its function being that of a carrier."

May it not be taken that the steam mentioned by Mr. Mountain and the moisture mentioned by yourself, Mr. Mountain having in mind the injection of such necessary amount of steam as may be required, should come under one head, as they are both chemically one and the same thing, viz., water vapour H_2O; and although there may not be actually a larger amount of heat generated by the conversion of this vapour into water gas the burning of this water gas into H_2O and CO_2 at the top of the fire, yet the fact that this heat is on the top of the fire makes it equivalent to a larger quantity; again, it helps combustion of the other gases, and thus Mr. Mountain may be rightly entitled to assume that the total useful and available heat is increased.

John Ed. Gresty.

Dust Destructors.

As my letter was the first to appear in the ELECTRICAL REVIEW objecting to the extraordinary claims of some one trying to boom the Shoreditch type of dust destructor, is my reason for again writing to you.

If Mr. Kershaw would simply, instead of writing long letters of refutation, quietly ask himself what led to the letter signed "Practical Experience," and those which followed in the ELECTRICAL REVIEW signed by different writers, he will find it was in consequence of a paragraph having gone the round of the press, that the district of Shoreditch was producing electric light for its requirements exclusively from the burning of the household and trade refuse collected in the parish.

When I read the paragraph in a newspaper I naturally thought such an absurd statement would soon be contradicted, but finding there was no contradiction and that the statement was referred to in publications of every possible kind, religious and otherwise, and keeping in view the mischief done in the past to a great industry, caused by claims of recent years under the headings "The Cheapest System"; "Electricity for Nothing by sale of bye-products," &c., &c., was the only reason for my writing and sending a mild protest to your influential journal.

Instead of repudiating the claims to which, as results show, there are no tangible facts to support, Mr. Kershaw, wisely or otherwise, brings out the lame excuse that they are obliged to use coal on Saturday afternoons and Sundays, in consequence of the dust carts knocking off work early on Saturdays.

Adjoining parishes would, no doubt, be pleased to send a supply free to last them over Saturday afternoons and Sundays.

It is quite clear an enormous weight and bulk of house and trade refuse is required to produce steam compared with a very small weight and bulk of coal, and when you put to one side speeches of professors and others delivered at the banquet to commemorate the opening of an important central station such as Shoreditch, and arrive at solid facts, the desirability of having a destructor in close proximity to valuable electric light machinery and private residences, simply for the benefit of the heat derived from its consumption, is a very doubtful advantage, especially if you take into account the disadvantages connected with the dirt and dust produced by its destruction where cleanliness and freedom from dust is of so much importance in the generating of electric light and power, to say nothing of the absolute necessity of having a reliable and uniform heat to produce the necessary pressure of steam for the engines.

These requirements cannot possibly be supplied from the varied qualities and conditions of refuse collected in any parish or district.

Of course, all credit is due to Shoreditch for its enterprise in attempting to solve the question of the use of a dust destructor combined with the production of electric light, but there is no justification for any one connected with the experiment claiming merits in connection with the enterprise which are not supported by actual facts.

Practical Experience.

January 8th, 1898.

The letter signed John Raworth is a somewhat curious contribution to the correspondence on the above subject. Its insincerity is palpable. The attempt at humour is pitiably grotesque. The condescension of its tone simply provokes a smile.

The writer confesses himself to be a student, but he has only learnt the rudiments of the subject.

Instead of sketching ridiculous and useless diagrams, he had better get his slate and pencil and help Mr. Kershaw to work out the following simple sums, taking care that he sees that the integrants are quite correct before adding them together. The sums are quite simple, and the student should have no difficulty in working them out:—

1. What is the cost of the power producing plant of the Shoreditch plant per kw. of mean output?

2. What is the cost of coal per actual output per kw. developed up to date?

If Student Raworth is prepared to accept a little wisdom, as he has certainly no relation to the Ex-Wisehead ("X. Y. Z.") of mathematics, and although he may be a nephew of "Aunty Humbug," he will in future know that the *rationale* and importance of an interrogation is independent of the mere name of the interrogator. When Mr. Student Raworth has learnt a little more of the science of dust destruction, in its relation to steam generation, he will recognise that the questions asked Mr. Kershaw in the various published letters are proper ones, and are interesting to the electrical community more than to individuals, and that their merit is independent of the names of the writers. Some of the questions have been repeated again by Mr. Brookman, and they demand an answer; the propositions as set forth by Mr. Raworth are school-boy like in their simplicity.

"The destruction of dust produces some heat." How true!
"Some heat will generate electricity." How wonderful!!
"*Ergo*, there is some saving." How absurd!!!

This is a perfect *reductio ad absurdum* in logical deduction. One might as well argue that because there is power in the rise and fall of tides, that this power is cheap; but the fact is, the impounding cost is so high, as to destroy any economic advantage.

The actual working results, compared with those of other plants and systems, are the only allowable figures for comparison. If the cost of plant attains a certain figure, the increased interest and depreciation may wipe out any advantage that cheap and nasty material may claim to possess.

Enquirer.

Some of your correspondents, Shoreditch and otherwise, appear to be much exercised in their minds with respect to the criticism passed upon these works, or the results, by your several correspondents. Surely this is very unreasonable. All that is wanted is reliable information, and that there appears to be some hesitation in supplying. I am quite in accord with you, Mr. Editor, and shall be only too happy to acknowledge the success of Shoreditch, should the installation prove a success even up to 75 per cent. of all that was promised. There is one matter to which reference has been made again and again, viz., the absolute silence of engineers who have a practical experience in the working of destructors year after year, I mean other than manufacturers and contractors; for instance, Laws, of Newcastle, Yabbacomb, of Bristol, and Jones, of Ealing. I think that the opinion of men such as these would be of value at the present time, and certainly would be appreciated by many.

X. Y. Z.

I am much obliged to Mr. Kershaw for his answers (as far as they go) to my questions. Had Mr. Kershaw stated two months ago that, owing to the destructor being worked under a guarantee for twelve months, it would be unwise to make any statement reflecting on the plant or appearing to reflect in any way on the performance, no doubt he would have saved himself and a number of your writers some trouble. Had I known it my questions would have not been asked, at any rate for some time to come.

I am delighted to find that the moonlighters have not seriously damaged Mr. Kershaw, and that he comes up as smiling as ever, determined to settle us all, anonymous or otherwise, with the twelve months' muzzle. However, I shall hope he will give us value for our questions when the time is up.

F. W. Brookman.

Rochdale, *January 11th*, 1898.

Dynamo Sparking.

I have long been a reader of your paper, which I have found of great use on several occasions, but I am now desirous of asking your assistance on the following subject.

I have in my case two dynamos, used chiefly for motor driving, each giving 750 amperes at 105 volts, and as the load varies considerably I have a deal of sparking at the brushes, though I have an attendant and engine man who alters the brushes when occasion arises, still they cannot attend to it as often as I would like.

I have thought, therefore, of applying some simple form of automatic brush rocker, and I propose to do it in the following way.

At the top of the magnet yoke fix a solenoid directly over the end of the brush-holder, and connect an iron core to this end, so that as the current increases through the solenoid it will attract the core and so lift the brushes forward, a suitable weight being placed on the brush-holder to reverse the motion when the load decreases.

The weight to be lifted would be 20 lbs. or so through a distance of 3 or 4 inches.

The difficulty I am in is to find the size of iron core and size and ampere-turns of solenoid that will lift this weight. I may say that it will not be necessary for the core to move until the load is about 100 amperes.

I would be greatly obliged if you could assist me in this matter. I have Thompson's "Electric Machinery," but this does not help me.

W. H. B.

[There are probably many of our readers who have experienced the same difficulty, and doubtless some of these will give our correspondent the benefit of their advice.—EDS. ELEC. REV.]

ELECTRICAL ENGINEERING AT HOME AND ABROAD.

MR. R. PERCY SELLON writes as follows to the *Times*:—

"Within the past few weeks I have had occasion to visit the leading Continental workshops representative of an industry which has already attained considerable proportions both in the Old World and the New, and is likely in the coming century to rank as one of premier importance as a field for the investment of capital and employment of labour. I refer to that of electrical engineering.

"My tour embraced the leading industrial centres of Germany, Austria, Bohemia, Hungary, Switzerland, and France, where electrical manufacture is being conducted on a large scale. Careful inquiry and observation upon the spot have elicited the following facts, which may be of some interest at this stage of a struggle between capital and labour, which, in the respects of organisation on both sides, of orderly conduct, and of the social, if not Socialistic, issues involved, marks a new era in the history of such disputes.

"Twenty years ago the electrical engineering, as distinct from its younger sister, the telegraph, industry was non-existent. All manufacturing nations therefore had an opportunity of 'starting level' towards the goal of industrial endeavour—viz., to supply their home and the world's markets with electrical products, for which the demand has grown and is increasing by leaps and bounds. If there were any odds at all, the advantage might have been held to lie with the country on whom rested the blessings of free trade, industrial experience, world-wide commercial relations, and unparalleled Imperial and Colonial possessions.

"What is the result? Briefly, as everyone interested in the subject is fully aware, that both American and Continental electrical manufacturers are underselling British-made goods in the neutral markets of the world, such as Central and South America, Russia, China, and Japan; have supplied a substantial proportion of the demand in our own colonies, where, alas! patriotism, when weighed in the balance against prices, is found wanting; and are to-day threatening, particularly in the respects of electric traction and power plant, to introduce ruinous competition in our home market itself.

"The capital invested in the electrical plant manufacturing industry in Great Britain has been estimated at not exceeding £4,000,000 to £5,000,000, in Germany at £10,000,000 to £12,000,000, and in the United States at £25,000,000 to £30,000,000. The output of manufactured electrical goods must be substantially in proportion.

"Various special causes—such as restrictive legislation, vested interests, and the proverbial caution which constitutes the commercial 'genius' of the British people—doubtless account in part for the relatively slow development of public electrical works, especially as regards electric traction and power, in Great Britain. But they do not account for the fact that Germany and America can undersell the English manufacturer in the common markets of the world which are equally open to all comers.

"The root cause of the latter phenomenon must be traced to the relative cost and methods of production in the different countries.

"Capital can be borrowed cheaper in England than in Germany or America. Materials, taken all round, cost about the same in the former, and decidedly higher in America. Hence the difficulty does not arise on these grounds. The explanation undoubtedly lies in the conditions on which labour is obtainable.

"I found that in the Continental workshops not only is a 60-hour week the invariable rule, but that the leading trades involved in electrical manufacture—machinists, fitters, and electrical artificers—are receiving on an average 25 per cent. less wage per week; or, taken with the fact that they work 10 per cent. longer hours than are usual in England, nearly 30 per cent. less per man per hour. This, of itself, is a serious handicap for the English manufacturer; but worse remains behind.

"English employers widely accuse the trade unions of attempting to dictate as to both the quality and quantity of labour to be employed in their workshops; of endeavouring to impose artificial restraints on the free and healthy productivity of both men and machinery by discountenancing piecework; by forcing highly-paid men to be employed on machinery, where a cheaper form of labour would suffice, and by limiting their members' daily output of work to a predetermined average, based on a low rather than a high standard.

"I was unable to meet with a single Continental employer who brought similar charges against the workmen's organisations in his country; and it need not be pointed out that, if correct, these charges knock the bottom out of the argument opposed by the mens' leaders here, that shorter hours in Great Britain will not prejudice industry, because the British artisan is a 'superior' or 'intenser' workman.

"The fact that American electrical engineering manufacturers can undersell British in the world's markets, in spite of their wage rates averaging some 30 per cent. higher, is pointed to by employers here in corroboration of these charges.

"I do not wish to suggest that the American or Continental workman is more disposed to abstain from agitation than the English workman because he is better satisfied with his lot. On the contrary, all students of the subject know that their dissatisfaction is chronic and profound; and probably most will agree in thinking that English militant trade unionism is a healthier manifestation of dissatisfaction than the explosive, though temporarily suppressed, socialism of the Continent, or the American workman's periodical struggles with despotic capitalism supported by special police and shot-guns. Many will go further, and hold that rational trade unionism is in the interests not only of the working classes but of society at large, as all ordered effort is better than chaos, and that it should not be discouraged.

"But into the socio-moral aspects of the question it is not possible here to enter. My object is to call attention to the influence which unsound economic doctrines on the part of British trade unions are having upon an industry which, although at present insignificant when compared with the staple industries of the world, is growing in importance every day, and is destined to become the most important section of the engineering trades in the near future.

"There are indications that the trade union leaders are willing to disavow, if they ever seriously held, these self-destructive doctrines affecting workshop management, regarded by employers generally as of far more vital consequence than the question of hours. If the unions through their leaders would clear up the present atmosphere of doubt and uncertainty by giving a clear and unequivocal statement of their attitude, the first and most important step will have been made towards a settlement alike honourable and advantageous to unionism by resulting in its willing recognition by employers, and acceptable to industrial capital by placing it in a position to compete favourably in the world's markets.

"I am, Sir, yours, &c.,

"R. Percy Sellon.

"London, *January 10th*."

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending Jan. 11th, 1897.	£	s.
Albany	49	0
Amsterdam	113	0
Auckland	53	0
Bilboa	20	0
Bombay	86	0
Brisbane	261	0
Calcutta. Teleg mat....	250	0
Cape Town	607	0
Colombo	124	0
" Teleg. mat. ...	265	0
Durban	397	0
East London	530	0
Flushing	339	0
Fremantle	274	0
" Teleg. mat.	2,547	0
Gibraltar	422	0
Gothenburg	47	0
Hamburg Teleg. mat...	723	0
Hiogo, Teleg. mat. ...	27	0
Hong Kong	40	0
Madras	31	0
" Teleg. mat. ...	500	0
Malaga	134	0
Melbourne	715	0
" Teleg. mat...	111	0
Ostend	58	0
Otago	300	0
Passages...	183	0
Port Elizabeth	680	0
" " Teleg. mat.	1,680	0
Reval	50	0
Rockhampton	70	0
Rosario	151	0
Rotterdam	95	0
Shanghai	105	0
Singapore	36	0
Stockholm. Teleg. mat.	327	0
Sydney	409	0
" Teleg. cable ...	805	0
Wellington	75	0
Yokohama	1,199	0
Total	£14,888	0

Week Ending Jan. 11th, 1898.	£	s.
Amsterdam	125	0
Barcelona	25	0
Beira	50	0
Bombay	422	0
Cape Town	166	0
Durban	112	0
Fremantle	1,640	0
Hamburg	50	0
Lisbon	30	0
Malaga	50	0
Malta	68	0
Marseilles	85	0
Melbourne	323	0
Monte Video	36	0
New York	25	0
Ostend	35	0
Paris	162	0
Perth	49	0
Port Elizabeth... ...	450	0
Rangoon	650	0
Rouen	82	0
Santander	29	0
Shanghai	13	0
Stockholm	470	0
Sydney	336	0
Teneriffe. Teleg. cable	3,625	0
Trinidad	22	0
Yokohama	737	0
Total	£9,867	0

Foreign Goods Transhipped.

	£	s.
Bombay	40	0

Agency.—The International Trading Company have been appointed sole representatives in the United Kingdom of the Maschinenfabrik für Kabelfabrikation (Conrad Felsing, jun.), Berlin, O., and will make a special line of cable-making or wire-covering machinery.

Ajax Enclosed Arc Lamp.—We are informed that Messrs. Hill, Gifkins & Co., of 68, Victoria Street, S.W., have joined interests with Messrs. Beanland, Perkin & Co. as sole selling agents of this lamp. It has lately been considerably improved, and as now constructed for single parallel, multiple series, and constant current working, is considered to be by far the most practical of the enclosed types which have yet been introduced. It is now made in all sizes from 2½ amperes. For street-lighting purposes the new holophane inner globe, with clear outer globe, will be found specially suitable, as there is, by this arrangement, practically no loss in light, while it affords perfect diffusion. The alternating current type will be ready for delivery very shortly. The fullest possible guarantees are given with the Ajax lamp, both as regards satisfactory working and freedom from infringement of any patents.

Bankruptcy Proceedings.—A sitting of the London Bankruptcy Court was held before Mr. Registrar Linklater for the public examination of Charles Nigel Stewart, 39, Victoria Street, Westminster, whose accounts show liabilities £13,566 and a deficiency of £11,532. Under examination by the official receiver, the debtor stated that in 1895 he became chairman of the Universal Electric Carriage Syndicate, Limited, whose patents and stock were sold in the following year to the British Motor Syndicate, Limited. The last-named company formed a branch company in May, 1896, entitled the Great Horseless Carriage Company, Limited, and witness acted as manager, at a salary of £300 a year, until last June, when he resigned, owing to disagreement with one of the directors. He then joined the Directorate of the British and Continental Syndicate, Limited, which was formed to run a line of steamers between Southend and Ostend. He was liable for a considerable sum in connection with that syndicate, but had been advised that he had never been legally elected as a director. Then in July last he became a managing director of the Lombard Financial Syndicate, Limited, which was formed to work patents for photographs in colours, a telephonograph, unbreakable glass, and certain petroleum schemes. Witness attributed his insolvency to embarking on enterprises of which he had no previous knowledge, to Stock Exchange speculations, and to his liabilities in connection with the British and Continental Syndicate, Limited, and the Lombard Financial Syndicate, Limited. The examination was concluded.

Liquidation Notice.—The *London Gazette* contains notice to creditors of the Coventry Electric Tramways Company (in liquidation) to send particulars of debts or claims, and the usual particulars, to Mr. E. T. Pierson, 17, Hereford Street, Coventry, the liquidator, on or before February 21st.

Calendars.—Messrs. Veritys, Limited, have issued a calendar of the present year with a slip for each day. Some of the firm's specialities are nicely arranged in colours on the card.

A small handy wall calendar has also been sent to us by Messrs. Croggon & Co., Limited.

Changes of Address.—The National Electric Free Wiring Company, Limited, have been compelled to remove to larger premises. The registered offices will be at 8 and 10, Charing Cross Road, opposite their former premises.

Mr. Wm. Patterson, late of the City Wire Works, Newcastle-on-Tyne, informs us that he has removed to new works at Walker Gate, where he has increased facility for manufacture, and new plant.

New & Mayne, Limited.—On Wednesday, before Mr. Justice Wright, sitting as an additional judge of the Chancery Division, in the matter of New & Mayne, Limited (which was the petition of the company and the liquidator), counsel asked the Court to sanction a scheme of arrangement proposed to be made between the creditors of the company and the company. The nature of the arrangement was that the liabilities and assets of the old company should be transferred to the new company, and the one debenture holder, who held debentures securing £52,000 agreed to accept in satisfaction of those debentures £25,000 in debentures of the new company, and £27,000 in deferred stock of the new company. The unsecured creditors of the old company agreed to accept, in satisfaction of their debts, an equivalent amount of deferred debenture stock of the new company. Arrangements had been made for securing the working capital by giving power to the new company to raise £10,000 on security of the "A" debentures, which would take priority over the "B" debentures and deferred debentures stock. There were creditors to the amount of £5,020 who voted for the scheme, one creditor for £900 (whose debt was not allowed by the liquidator) voted against the scheme, and creditors for £117 did not vote. There was practically, therefore, no opposition to the scheme. His Lordship granted the application, subject to the filing of proper evidence that the meeting approving of the scheme was duly convened.

New Branch.—Messrs. Ames, Garrard & Co., have opened a branch establishment at 36, High Street, Northwich, Cheshire, where they are showing a varied selection of electric light fittings, accessories, &c. They have recently carried out a number of installations in the town, among them being both arc and incandescent lighting for business and residential premises. Other installation jobs are now in hand. The firm also lighted temporarily the table for the inauguration dinner of the directors of the Northwich Electric Supply Company on the 10th inst., the table being lighted by means of small lamps partially hidden by real flowers.

Partnership Notices.—Messrs. Clark, Forde & Taylor (Mr. Latimer Clark and Mr. Herbert A. Taylor) inform us that they have admitted into partnership Mr. R. E. Peake and Mr. Arthur L. Dearlove, who have for the past 20 years assisted them in their business of consulting, civil, electrical and cable engineers. Although we have only had the pleasure of meeting Mr. Peake on one or two occasions, Mr. Dearlove has been well known to us during the above-mentioned period, and he has occasionally contributed to our columns. We think the original members of the firm and their new partners are alike to be congratulated on the eminently wise step adopted. The style and address of the firm will be as heretofore—Clarke, Forde and Taylor, 4, Great Winchester Street, E.C.

With reference to our last week's notice under this heading, we are informed that Mr. Cortez Leigh is a partner in the firm of Lacey, Clirehugh & Sillar.

Mr. T. Scott Anderson informs us that he has taken into partnership Mr. Henry Harold Beit, A.I.E.E., and that in future the firm will be known as Scott Anderson & Beit, electrical and mechanical engineers, Royal Insurance Buildings, Sheffield. During the past year Mr. Scott Anderson has erected, besides other plants, nine electric welding plants for a great variety of work, and has also installed a complete lighting plant in a county asylum, and another in a large metropolitan hospital.

Personal.—We have pleasure in announcing that Mr. J. E. Lickfold, solicitor, has just taken offices at 4, Copthall Chambers, Throgmorton Street, E.C., where he is now practising on his own account. Mr. Lickfold was associated with the firm of Messrs. Lewis and Lewis, of Ely Place, Holborn, for over 30 years. Probably our readers have not forgotten how ably he handled all the cases in which the Electrical Review was opposed to Mr. C. B. Harness over the electropathic belt litigation, and we feel quite convinced that Mr. Lickfold will carry through equally well any legal business with which they may entrust him. We extend to him our best wishes for his success.

Mr. W. Arnot, M.I.C.E., M.I.M.E., M.I.E.E., late electrical engineer to the Glasgow Corporation, who is now carrying on business as consulting engineer, announces that his address is 79, West Regent Street, Glasgow.

Price List.—The Newton Electrical Works, Limited, have issued an 1898 price list, describing and illustrating the "Taunton" dynamos and motors. Photographic views are shown of electric haulage plant, launch and commercial motors, combined Taunton-Willans plant, combined gas engine and dynamo, transformers, switches, &c. Some instructions are given for fixing and working motors.

Staff Smoker.—A staff smoking concert of the City of London, Metropolitan and London Electric Lighting Companies was held at the Falstaff, Eastcheap, E.C., on Tuesday evening last, January 11th.

The Rumoured Amalgamation.—The *Westminster Gazette* says that what has been termed the Armstrong-Whitworth-Easton-Anderson combine does not exist, and is not likely to. As a matter of fact, the first-mentioned firm has nothing whatever to do with the important new undertaking, which will be styled "The Thames Ordnance and Engineering Company, Limited (with which is incorporated the business of Messrs. Easton, Anderson & Goolden, Limited)." The company, our contemporary understands, will be licensed by the great French firm of Schneider & Co., of Creusot and Havre, to manufacture the Schneider-Canet artillery; and by the German firm of Schuckert & Co., of Nuremberg, for the manufacture of electrical machinery under that firm's patents, everywhere save in Germany.

ELECTRIC LIGHTING NOTES.

Acton.—The Urban District Council of Acton having appointed Messrs. Kincaid, Waller & Manville to advise them on the subject of electric lighting, and at the time of so appointing them not having mentioned the fact that the Council had resolved to have two reports, Messrs. Kincaid, Waller & Manville, on hearing of this fact, felt it necessary to resign the appointment.

Asylum Lighting.—It is recommended that the works for the centralisation of the heating station and an installation for the supply of electric light be carried out at an estimated cost of £16,500. The cost per annum of gas, at 2s. 6d. per 1,000 cubic feet, is £1,100; cost of electric lighting, £978 17s. 4d.

Bangor.—The proposal to purchase a site in Garth Road for electricity works has been referred to a committee.

Bethnal Green.—A special committee recently recommended that the Vestry apply for a provisional order; that they arrange for an electrical engineer to report as to providing electricity in the parish. An amendment was moved that the recommendation be referred back. Both the motion and the amendment were defeated.

Bilston.—The scheme of the Midland Electric Corporation has been approved by the District Council on certain conditions. The Council reserves right to itself to apply for a provisional order for the district without interference on the part of the company.

Blackburn.—The Council has instructed the electrical engineer to obtain tenders for the additional electric lighting plant required during 1898, such extension not to exceed £8,000 under existing borrowing powers.

Brighton.—The Technical Instruction Committee has decided to purchase £360 worth of electrical plant to serve the double purposes of education and of lighting a portion of the building. The Committee has also resolved to appoint Mr. Armstrong as head of the Mechanical Engineering Department, at a salary of £200 per year, rising by annual increments of £25 to £250.

The Lighting Committee has appointed a sub-committee to go into the question of extensions to the public street electric lighting.

Burnley.—The Gas and Electric Lighting Committee are about to put down new plant at the electric lighting station, and are advertising for tenders for a high-speed engine and dynamo. The works are also being extended, building contracts for which have already been let. At the last meeting of the Town Council Mr. Councillor Parsons said that the Committee had entered into the question of a departure from the present system of engine with great hesitation and anxiety, but they had satisfied themselves that such a change was distinctly to the advantage of the works. Alderman Keighley expressed the opinion that the Committee were justified in adopting the proposed new plant.

The new type of engine is a high-speed compound condensing three-crank engine of 450 B.H.P.

Canterbury.—To-day (Friday) the City Council will have before them the report of the Electric Lighting Committee embodying the report of the consulting engineer, Mr. Robert Hammond, upon the tenders recently submitted for the supply and erection of plant and mains on the low tension system, for the municipal electricity supply undertaking. The Committee's recommendation is as follows:—

The Committee (acting upon the advice of the electrical engineer) recommend that the following tenders be accepted:—

Section.	Plant.	Name of firm.	Amount of tender. £	s.	d.
A.	Boiler house plant.—Lancashire boilers and accessories; mechanical stokers, feed pump, injector, economiser; electric motor.	R. Taylor & Sons.	1,512	0	0
B.	Engine house plant.—Steam dynamos and accessories: condensers, oil filter; steam, exhaust feed, blow-off and sundry pipes, valves, feed water and storage tanks, &c.	India-Rubber, Gutta-Percha Telegraph Works Company, Limited.	8,778	18	0
C.	Overhead travelling crane	James Spencer and Co.	235	0	0
D.	Switchboard and instruments ..	Crompton & Co., Limited.	999	0	0
E.	Accumulators	Chloride Electrical Storage Syndicate.	1,165	0	0
F.	Mains, insulated cables and trenching.	Fowler-Waring Cables Company, Limited.	5,836	0	0
G.	Public lamps, arc and incandescent street lamps, lamp-posts, and brackets.	Crompton & Co., Limited.	1,400	0	0
H.	Meters	S. Z. de Ferranti, Limited.	262	10	0
			£14,683	8	0

In addition to the plant included in the above sections, the estimate laid before the Local Government Board inspector included:—Connecting consumers to mains, £1,000; reinstatement of roads and footways, £500. The estimated expenditure in respect of the above items was £16,850, as against the totals of the recommended tenders, &c., of £16,183 3s., the difference of £333 3s. being more than covered by the amount included in the estimate for contingencies.

Cardiff.—Mr. W. Applebee has submitted to the Electric Lighting Committee a report upon the question of condensing water at the electricity works, and the saving effected thereby. The report sets forth the different methods of condensing, one of which has been tried at the electrical works for the past nine months, and has worked satisfactorily. The engineer recommends an extension of the system now in use, which is the cooling action derived by forcing the warm water at a slight pressure through a series of specially-shaped nozzles, which throw it into the air in jets of spray, which effectually cool it to the required degree. Mr. Applebee urged that over £100 per annum would be saved by adopting this system.

Chatham.—We understand that Messrs. Geipel & Lange have been appointed consulting engineers to the Chatham, Rochester and District Electric Lighting Company.

Cheltenham.—The net revenue of the electricity undertaking for the last quarter of 1897 was about £1,400 as compared with about £830 in the corresponding period of 1896.

Colchester.—The temporary lighting of the Military Hospital has been taken over by Messrs. Siemens Bros., Limited, and is working satisfactorily.

Croydon.—On Friday a Local Government Board inquiry was held into an application for permission to borrow several sums for municipal purposes, including £5,000 for electric lighting extensions to which we referred last week. The Town Clerk (Mr. E. Mawdesley) said they required the loan for the installation of the light in the South End, Croydon. There had been numerous requests for the light, and it was proposed to have a sub-station and additional plant at the central station. Prof. Kennedy said he had carried out all the electric lighting works for the Corporation, and the estimate was based on prices actually paid by the Corporation for work done. Alderman Miller gave his opinion as to the necessity of the work, and mentioned that there were 15,000 private lamps connected and 2,500 more had been applied for. There was no opposition.

Dundee.—The electricity rental collected for the seven months ended November 30th amounted to £1,629 7s. 11d., in December £356 8s. 9d., bringing out a total of £1,985 16s. 8d., or £277 4s. 4d. in advance of last year.

There is a proposal on foot to light High Street, Lochee, with the surplus electric energy from the Baths, and the electrical engineer (Mr. Tittensor) and the superintendent of the Baths are to report on the proposal, and give an estimate of the cost of erecting two or three arc lamps.

Eighteen electric arc lamps are to be placed in the centre of the city.

Ealing.—At last week's Council meeting, it was reported that there were now 13,412 8-candle-power lamps connected.

Elland.—The District Council has under consideration the advisability of providing the town with electric light. The committee, who visited Nelson and other towns recently, were struck with the limited space occupied by the Nelson installation. Gas at Elland is 2s. 6d. per 1,000 cubic feet, and is supplied by a private company.

Fort William.—The proprietor of the gasworks has intimated that the gasworks will be discontinued at the end of this month. Fort William will now depend entirely on electric light for illumination purposes.

Fulwood.—The District Council has consented to the application for a provisional order by the National Electric Supply Company, Limited.

Garston.—The proposal to erect a dust destructor plant in connection with the electric lighting installation is being strenuously opposed by ratepayers in Aigburth and Grassendale. The destructor site suggested is in the latter district, and it seems to be more the situation of the destructor than the idea of the destructor itself that does not meet the ratepayers' wishes. They will oppose the scheme when the Local Government Board inquiry is held, if necessary.

Glasgow.—A discussion arose at last week's meeting of the Corporation regarding the inefficiency of the arc lighting at St. Andrew's Hall. It was stated by Mr. Pettigrew, the Convener of the Lighting Committee, that if it were found that the system was defective the Committee was under an obligation to introduce a new system at the end of the present season. A report will be brought before the Corporation at that time.

Guildford.—The sixth annual report of the Guildford Electricity Supply Company shows that the subscribed capital is now £7,220, but it is anticipated that owing to the increased demand for the light further capital will shortly be required for the purpose of extending the works.

Hammersmith.—Remarkable success, says *London*, has attended the introduction of electric lighting in Hammersmith by the municipal authority. Although the works have only been in full operation for three months, the demand for current by private consumers is so great that the Vestry are about to expend a further sum of nearly £30,000 in extending the plant, so that the whole of the compulsory area mentioned in the provisional order will be covered. Only the main thoroughfares will at present be supplied with arc lamps, but as the station becomes more equipped attention will be paid to the principal side streets. There are now 104 arc lamps of 2,000-C.P. in the parish, and the extension will provide for 48 more. The number of consumers has grown to 108, and every week fresh applications are received from tradesmen and others. The scale of charges compares favourably with that of any other body in London. The Vestry is doing a good business in the supply of electricity for motive power at 2½d. per unit. A number of factories have taken advantage of the supply, as well as several large bakeries, including that belonging to Lyons, the great refreshment caterers. There are two scales for ordinary lighting purposes. Under the first a charge of 6d. per unit is made, but if the maximum demand as recorded on the indicator has been more than two hours per day, the charge is 4d. per unit for all current consumed in excess. The other alternative is a charge of 2½d. per unit, with a fixed charge of 1s. 3d. per quarter for the equivalent of every 8 C.P. lamp used at one time. The committee have ample scope for extending their plant, &c. The parish has acquired an open space of about five acres, and only about three-quarters of an acre is at present covered. The station is just on the borders of Fulham, and it is within the bounds of possibility that the Hammersmith Vestry may become the electric lighting authority for Fulham, now that they have thrown out their own scheme for establishing a system.

Hampstead.—The Vestry has appointed Mr. W. S. Ross, of Sunderland, and Mr. A. H. Seabrook, of Great Yarmouth, as assistant electrical engineers, to fill the vacancies caused by the resignation of Messrs. Hesketh & Morton.

Horsham.—A Committee has been appointed by the District Council to go into the subject of electric lighting, and a provisional order is to be applied for.

Huyton-with-Roby.—The District Council will support the British Insulated Wire Company's application for a provisional order.

Islington.—At the last Vestry meeting, in answer to Mr. Mills, the Treasurer said there had been no net profit on the working of the electric lighting installation. Mr. Towers further stated, in answer to Mr. Mills, that a sum of £1,554 2s. 2d. would be required per annum if the shorter period of repayment of loans prescribed by the Local Government Board were adopted.

Leeds.—At the last meeting of the City Council Mr. Wilson presented a report from the Parliamentary Committee as to the expediency of the purchase by the Council of the undertaking of the Yorkshire House-to-House Electricity Company, Limited, and moved its adoption. The Committee, he said, were of opinion that if the undertaking was to be purchased at all, it ought to be acquired as quickly as possible. The peculiar conditions under which the Corporation had power to acquire the undertaking made it abundantly clear that the longer the delay the greater the sum the Corporation would be called upon to pay. Up to December 31st, 1896, the House-to-House Electricity Company had expended upon works £105,377 6s. 1d., which had been discounted by the transfer to depreciation account of £4,300, thus leaving a sum of £101,077 3s 1d., certified by the official auditor of the company as the value of the undertaking at the date named. He mentioned these figures without, of course, necessarily accepting them as accurate. The Parliamentary Committee had come to the conclusion that it was the best thing the Corporation could do to lose no time in possessing themselves of the undertaking, and thus repair a mistake they made earlier. It might be there was some reason for not moving in this direction before. People had been afraid to touch electricity, but that fear had now to a great extent disappeared. The experimental stage in electric lighting had passed, and the Council would do wisely in adopting what was the unanimous recommendation of the Parliamentary Committee. The resolution was carried. Mr. Wilson moved a resolution that application be made by the Corporation to the Local Government Board for a provisional order to issue irredeemable or redeemable stock, or for powers otherwise to enable them to acquire the House-to-House Company's undertaking. He contemplated considerable difficulty in getting the necessary powers to purchase. The resolution was carried, and a third resolution was adopted empowering the Council without prejudice to their Parliamentary powers, to open negotiations with the Electricity Company for the purchase of their undertaking.

Lincoln.—The Local Government Board has sanctioned the borrowing of £1,500 for land and £19,150 for electric lighting purposes. Lincoln £3 per cent. stock is to be created to raise the sum.

Liverpool.—At a meeting of the Lighting Committee last week, it was resolved that two sets of electrical plant be ordered from Messrs. Willans & Robinson at a cost of £1,727, and that the work be proceeded with as early as possible for the Oldham Street and Paradise Street Stations. Efforts are being made to obtain in Lodge Lane and Smithdown Road the necessary ground for substations. It was also resolved that the electric main be extended along Scotland Road, at an estimated cost of £741, thus completing the system in that neighbourhood.

Llanrwst.—Mr. G. R. Peers, electrical engineer, Colwyn Bay, has written to the District Council, setting forth the conditions upon which he would be prepared to light the town with electricity. The Council is favourably disposed toward the scheme, but will first submit the matter to the ratepayers.

London.—The St. Luke's Vestry has referred it to a committee to inquire into and report upon a scheme for the better lighting of the parish with electricity or other light.

Lynn.—The Electric Lighting Committee is authorised to engage the services of an expert to advise and report upon electric lighting.

Manchester.—The City Council has agreed to the proposal mentioned last week, to purchase the plot of land in Stuart Street, Bradford, containing an approximate area of 83 statute acres, including one-half of Stuart Street, and up to the north side of the Manchester and Ashton-under-Lyne Canal, for the establishment of a new generating station, at 2½d. per square yard per annum and 21 years' purchase—equal to 4s. 4½d. per square yard freehold. The Corporation will be able to put on the land plant to supply the whole city of Manchester with electricity for lighting and traction purposes.

Merthyr.—At last week's District Council meeting the Clerk explained that up to the present time no steps had been taken to comply with the provisional order, and Messrs. Howell & Co. now sought to have the order transferred to Messrs. Crompton & Co., with whom they had made arrangements for carrying out the undertaking. The Council has passed a resolution objecting to the suggested transfer and declaring in favour of the order being revoked unless Messrs. Howell & Co. commenced the work at an early date.

Mumbles.—Mr. W. Weaver has made an offer to the Local Board to light a large area of the district by electricity at an annual cost not exceeding that at present paid, the Council to either obtain powers itself and transfer to him at his cost, or to consent to him applying for the power. The clerk is to report on the scheme.

Norden.—The District Council has had the main road lighted electrically, the contract being carried out by Mr. G. L. Adamson, electrical engineer, Smallbridge. The power house contains a 2 brake H.P. gas engine, made by the National Gas Engine Company. This engine drives a dynamo. The poles on which the line is carried are 50 yards apart, and on each alternate pole is fixed a strong lamp bracket. The lamps, which are of Edison-Swan manufacture, are 25 C.P. The formal inauguration ceremony took place in the power house at Wolstenholme some days ago.

Norwich.—The Blofield District Council has consented to the proposed application of the Norwich Electricity Company, Limited, for electric lighting powers for its district. The St. Faith's Council has also approved.

Oldbury.—Application was made by the Midland Electric Corporation and Power Distribution Company for the consent of the Council to their draft provisional order giving them power to supply the district with electric light, but the Council refused.

Otley.—A proposal was recently made at the District Council that tenders be invited from electrical engineers for lighting the streets of Otley with the electric light; but after discussion, the matter was referred to a committee for inquiries.

Penarth.—The District Council will consent to the proposed provisional order promoted by a company, on condition that certain clauses are inserted.

Peterborough.—The special Council meeting, to which we referred last week, was held at the Guildhall on 5th inst., to consider the refusal of the Local Government Board to allow the Corporation to borrow £15,000 for electric lighting on the ground that the borrowing powers of the Corporation were not sufficient. The discussion chiefly considered what reply should be sent to the board. The reply approved by the Council, after a great deal of talk, in which much that was unnecessary was said, gave a statement of the Corporation's borrowing powers, and referred to the fact that a company is applying for electric lighting powers. The Council is anxious that the undertaking should be a municipal one, and urges the board to either hold an inquiry forthwith, or receive a deputation on the matter.

Salford.—The Council is applying to the Local Government Board for a £50,000 loan to cover the cost of the land, building and machinery, to extend the electric light undertaking in accordance with the estimate submitted by the engineer. When the proposal came before the Council, Councillor Haworth stated that it was some nine months since the Electric Lighting Committee was appointed to take charge of this question. One of the first things they took in hand was to consider how the loss arose, and how to remedy it. When they took charge they had 11,400 8-C.P. lamps connected with the mains; at the present time they had 22,000, and in a week or two he anticipated they would have several thousand more. In money spent upon wages, coke and stores during the nine months they had effected a saving of £124, although they had turned out so much more current during that time. Their revenue had increased from £1,005 to £1,469, and this in spite of the fact that they were selling the current at a reduction of 33⅓ per cent. as compared with 12 months ago. That was a very satisfactory state of things for so short a time. One of the greatest obstacles they had had to contend with was that a number of customers connected with the mains only took the Corporation light when they had a breakdown in their own machinery. They had since altered the system of charging, so that anyone taking the current, for however short a time, would have to pay a charge per lamp, and they found that that had worked out in a satisfactory manner. In the June quarter, 1896, the number of units sold was 5 026, whereas in the same quarter this year it had increased to 11,513. In the September quarter, 1896, they sold 6,843, and the number had increased to 16,234 in the corresponding quarter of 1897. Next quarter there would be a further increase, and they estimated they would, at the end of the year, reduce the loss by fully £1,000. He desired to impress upon them that they had progressed as far with the scheme as it was possible at present. They had, as a matter of fact, more customers than the mains would supply. They had 22,000 lamps connected at the present time, although their power was only calculated to sustain 12,000 lights at one time. The committee had gone into the matter carefully, and proposed to build a new station in a spot which would be convenient for future developments. They had such a plot of land in view.

Sheffield.—The minutes and correspondence of the Parliamentary Committee re the proposed purchase of the electricity works and the removal of the difficulties at present in the way thereof, came before the Corporation on Wednesday. The recent decision by Mr. Justice North is referred to, and it is recommended that the Council apply to the Local Government Board for a provisional order amending so much of the Local Government Board's Provisional Order's Confirmation (No. 9) Act, 1892, as will enable the Corporation to issue irredeemable stock to an amount sufficient to raise the purchase money required for the purchase of the undertaking of the Sheffield Electric Light and Power Company, Limited, under the powers conferred by Article 60 (1, of the Sheffield, 1892, provisional order. A letter has been received from the Local Government Board stating that the Corporation's application for an order empowering the issue of irredeemable stock is under consideration. The Board point out "that for many years past they have entertained objection to the issue of irredeemable securities by local authorities, and they have been accustomed to represent their views in this matter to Parliament in connection with proposals affecting stock contained in bills promoted by local authorities. It has not been the practice of Parliament during recent years to authorise the issue of irredeemable stock, but on the contrary the Local Acts of recent Sessions relating to the issue of stock have made provision for the redemption of the stock at par within a specified period. The Board also consider that it may be doubted whether a provision such as is contemplated would not be in contravention of the Standing Orders, which (see Standing Order 173 (A), House of Commons) provide that a committee to whom a bill is referred shall not in any case allow a longer term than 60 years for the redemption of any charge or debt under the bill. Having regard to all the circumstances, it appears to the Board to be desirable that any legislation such as is suggested in the matter of the purchase of the undertaking by the City Council, should be by private bill." The Parliamentary Committee advises that notwithstanding this advice, further representations be made to the Board in conjunction with the Leeds Corporation who are seeking a provisional order similar to that which the Sheffield Corporation are applying for; that the chairman and the deputy-chairman, together with the town clerk, be appointed to join a deputation from Leeds to wait on the Right Hon. Henry Chaplin, M.P., the President of the Local Government Board, with a view to induce him to grant the provisional orders applied for, and that the members of Parliament for the city be requested to attend the proposed interview with the president of the board. The Sheffield Electric Light and Power Company has written to the Corporation, under date December 15th, saying that although Mr. Justice North's decision established that the Corporation were not in a position to require the company to sell, they were prepared—if the Corporation desired to purchase—to consider an offer, but on the basis that the sale took effect as from December 31st, 1897, or some subsequent date to be agreed upon. Certain matters connected with the company which would shortly have to be dealt with, rendered it necessary that any offer by the Corporation should be made without delay. The chairman of the Parliamentary Committee reported that the terms on which the committee had negotiated with the Sheffield Electric Light and Power Company, prior to July 5th, 1897, were that the Corporation for each £100 of the sum properly expended by the company upon their undertaking, and chargeable to capital account, should, on completion of the purchase, issue or transfer to the company, or as they might direct, £220 of new 2½ per cent. redeemable Sheffield Corporation stock, such stock not to be redeemable before the year 1925, and to be issued free from stamp duty; that the balance of the purchase money in respect of the amount payable to make up the dividends to 5 per cent. per annum should be paid by the Corporation to the company in cash on completion of the purchase, and that the date of the purchase should be May 31st, 1897. The chairman also reported that certain heads of agreement had been drawn by the late town clerk on behalf of the Corporation, and Mr. Moore on behalf of the company, which provided for certain other matters consequent on the purchase and transfer of the undertaking of the company. The Committee resolved that the chairman and deputy-chairman be authorised to negotiate with the representatives of the Sheffield Electric Light and Power Company on the terms mentioned above, namely, £220 of Sheffield Corporation 2½ per cent. Redeemable Stock for every £100 of the sum properly expended by the company upon their undertaking and chargeable to Capital Account, provided that the basis be that the sale take effect as from September 29th last, and not from December 31st, and that the amount of such capital expenditure shall not in any event exceed £112,000, any further expenditure properly made being repaid to the company with 5 per cent. interest from the date of payment.

The Committee recommends that the scheme of the General Power Distributing Company, so far as it concerns Sheffield, be opposed by the Corporation.

Stirling.—Professor Kennedy, the electrical engineer employed by the Corporation, visited the reservoirs at Touch on Saturday with a view to ascertaining whether water-power could not be utilised to drive the dynamos. He was accompanied by the Lighting Committee.

St. Pancras.—It is understood that the Vestry is to extend the electric lighting mains to the whole of the Highgate part of its district. The outlay is estimated to be about £7,585.

Sunderland.—The Lighting Committee have agreed on an application by the Sunderland Guardians to supply the Union Workhouse with electric light, to carry the mains to the Workhouse gates at a cost of £1,200.

Train Lighting.—The express trains of the Caledonian Railway running between Edinburgh and Glasgow have now been fitted up with the electric light.

Wallasey.—It has been decided to reduce the charge for electric light by one penny per unit, from 7d. to 6d., with proportionate reductions for large users.

West Bromwich.—The Town Council will oppose the application of the Midland Electric Power Distribution Company for a provisional order.

West Ham.—On Thursday, last week, a Local Government inquiry was held at the Town Hall into the application of the District Council for sanction to borrow £11,573 for electric lighting and other purposes.

Whitechapel.—The Electric Lighting Committee has been paying a visit to the Brighton Corporation electricity works in connection with its proposed installation, for which a site was recently purchased by the District Board.

Winchester.—The Winchester Electric Light and Power Company recently deposited with the City Council its plans, together with a description of the system proposed. It was proposed to get the assistance of some competent person, having technical knowledge, to advise.

Windsor.—The Windsor Electrical Installation Company have just completed a contract for the supply of steam from the central lighting station to one of the Windsor hotels for heating, cooking, and laundry purposes. The experiment has been going on for some time, and has proved so successful that a contract for five years' supply has been entered into.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Blackpool.—At last week's Town Council meeting the question of the proposed construction of a tramway on Queen's Drive, in Claremont, was discussed. Mr. Brodie, chairman of the Tramways Committee, moved that the recommendation of the committee in favour of the proposal be adopted, and also that the overhead electric system of traction be used. Mr. J. Bickerstaffe opposed the recommendation, arguing that the time was not opportune, especially as the Board of Trade had not sanctioned the overhead system. It was also pointed out that the poll of the town on the matter of a new tramway on the middle walk in Claremont Park had not yet been taken. Mr. Grime said the present line at that end of the town was worked at a loss. If the new tramway were laid, some £2,000 or £3,000 would be earned. It would be a convenience to visitors and to residents alike, besides being remunerative. Mr. Ward spoke strongly in favour of the scheme. He said the time was opportune, because the North Shore works were about to be completed. All the road would have to be pulled up, and it would cost a good deal more if the work were not done now. Mr. Bickerstaffe's amendment was defeated by 13 votes to 11. A further amendment was proposed, to the effect that the lines for the new tramway in the Park be laid down, but that no steps be taken to fix the system of electric traction for several months. During the discussion, it was pointed out that the Board of Trade had refused to allow the Corporation to adopt the overhead system on the Promenade. Now the Council wanted to utilise the powers they already possessed to work a proposed tramway through the Park on the overhead system. It was contended that if the Council went on with this, they would be administering a slap in the face to the Board of Trade, and accordingly the amendment was strongly objected to. On the other hand, hope was expressed that, despite the recent pronouncement, the Board of Trade would sanction the trolley system in the Park. At any rate, a deputation would wait upon the Board, and ask why so many other towns should be given permission to adopt the overhead system, while it was refused to Blackpool. The expensive working of the accumulator system would also be pointed out, and if necessary, demonstration could be made of the complete safety of the overhead system. In the end the amendment was defeated, and the original scheme will proceed.

Derby.—The Council has resolved, in connection with the proposed purchase of the tramways, to seek expert advice as to the value of the undertaking, and the offer to be made.

Dover.—The Town Council last week decided to order three more motor cars for the electric tramways. A quicker service is to be given, and these cars are required for the purpose.

The returns of the tramways for the week ending January 1st were:—Passengers carried, 36,236; fares taken, £150 19s. 8d.; average per day, £25 3s. 3d. The total receipts from the commencement of operation (about four months) come to £1,931 odd. The expenditure is estimated at £100 a week.

Electric Cabs.—At a meeting of a number of gentlemen interested in the motor car industry, at the Queen's Hotel, Leeds, on Thursday last, one of the electric cabs, similar to those running in London, was on view. The meeting was held under the auspices of the Electrical Vehicle Company. The vehicle was in charge of Mr. Bersey. At the conclusion of the trials the company was entertained to luncheon, the chair being occupied by Mr. Holmes, of Messrs. Holmes & Co., of Newcastle.

Glasgow.—In connection with the recent controversy regarding the new form of electric car to be used on the Springburn section, a member of the Town Council has given notice of the following motion:—"That, in view of the dangers likely to arise to passengers entering or leaving the cars by a door in the centre of the side of the cars which at present are being built, the Tramways Committee be instructed to have a tramway car constructed as speedily as possible with entrances and exits at either end."

Halifax.—The Town Council has resolved to apply to Parliament for a bill empowering it to do certain works, among them being power to lay down and work electric tramways through twelve districts, and to widen several streets.

Isle of Man.—The Isle of Man Electric Tramway Company have, according to the *Daily Tenders*, entered upon possession of all the land acquired for the extension of their line from Laxey to Ramsey.

London.—*Daily Tenders* says that applications are being invited for taking up the leave to provide and run an electric tramway on well patronised grounds, near London, now being opened to the public. Applications, by appointment, for further particulars to Messrs. Taylor & Field, 14, Victoria Street, Westminster, London, S.W.

Newcastle.—The Corporation last week had a lengthy discussion on the proposed taking over and working of the tramways as a municipal concern at the expiry of the present tramway lease. The debate was adjourned until January 26th.

Norwich.—The Blofield District Council will not consent to the proposed application of the Norwich Electric Tramways Company for tramway powers which would affect their district.

Sheffield.—The work for the extension of the tramway system has been started in earnest, and the men are busily engaged on the Nether Edge section. These new rails are to be laid as soon as possible on concrete foundations, and it is expected that the electric cars will be in working order in this part of the city by June.

The Jungfrau Railway.—The latest report on the progress of the Jungfrau Railway shows, says the *Times*, that the work of construction is being pushed forward, notwithstanding the severe weather prevailing this winter in Switzerland. Water power to the extent of 2,400 horse-power is now available at Lauterbrunnen, half of this force being utilised for the dynamos employed in the boring of the Eiger glacier tunnel. The mountain stream has been diverted from its course for a distance of six miles, extending from the water wheelhouse to Scheidegg Station and the Eiger glacier, while the open line between the Scheidegg and the glacier, with its tunnel of 88 yards, is finished in its main details, so that the electric railway over this portion will probably be opened in the first half of next June, and in time for the tourist season. The principal tunnel has been carried to a distance of 164 yards by hand boring—chiefly done by Italian workmen—and the preliminaries for tracing out the great tunnel have been accomplished after some two years of labour. The rock is found to be excellently adapted for tunnelling, and experiments on the Jungfraujoch have proved that it is reached at a depth varying from 80 feet to 100 feet under the snow, instead of at 230 feet, as was at first expected. In connection with Swiss mountain railways, it may be mentioned that the opening trial of the Gornergrat Electric Railway has proved satisfactory. The line was completed a short time ago, and it is to be opened for passenger traffic early in the spring.

West Australia.—At a recent meeting of the West Australian Mining Company, in London, the chairman said that the company had secured a valuable concession for the construction of electric tramways in the city of Perth. The concession was granted by the municipality in April last.

TELEGRAPH AND TELEPHONE NOTES.

Pacific Cable.—Speaking recently at East London, Sir John Gordon Sprigg, the Premier of Cape Colony, referred to the proposal made by the Afrikander Bond for the laying of a deep sea cable to the mother country, and said that while in England he had negotiated upon the matter, the proposition being that the cable should go from England to Gibraltar, and thence *via* Sierra Leone, Ascension, and St. Helena, to Capetown, whence it would pass overland to Durban, and from Durban be carried to Mauritius and to Perth, West Australia. The Premier added that should this scheme be carried out he would submit to Parliament that the Cape as its share should bear the cost of construction to Capetown and Durban. This idea, however, was apart from the naval contribution scheme.

Reductions in Rates to the West Indies.—The traffic manager of the Direct United States Cable Company announces the following important reductions in the rates over the wires of this company to the following places in the West Indies, and which come into force immediately:—Antigua reduced from 7s. 5d. per word to 4s. 7d.; Barbadoes reduced from 7s. 10d. per word to 5s.; Dominica reduced from 7s. 3d. per word to 4s. 5d.; Grenada reduced from 7s. 9d. per word to 4s. 11d.; Jamaica reduced from 5s. 10d. per word to 3s.; Porto Rico reduced from 8s. 8d. per word to 5s. 10d.; St. Croix reduced from 8s. 3d. per word to 5s. 5d.; St. Kitt's reduced from 7s. 9d. per word to 4s. 11d.; St. Lucia reduced from 7s. 7d. per word to 4s. 9d.; St. Thomas reduced from 8s. per word to 5s. 2d.; St. Vincent reduced from 7s. 7d. per word to 4s. 9d.; Trinidad reduced from 8s. 1d. per word to 5s. 3d.; British Guiana reduced from 10s. per word to 7s. 2d.

Rugby Telephones.—The National Telephone Company opened an exchange at Rugby on Thursday last week.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1893 ...	...
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Cape Haytien-Puerto Plata	Dec. 31st, 1897 ...	...
Puerto-Plato Martinique	Dec. 31st, 1897 ...	Jan. 6th, 1898.
Curaçao-La Guayra ...	Jan. 5th, 1898 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	.
San-Thomé-Loanda	Dec. 13th, 1897 ...	Jan. 10th, 1898.
Ceara-Maranham	Dec. 23rd, 1897 ...	...
Teneriffe-St. Louis (Senegal)	Dec. 24th, 1897 ...	...
Para-Maranham	Jan. 3rd, 1898 ...	...
Saigon-Hong Kong	Jan. 8th, 1898 ...	...
Bundaberg-New Caledonia ...	Nov. 4th, 1897 ...	...
Emden Vigo	Dec. 24th, 1897 ...	Jan. 5th, 1898.
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Carthagena - Barranquilla (Columbia)	July 4th, 1896 ...	...
Fao landlines...	Jan. 3rd, 1898 ...	Jan. 4th, 1898.
Saigon-Bangkok	Jan. 7th, 1898 ...	Jan. 10th, 1898

The Telegraph Wire Export Trade.—The last month of 1897 proved to be the busiest one of the whole 12 months, in so far as the exports of telegraph wire and apparatus connected therewith are concerned, the total value being given as £172,140, as against only £34,341 in the preceding month, and only £118,720 in December, 1896. This large increase had the result of making the 12 months total the best recorded for several years past, as will be seen from the following figures:—1897, £1,001,102; 1896, £857,174; and 1895, £782,375. The trade is one that is subject to great fluctuations, as while the lowest monthly total was £34,341 (in November), the highest was that recorded in the last month of the year—£172,140.

The Telephone Service.—The Commission of Sewers passed the following resolution last week:—"That application be made to the Treasury, asking for an inquiry into the cost and efficiency of the telephone service in London, and all other matters relating thereto."

Trunk Telephones.—The new trunk telephone line from Aberdeen to Inverness, *viâ* Peterhead, Banff, and Elgin, was opened to the public on 6th inst., and these towns are now placed in direct telephonic communication with the rest of the country.

CONTRACTS OPEN AND CLOSED.

OPEN.

Ashton-under-Lyne.—February 2nd. The Baths Committee want tenders for the installation of the necessary wires and fittings for the electric lighting of the Corporation Baths. Consulting engineers, Messrs. Lacey, Clirehugh & Sillar. See our "Official Notices" for particulars.

Bilbao.—February 28th. The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Consul at Bilbao, reporting that the provisional board appointed in connection with the electric tramway which it is proposed to lay from Zumarraga to Zumaya, in the province of Guipuscoa, invite plans and tenders, to be received by February 28th, for the construction and equipment of the line. Further particulars of the conditions of the tenders for the above-named tram line and branch, which together measure 30 miles, may be inspected at the Commercial Department of the Foreign Office any day between the hours of 11 and 6.

Bedford.—January 24th. The Corporation want tenders for the supply and delivery of vulcanised rubber cables. See our "Official Notices" January 7th.

Blackburn.—January 22nd. The Corporation want tenders for a 500-kw. continuous current steam dynamo, and a 120-kw. steam alternator. Consulting engineer, Mr. E. M. Lacey. See our "Official Notices" January 7th.

France.—January 22nd. The Municipal Authorities of Neuilly-sur-Seine are inviting tenders for the concession for the establishment and working of a central electric station in the town. Particulars from, and tenders to, La Mairie de Neuilly-sur Seine.

Germany.—January 29th. The Hanover Direction of the Prussian State Railways is inviting tenders until the 29th inst. for the supply of 39,000 porcelain insulators, 1,000 screw supports, 300 tons of galvanised wire and about 2¾ tons of insulated wire. Particulars from, and tenders to, Die Königliche Eisenbahn Direction, Hanover.

Gloucester.—January 18th. The Electricity Committee want tenders for boilers, dynamos, overhead crane, switchboard, accumulators, mains, arc lamps, meters, &c., for electric lighting. Consulting engineer, Mr. Robert Hammond. See our "Official Notices" December 10th.

Leicester.—January 31st. The Leicester Corporation invites designs and tender for motor vehicles for the collection of house refuse. Specifications and particulars, with drawings, to be sent to the Chairman of the Sanitary Committee, to the office of Mr. E. Geo. Mawbey, C.E., borough engineer, Town Hall, Leicester.

Newport.—January 24th. The Electricity Committee want tenders for the supply and erection of mains, transformers, switch gear, cast-iron posts and for arc lamps. Consulting engineer, Mr. Robert Hammond. See our "Official Notices" January 7th.

Newport.—January 25th. The Corporation want tenders for temporary electric lighting plant for the Wentwood Waterworks, for arc and incandescent lighting. See our "Official Notices."

Rochdale.—February 19th. The Corporation want tenders for steam dynamos, balancer, and boosters, &c. Engineers, Messrs. Lacey, Clirehugh & Sillar. See our "Official Notices."

Roumania.—March 15th. Tenders are being invited by the General Direction of the Roumanian Post and Telegraphs in Bucharest for the supply of 56,000 metres of galvanised iron and steel wire.

Spain.—February 1st. Tenders are being invited by the Municipal Authorities of Tarifa (Cadiz province) for the 20 years' concession for the lighting of the public streets of the town by electricity, acetylene or gas. Tenders to El Secretario del Ayantamiento de Tarifa (Cadiz) from whom particulars may be obtained.

St. Marylebone.—January 17th. The Guardians want tenders for electric light wiring and fittings at their new administrative buildings of their workhouse in Northumberland Street, W. Particulars from the Guardians' Architect, Mr. A. Saxon Snell, F.R.I.B.A., of 22, Southampton Buildings, Chancery Lane, W.C.

Stockport.—January 27th. The Corporation is wanting tenders for various plant and machinery for electricity supply works at Millgate, Stockport, including Lancashire boilers, steam dynamos, feed water heater, storage battery, electrical instruments, electrical connections, wiring, &c., at the generating stations, underground cables. Electrical engineer, Mr. James N. Shoolbred, 47, Victoria Street, S.W. See our "Official Notices" this week.

Wallasey.—January 20th. The District Council wants tenders for the supply and erection of a 5-ton hand-power overhead travelling crane for the electricity works. Engineer, Mr. J. H. Crowther. See our "Official Notices" this week.

Wimbledon.—February 2nd. The District Council wants tenders for the supply, delivery and erection of water tube boilers, condensing plant, overhead crane, high speed steam engine and alternator, switchboard, underground mains, conduits, &c. Consulting engineer, Mr. A. H. Preece. See our "Official Notices" for particulars.

CLOSED.

Blackburn.—The following are the tenders to Mr. E. M. Lacey's specification for eight 60-passenger cars for the Blackburn Corporation:—

	£	s.	d.
Crompton & Co.	6,620	0	0
Electric Construction Company	6,087	0	0
British Thomson-Houston	5,579	15	8
Laing, Wharton & Down	5,557	11	0
R. W. Blackwell	5,450	0	0
Siemens Bros. & Co.	5,444	0	0
Westinghouse Electric Company	5,296	0	0

The accepted tender is that of Messrs. Siemens Bros. & Co. who are already supplying the generating plant and are erecting the overhead line.

Dewsbury.—The Council has accepted the tender of Messrs. Crawshaw and Warburton for coal for the electricity works.

Hammersmith.—The Vestry has accepted the tender of the Electrical Construction Company, for the supply of two alternators, exciters, &c., at £3,600.

Leeds—Messrs. S. Dixon & Son have secured the contract for electric fittings, &c., for the City Square lighting.

Liverpool.—The Lighting Committee has given out a contract to Messrs. Willans and Robinson for two sets of electrical plant at £1,727.

Yarmouth.—Three tenders were received by the School Board for installing the electric light at Nelson School, as follows:—Crompton & Co., £88 10s.; Gray & Palmer, £86 5s.; and Mr. Pank, £75. The Board's architect's estimate was £65. Mr. Pank's tender was accepted.

FORTHCOMING EVENTS.

1898.

Friday, January 14th, at 8 p.m.—Institution of Civil Engineers. Students' meeting. Paper to be read:—"Mechanical Draught." By R. Gordon Mackay, Stud.Inst.C.E. Sir Albert J. Durston, K.C.B., M.Inst.C.E., will preside.

Saturday, January 15th, at 3 p.m.—North-East Coast Institution of Engineers and Shipbuilders—Visit to inspect the electric power transmission plant installed at the works of Messrs. Thos. Richardson & Sons, West Hartlepool.

Wednesday, January 19th.—Institution of Electrical Engineers Students' meeting. Discussion on "Accumulator Traction."

Thursday, January 20th.—Royal Institution. First of a course of three lectures by Prof. Dewar on "The Halogen Group of Elements."

At 2.30 p.m.—Institution of Civil Engineers—Students' visit to the Central London Railway Works.

At 8 p.m.—Chemical Society. Ballot for the election of Foreign Members. Papers as follows:—"The Action of Caustic Alkalies on Amides," by Julius B. Cohen, Ph.D., and Edward Brittain, B.Sc.; "The Formation of Monomethylaniline from Dimethylaniline," by Julius B. Cohen, Ph.D., and H. T. Calvert, B.Sc.; "Note on the Aluminium-Mercury Couple," by Julius B. Cohen, Ph.D., and H. T Calvert, B.Sc.; "Action of Chloroform and Alkaline Hydroxides on the Nitro-Benzoic Acids," by W. J. Elliott, M.A.; "Researches on the Terpenes.—II. On the Oxidation of Fenchene," by J. Addyman Gardner, M.A., and G. B. Cockburn, B.A.; "The Preparation of Pure Iodine," by Bevan Lean, D.Sc., B.A., and W. H. Whatmough.

Friday, January 21st, at 5 p.m.—Physical Society, at the rooms of the Chemical Society, Burlington House. Agenda:—(1) "On Electric Signalling without Conducting Wires," by Prof. O. Lodge, F.R.S.; (2) A Tesla Oscillator will be exhibited by Prof. S. P. Thompson, F.R.S.

At 8 p.m.—Institution of Junior Engineers, at the Westminster Palace Hotel. Lecture on "Laboratory Testing Machines, and the Latest Example," by Prof. A. C. Elliott, M.Inst.C.E., Hon.M.Inst.J.E., of Cardiff.

Saturday, January 22nd, at 3 p.m.—Institution of Junior Engineers—Visit to the Engineering Laboratory of the Central Technical College, South Kensington. Demonstrations by Prof. W. C. Unwin, F.R.S, Past Pres. Inst.J.E.

NOTES.

Photography and Light.—The New York correspondent of the *Standard* says that Mr. Tesla announces that his vacuum tubes are now so perfect, as to take photographs surpassing flash pictures. Two seconds' exposure was used at a distance of 4 feet from a tube, with a radiating surface of 200 square inches, giving 1,000 candlelight from current oscillations of 2,000,000 per second. Mr. Tesla says that his system will give an equivalent light, without heat, from tubes the size of ordinary incandescent bulbs. This may be more scientific, says the *Standard* writer, but it is less amazing than the declaration by an inventor, named Nickum, heretofore obscure, that he has obtained a brilliant permanent light from chemicals within a sealed globe. There are reputable witnesses of Nickum's light, which gives a cool, steady, mellow glow theoretically for ever, being inextinguishable, and without waste. When it is not wanted, it is laid away in a cupboard, or otherwise obscured. The only flaw in the story is that Nickum declares that the discovery, which his light attests, also disproves the theory of gravitation, and shows that a vacuum is impossible. The perpetual vibration of atoms is the base of his principle, which as yet is equally difficult of proof or disproof, those admitted to his confidence having no scientific authority.

Coherers.—An American contemporary says that Prof. Temistocle Calzecchi, of the Liceo of Fermo, claims priority over Branly himself in the discovery and employment of coherers. As long ago as July, 1884, he says he made known the characteristic properties of metallic filings in the pages of the *Nuovo Cimento*. Subsequently, in conjunction with Prof. Auerbach, of Breslau, he employed his coherer for various practical purposes, but not, apparently, for wireless telegraphy. One of his papers was entitled, "On a new form which may be given to the Microseismic Indicator." He says in it: "A slight tremor communicated to the table holding the tube, a small tuning fork standing on it and vibrating, and sometimes a note sung are sufficient to deprive the filings of their conductivity."

"Nothing New Under the Sun."—The *New York World* of December 26th, says the *Electrical Engineer* of New York, prints a story with an "illustration" of Mr. Nikola Tesla's latest work, consisting of an apparatus for generating steam by means of the heat of the sun's rays when available. According to the *World*, Mr. Tesla is planning to build an immense plant on Long Island as soon as his model is perfected. In the centre of a large room with a glass roof will be placed a huge cylinder of thick glass. This will repose on a bed of asbestos. A system of mirrors will reflect the rays of the sun into the glass cylinder full of chemically-treated water, and thus generate steam which will be led to a steam engine. Mr. Tesla proposes to give his invention free to the world when it is worked out. Whether the world, assuming it is not the *New York World*, will derive much benefit from Mr. Tesla's munificent gift remains to be seen. Probably, however, the whole affair is a huge joke, that has had its inception in the teeming brain of a *World* reporter. Still the idea credited to Mr. Tesla is not strikingly new. Twenty-five years ago, and the very recollection is convincing that age groweth upon us, we assisted in experiments at the works of the British Telegraph Manufactory, which showed the heating effect obtainable from the reflected rays of an arc lamp. By means of parabolic reflectors we were able to anticipate electric cooking, for not only was water boiled but we succeeded in cooking chops, the apparatus being almost identical with that attributed to Tesla:—A copper boiler in the shape of a tube, a glass casing, covering but separated from the boiler by an air space, and the parabolic reflector for concentrating and focussing the rays of the sun or an electric arc. In Algeria experiments on a bigger scale were attempted, and steam was actually raised in a boiler which was subject to the reflected rays of the sun. Moreover, Sir Henry Bessemer has for years, by means of a specially-constructed glass house and reflectors, demonstrated the extraordinary heating effect of the sun's rays.

Röntgen Rays.—Before the Röntgen Society, on Tuesday evening, at 11, Chandos Street, under the presidency of Prof. Silvanus Thompson, a paper was read by Mr. W. Webster, F.C.S., on "Practical Work with the X Rays." He first dealt, says the *Chronicle*, with the question of the best apparatus to use, and pointed out the value of primary batteries. The best coils were of English manufacture, and he used a 20-inch coil, which gave a 20-inch spark, and which, with a pneumatic attachment, worked admirably. Mr. Webster then pointed out how much had been done by Sir William Crookes and Mr. Jackson, and remarked that Dr. Röntgen had merely put the finishing touch to their discoveries. He showed the tube which had been made by Mr. Jackson in 1894, with which he had demonstrated that wood and other materials were pervious to certain rays. He had found an improvement to prevent the spark from passing round the bowl of the tube, and thus lessening the danger of perforation. By heating the tube and starting with a small spark he was able gradually to produce the effect he wished, and had thereby saved the lives of many tubes. The bulb of the tube should not be very large, as the larger it was the more difficult the tube was to condition, and the greater were the number of accidents. An aluminium cover for the cathode tube was an advantage, and a protector of sheet-iron was useful for saving the hands from the effect of the rays. The effect of the rays varied very much with different subjects. In the case of one patient, whose head was photographed, a patch of his hair first turned grey and then came out, and he was not grateful to the rays; however, the hair had grown again afterwards of the original colour. In other cases, however, the pain in the injured or diseased part had entirely ceased after five or six minutes' exposure to the rays. Anæmic subjects were the best to photograph, while gouty subjects were particularly difficult. To produce good negatives, considerable experience in photographic development was necessary, especially in the production of cloud negatives.

Electricity and Fires.—A *Pall Mall Gazette* representative has been interviewing Dr. John Hopkinson to ascertain his opinions as to whether greater immunity from fire might be expected from a wider use of electricity as an illuminant. While admitting at the outset that many fires had been due in the past to electrical causes—commonly through the wires overheating and igniting woodwork—Dr. Hopkinson said that in properly wired premises there was absolutely no danger. The fuse had always been used, but not always with sufficient care. The fuse was an expedient for safety—a piece of lead interposed in a circuit, that melted before the wires became red hot, and thus broke the circuit. No one, he continued, knew how to get security in the use of gas. A careless person, leaving the gas on, filled the room, and an explosion followed, with consequences generally more disastrous than in fires electrically caused, which, of course, were cases of simple ignition. Then, too, gas supplied combustible material to fires when once they had started.

The Electrical Engineer Volunteers.—A circular is shortly to be issued, says the *Daily Mail*, respecting this volunteer corps, to electrical engineers in the country. The corps is, for the present, limited to 240. Its duties are principally to carry out operations with the search light. The members will be exempt, in a large measure, from ordinary drill, but will have to go for eight days' continuous training during the year at the various naval bases. The uniform is that of the submarine miners. Lord Kelvin is the honorary colonel and Dr. Hopkinson is major and commanding officer. Applications are arriving daily, and it is said that in some electrical works near London 100 men have volunteered for service. For the moment, and until some details as to headquarters, and the like have been settled, the commanding officer is not inviting recruits.

A New Metal.—According to a daily paper, Mr. Thomas A. Edison announces a discovery of a new metal, which, admixed with iron, renders cast-iron as tough and strong as wrought-iron. Mr. Edison declines to go into the details now. It is stated that he is about to begin a series of exhaustive experiments to determine the conditions most favourable to obtaining the best results.

Marriage of Mr. Philip Dawson.—The little parish church of Fittleworth was overcrowded on Wednesday last on the marriage of Mr. Philip Dawson, M.Inst E.E., and Assoc.M.Inst.C.E., with Miss Lucy Hume Simpson, daughter of the Vicar, Prebendary A. B. Simpson. To do honour to the ceremony, the village turned out to a man, and the church and railway station were handsomely decorated with flowers. Mr. Dawson had taken complete possession of the picturesque old Swan Inn, and there entertained a large party of his friends on Tuesday evening. Among his guests were Messrs. F. H. Webb, Conrad Cooke, R. W. Blackwell, H. F. Parshall, O. H. Baldwin, A. K. Baylor, and I. E. Winslow, representing the electrical fraternity. The presents were many and handsome, the most noticeable being a magnificent silver punch bowl and goblets presented by Mr. R. W. Blackwell's staff. Immediately after the ceremony, Mr. and Mrs. Dawson left for the Continent, where they will spend their honeymoon.

Obituary.—We regret to record the death of Sir Charles Hutton Gregory, who passed away on Monday last at his residence, Duchess Street, Portland Place. He was a son of Mr. Olinthus G. Gregory, a professor of mathematics at the Military Academy at Woolwich, and was born in 1817. He was President of the Institution of Civil Engineers in 1868, and occupied the post for two years. Sir Charles served in many public capacities connected with his profession. He was employed abroad as consulting engineer for railways to the colonies of Ceylon, Cape of Good Hope, Trinidad, and some of the Malay territories. He was created K.C.M.G. in 1883.

We also regret to observe that Mr. John Farquharson, late electrician to the Admiralty, died at Woodland Cottage, Acton, some days ago. He was in his 76th year.

Lectures.—Mr. James Swinburne commenced a course of lectures upon "Dynamo and Transformer Construction," at the Electrical Standardising, Testing, and Training Institution yesterday (Thursday).

Appointment Vacant.—The West Ham Council want a chief assistant engineer in the borough electrical engineer's department at £130 per annum. See our "Official Notices" for particulars.

NEW COMPANIES REGISTERED.

International Lighting Association, Limited (3,720).—Registered at Edinburgh, January 5th, with capital £100,000 in £1 shares, to acquire as a going concern the business now or lately carried on by the Colonial Lighting Syndicate, Limited, and to carry on in any part of the world the business of an electric light company in all its branches. The subscribers (with one share each) are:—J. Hepworth, 4, Priestfield Road, Edinburgh, civil engineer; W. Haldane, 59, Queen Street, Edinburgh, W.S.; T. Laird, 46, Castle Street, Edinburgh, chartered accountant; F. Haldane, The Lodge, Ratho, Edinburgh, W.S.; T. Law, Woodlands, Duddingston, gentleman; W. Mackenzie, 12, Alva Street, Edinburgh, advocate; J. Pattullo, 28, Frederick Street, Edinburgh, S.S.C. The first directors are: J. Hepworth, W. Haldane, J. Dempster, Newton Heath, Manchester; W. Cowan, London. Qualification, £500. Registered by J. Pattullo, 28, Frederick Street, Edinburgh. Registered office, 28, Frederick Street.

Synchronome Syndicate, Limited (55,474).—Registered December 31st, with capital £15,000 in £1 shares, to acquire the business carried on at Westminster as "The Synchronome Syndicate," to acquire certain patents relating to electric clocks, to adopt an agreement with F. H. Jones and G. B. Bowell, and to manufacture, sell, and deal in electric clocks, electric synchronisers, dials, and other electric plant. The subscribers (with one share each) are:—A. M. Fletcher, 85, Gracechurch Street, E.C., gentleman; M. Robertson, 85, Gracechurch Street, E.C., secretary; W. B. Butler, 2, Portsea Place, Hyde Park, W., gentleman; J. M. Macnerran, 2, East India Avenue, E.C., gentleman; W. Murray, Elm Lodge, Ditton Hill, gentleman; F. B. Grey, Monk's Gate, Horsham, gentleman; C. S. Hobson, 55, Cornhill, E.C., stockbroker. The number of directors is not to be less than three nor more than six. The first are F. E. D. Acland, W. Murray, and J. M. Macnerran; qualification, £100; remuneration, £50 each per annum and a share in the profits. Registered by Ashurst & Co., 17, Throgmorton Avenue, E.C.

Heswall Electric Light Company, Limited (55,482).—Registered January 1st with capital £1,500, in £1 shares, to carry on at Heswall, Cheshire, or elsewhere, the business of electricians, mechanical engineers, suppliers of electricity, and electric apparatus manufacturers. The subscribers (with one share each) are:—C. MacIver, Beechfield, Heswall, Cheshire, gentleman; L. J. Dobie, Moorland House, Heswall, Cheshire, schoolmaster; T. Brocklebank, The Rescote, Heswall, Cheshire, gentleman; C. B. Reyds, 35, Church Street, Birkenhead, cotton broker; R. E. R. Brocklebank, Poulton Reyde, Bebington, coal merchant; R Brancker, Sunnyside, Heswall, Cheshire, coal merchant; Mrs. E. M. Brancker, Sunnyside, Heswall, Cheshire. The number of directors is not to be more than four; the first are T. Brocklebank, L. Dobie, C. MacIver and R. Brancker. Registered by Norris & Co., 20, Bedford Row, W.C.

Northern Counties Electric and Motor Company, Limited (55,551).—Registered January 7th with capital £10,000, in £1 shares, to purchase, manufacture, sell, hire, let on hire, or otherwise deal in, electric and other motors, cycles, carts, cabs, waggons, vehicles, ships, boats, launches and carriages. The subscribers (with one share each) are:—S. Jackson, Tanfield Chambers, Bradford, architect; W. Beverley, 16, Piccadilly, Bradford, barrister; G Scarborough, Halifax, manufacturer; G. Buckley, Tower Chambers, Halifax, architect; J. Pollard, Halifax, chemist; W. Hanson, Halifax, cotton spinner; W. Asquith, Birks Hall, Halifax, engineer. The number of directors is not to be less than two, or more than seven; the subscribers are to appoint the first. Qualification, £100; remuneration as fixed by the company. Registered by C. Doubble, 14, Serjeant's Inn, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Electro-Chemical Company, Limited (40,496).—This company's return, made up to December 3rd, shows that the capital of £200,000 in £5 shares (26,000 preference) has been fully subscribed. 14,000 ordinary and 5,000 preference are considered as paid. £5 per share has been called on 12,710, and £4 per share on the others, and £99,834 has been paid.

Newton Electrical Works, Limited (48,936).—This company's annual return was filed on September 7th. The capital is £30,000 in £10 shares. 2,100 have been taken up, 1,400 are considered as paid, and £7,000 has been received.

Wireless Telegraph and Signal Company, Limited (53,403).—This company's statutory return, made up to December 2nd, was filed on December 10th. The capital is £100,000 in £1 shares, of which 95,015 have been taken up. 60,000 are considered as paid, and £35,015 has been received.

Venezuela Telephone and Electrical Appliances Company, Limited (31,305).—This company's return was filed on December 4th. The capital is £85,000 in 70,000 shares of £1 each, and 1,500 shares of £10 each. All the £1 and 360 £10 shares have been taken up, and 56,506 £1 shares are considered as paid. The full amount has been called on the others, and £17,094 has been received.

Electric Welding Company, Limited (31,364).—This company's return, made up to December 14th, was filed on December 24th last. The capital is £460,000 in £10 shares (1,000 founders'); 24,780 ordinary and 953 founders' shares have been taken up, and 8,333 ordinary are considered as paid. The full amount has been called on the founders' and £6 per share on the remaining ordinary, and £119,092 has been received, leaving £54,908 to be brought in.

New Phonophore Telephone Company, Limited (44,654).—This company's return was filed on November 9th, when 5,111 ordinary and 1,000 founders' shares were taken up out of a capital of £10,000 in £1 shares. The founders' shares are considered as paid, and 10s. per share has been called and paid on the others.

National Electric Free Wiring Company, Limited (53,364).—This company's statutory return, made up to November 17th, has just been filed; 100,000 shares are to be taken up out of a capital of £250,000, in £1 shares, and 5s. per share (£25,000) has been paid.

Electrical Undertakings, Limited (52,917).—This company's statutory return was filed December 16th, when a capital of £10,000 in £1 shares was fully taken up. 7,493 shares are considered as paid, and £2,507 has been paid on the others.

Electrical Pioneer Syndicate, Limited (52,917).—This company's statutory return was filed October 15th, when 42 shares were taken up out of a capital of £10,000 in £50 shares, £25 has been called, and £1,000 received, leaving £75 unpaid; £25 has been received in advance.

CITY NOTES.

Oldham, Ashton and Hyde Electric Tramway Company, Limited.

There has been before the public this week a prospectus of the above company, which has a nominal share capital of £80,000, offering the whole of that sum for subscription in the form of 4,000 5 per cent. £10 cumulative preference and 4,000 ordinary shares of £10 each. There will also be an issue of £40,000 debentures as occasion requires. The company will construct and work an electric tramway, eight miles in length, from the boundary of Oldham through Ashton-under-Lyne, Audenshaw and Denton to Hyde, as authorised by a provisional order granted to the British Electric Traction (Pioneer) Company in 1896. The prospectus gives a few remarks on the advantages of electric traction, and particulars and map of the districts to be served by the tramways. The electrical energy will be supplied by the Corporation of Ashton under an agreement made by the British Electric Traction (Pioneer) Company. It is estimated that when the tramways are in full operation the net profit will be about £10,000 per annum. The dividend on the preference shares for the first three years has been secured by the deposit of cash or securities with the Electric and General Investment Company. It is estimated that the line will be in full working order within that period. The permanent way is being laid by Messrs. Dick, Kerr & Co., and the whole of the electrical equipment and rolling stock will be provided by the British Thomson-Houston Company. The total payable under the various contracts is £105,362. The list of applications opened on Monday last and closed on Wednesday. The directors are Mr. Emile Garcke (chairman), and Messrs. Atherley Jones, Q.C., M.P.; Alderman Thomas Higginbottom, J.P.; A. R. Monks, Alderman Robert Whittaker, J.P. Messrs. H. F. Parshall and Stephen Sellon are the engineers. The registered offices are Donington House, Norfold Street, Strand, and Mr. H. S. Hodgson is secretary.

The Sussmann Electric Miners' Lamp Company, Limited.

An extraordinary general meeting of the shareholders of this company was held yesterday at the Cannon Street Hotel, Mr. A. Castle presiding.

The Chairman explained that the sole object of the meeting was to propose resolutions for altering articles in certain particulars. The board promised at the annual meeting that they would consider the advisability of reducing their number and the fees paid to them. Having given the question careful attention, they had decided to ask the shareholders to alter the articles, so that instead of the board consisting of five as heretofore, and the remuneration £200 each, its future strength would be three at a remuneration of £100 each. He then moved the necessary resolutions, which were seconded by Mr. J. D. Wright, and carried.

The Direct United States Cable Company, Limited.—The board have resolved upon the payment of an interim dividend of 3s. per share, free of income tax, being at the rate of 3 per cent. per annum, for the quarter ending December 31st, 1897, such dividend to be payable on and after 29th inst., setting aside £12,000 to reserve fund account, and carrying forward a balance of £4,090 2s. 2d. And notice is also given that the transfer books of this company will be closed from January 11th to the 25th (both days inclusive).

The Westminster Electric Supply Corporation, Limited.—To provide for the redemption of the present 5 per cent. and 4½ per cent. first mortgage debenture of the corporation, and to meet the necessary capital expenditure, owing to the continued increase of the company's business, this company has resolved to issue an amount of £200,000 first mortgage debentures, carrying interest at the rate of 3½ per cent. per annum.

The House-to-House Electric Light Supply Company, Limited.—An extraordinary general meeting of this company was held at Winchester House on Wednesday, when the resolution which was passed at the extraordinary general meeting of the company, held on December 28th, 1897, and reported in our issue of December 31st, was submitted and confirmed as a special resolution.

Direct West India Cable Company.—The 4½ per cent. debentures can now be obtained in exchange for script. Cheques for interest on instalments to December 31st will be issued with the debentures. The laying of the company's cable was began last Friday from Bermuda. Jamaica is expected to be reached about 20th.

River Plate Electric Light and Traction Company.—A meeting of the above company was held on Wednesday at the offices, 78, Coleman Street, but a representative of the Electrical Review was informed that the meeting was private.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending January 9th, 1898, were £1,124; week ending January 10th, 1897, £1,111; increase, £13; total receipts for half-year, 1898, £2,174; corresponding period, 1897, £2,188; decrease, £14.

The Cuba Submarine Telegraph Company. The receipts for the month of September were £2,684, as compared with £3,966 in the corresponding month of last year.

The Great Northern Telegraph Company. The receipts in December, 1897, were £25,000; January 1st to December 31st, 1897, £277,800; corresponding months, 1896, £285,800; corresponding months, 1895, £312,400.

The Liverpool Overhead Railway Company. The receipts for the week ending January 9th, 1898, amounted to £1,438; corresponding week last year, £1,265; increase, £173.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending January 7th, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,405.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation, Jan. 5th.	Closing Quotation, Jan. 12th.	Business done during week ended Jan. 12th, 1898. Highest.	Lowest
137,400*l*	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	...	100 104 xd	100 —104	...	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	5½— 6½	6 — 7	...	...
923,900*l*	Anglo-American Teleg., Ltd.	Stock	£2 2s.	£2 9s.	£2 13s.	61 — 63	61 — 63	62	...
3,038,020*l*	Do. do. 6 % Pref.	Stock	£4 4s.	£4 18s.	£5 6s.	110 —111	111 —112	112¼	110½
3,038,020*l*	Do. do. Defd.	Stock	...	...	...	13½— 14	13½— 14	14¼	13 11/16
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	7 %	...	16 — 16½	16½ — 16⅝	16⅝	16½
75,000*l*	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	...	112 —116 xd	112 —116	...	...
44,000	Chili Teleph., Ltd., Nos. 1 to 44,000	5	2½%	4 %	4 %	3 — 3½	3 — 3½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	182 —187 xd	182 —187	...	...
653,586*l*	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	104 —106 xd	105 —107	105½	...
224,850	Consolidated Teleph. Const. and Main., Ltd.	10/-	1½%	1½%	2 %	1/16 — 3/16	1/16 — 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	8½— 9½	8 — 9	9	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	18½— 19½	18 — 19	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 11	10 — 11	...	...
30,000*l*	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	4½%	102 —105%xd	102 —105%	...	...
60,710	Direct United States Cable, Ltd.	20	2 %	2½%	2½%	10½— 10⅝	10½— 11	10⅞	10 5/16
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	6½%	17 — 17½	17½ — 17¾	17⅝	17⅛
70,000	Do. 6 % Cum. Pref.	10	6 %	6	6%	18 — 19	18 — 19	18⅞	...
89,900*l*	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5%	102 —105	102 —105	...	...
1,302,615*l*	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4%	130 —133	130 —133	132⅝	130½
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	18½— 18⅝	18½ - 19	18⅞	18½
25,200*l*	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5%	99 —103 xd	99 —103	...	...
100,500*l*	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5%	100 —103 xd	100 —103	100	...
320,000*l*	Do. 4 % Deb. Stock	Stock	4 %	4 %	4%	132 —135	132 —135	133½	132¼
51,100*l*	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5%	99 —103 xd	99 —103	...	...
69,200*l*	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5%	100 —104 xd	100 —103	...	...
300,000*l*	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4%	103 —106	103 —106	...	...
200,000*l*	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4%	108 —111 %	108 —111%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	4½%	11½— 12	11⅝ — 12¼	12 1/16	11⅝
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6%	17½ — 18	17¾ - 18¼	18⅛	17¾
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜%	10 %	10%	25½— 26½	25½ - 26½	26⅛	...
160,000*l*	Do. do. do. 5 % Debs.	100	5 %	5 %	5%	102 —105	101 —104	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10%	52 — 55	52 — 55	52	...
100,000*l*	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6%	107 —110	107 —110	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 %	5½%	5½%	6½— 6⅝	6½ - 6¾	6⅝	6½
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	15 — 17	15 - 17	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	14 — 16	14 — 16	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6 — 6½	6 — 6½	6¼	...
130,766	Do. do. Nos. 119,235 to 250,000, £5 paid	5	...	...	...	5⅝— 6¼	5¾— 6¼	...	...
1,329,471*l*	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	102 —107 xd	102 —107	105⅝	103
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	4½%	5 %	5 %	9/16 — 11/16	9/16 11/16	...	..
100,000*l*	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	105 —108 xd	105 108	...	...
11,839	Reuter's Ltd.	8	nil	5 %	5 %	7½ - 8½	7½ 8½	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	136 —141	136 141	...	...
58,000	United River Plate Teleph., Ltd.	5	3 %	4 %	...	3¾— 4½	4 - 4½	...	...
146,733*l*	Do. do. 5 % Debs.	Stock	5 %	5 %	...	100 —105 xd	101 106	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	nil	4 %	nil	4½ — 5½	4 5	...	...
213,400*l*	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	103 - 106	103 —106	...	...
64,256	Western and Brazilian Teleg., Ltd.	15	3 %	3 %	2 %	9⅝— 10½	9¾ 10¼	10⅛	9⅞
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	7½— 7⅝	7¼ 7¾	7 11/16	7½
33,129	Do. do. do. Def. Ord.	7½	1 %	1 %	...	2¾ - 3¼	2¾ 3¼	...	...
382,230	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	104 —107 xd	104 —107	...	...
88,321	West India and Panama Teleg., Ltd.	10	½%	⅞%	1 %	⅜ - ⅝	⅜ - ⅝	½	7/16
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	7½— 8	7½ - 7¾	7⅝	7¼
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	5 — 7	5 — 7	...	...
80,000*l*	Do. do. 5 % Debs. No. 1 to 1,600 ...	100	5 %	5 %	5 %	105 —108 xd	105 —108	...	...
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7%	105 —110	105 —110	...	...
160,100*l*	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6%	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share.	1894.	1895.	1896.	Closing Quotation, Jan. 5th.	Closing Quotation, Jan. 12th.	Highest.	Lowest
30,000	Charing Cross and Strand Electy. Supply	5	4½%	5 %	6 %	12½ — 13½	12½ - 13½	13⅜	13 1/16
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6¼ - 6¾	6⅜	...
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	5 %	10½— 11	10½— 11	...	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	4½%	4½%	112 —114 xd	112 —114	...	...
40,000	City of London Elec.Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	5 %	7 %	26 — 27	26 — 27	26⅝	26¼
10,000	Do. do. Prov. Certs.	5	...	...	...	25½— 26½	25½— 26½	...	...
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17 — 18	17 — 18	17⅝	17⅜
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	129 —134 xd	129 —134	...	...
30,000	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—30,000	10	...	nil	nil	13½— 14	13¾ — 14¼	14 1/16	13¾
20,000	Do. do. do. 6% Pref., 40,001—60,000 ...	10	...	6 %	6 %	15½— 16	15½— 16	15½	...
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5	...	...	...	9 — 10	9 — 10	...	...
10,000	Do. do. 7 % Cum. Pref. ...	5	...	...	...	11 — 11½	11 — 11½	11½	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	3 %	4 %	5 %	18½— 19½	18½— 19½	18½	...
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem. ...	10	...	...	...	18 — 19	18 — 19	18½	...
220,000	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½%	117 —121 xd	117 — 121	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	1 %	2 %	4 %	17½— 18½	17½ — 18½	...	...
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	6½%	7½%	10½%	17 — 18	17 — 18	17⅝	17⅛
20,000	Do. do. 7 % Pref., 20,081 to 40,000	5	7 %	7 %	7 %	10 — 11	10 — 11	10½	...
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	...	101 —104 xd	101 —104	...	...
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2⅝— 2⅞	2⅝— 2⅞	2⅞	2⅝
79,900	Westminster Electric Supply Corp., Ord., 101 to 80,000 ...	5	5 %	7 %	9 %	16 — 17	16 — 17	16½	15¾

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	896.	Closing Quotation Jan. 5th.	Closing Quotation, Jan. 12th.	Business done during week ended Jan. 12th, 1898. Highest.	Lowest.
30,000	British Electric Traction	10	...	...	...	$16\frac{1}{2}$— 17	$17\frac{1}{2}$— 18	$18\frac{1}{8}$	$16\frac{5}{8}$
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	$2\frac{1}{2}$%	...	...	$1\frac{7}{8}$— $2\frac{1}{8}$	$1\frac{7}{8}$— $2\frac{1}{8}$	2	$1\frac{15}{16}$
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	...	...	$2\frac{1}{8}$— $2\frac{3}{8}$	$2\frac{1}{8}$— $2\frac{3}{8}$	$2\frac{5}{16}$	$2\frac{1}{8}$
125,000*l*	Do. do. $4\frac{1}{2}$ % Perp. Deb. Stock.... ...	Stock	$4\frac{1}{2}$%	...	...	109 —113	109 —113	$110\frac{1}{2}$	...
50,000	Do. do. $4\frac{1}{2}$% 2nd Deb. Stock Red. ...	Stock	...	...	...	100 —103xd	100 —103	102	...
19,126	Central London Railway, Ord. Shares	10	...	...	...	$9\frac{3}{4}$— $10\frac{1}{4}$xd	$9\frac{3}{4}$— $10\frac{1}{4}$	$9\frac{15}{16}$	...
143,106	Do. do. do. £6 paid	10	...	...	...	$5\frac{1}{2}$— 6xd	$5\frac{1}{2}$— 6	$5\frac{3}{4}$	...
58,830	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	$1\frac{1}{4}$— $1\frac{3}{4}$xd	$1\frac{1}{4}$— $1\frac{3}{4}$	...	...
61,777	Do. do. Def. do. £5 pd. ...	...	...	...	...	4 — $4\frac{1}{2}$xd	4 — $4\frac{1}{2}$	...	...
630,000*l*	City and South London Railway	Stock	$1\frac{1}{8}$%	$1\frac{3}{16}$%	$1\frac{9}{16}$%	67 — 69	69 — 71	70	$68\frac{3}{4}$
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	*nil*	...	2 — $2\frac{1}{2}$	2 — $2\frac{1}{2}$	...	...
99,261	{Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 93,261}	5	5 %	5 %	$5\frac{1}{2}$%	$2\frac{1}{2}$— 3	$2\frac{1}{2}$— 3	$2\frac{11}{16}$	...
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5 %	$5\frac{1}{2}$%	$4\frac{1}{2}$— $5\frac{1}{2}$	$4\frac{1}{2}$— $5\frac{1}{2}$	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	5 %	6 %	$2\frac{3}{8}$— $2\frac{5}{8}$	$2\frac{3}{8}$— $2\frac{5}{8}$	$2\frac{9}{16}$	2 7
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 ...	2	7 %	7 %	7 %	$3\frac{1}{8}$— $3\frac{3}{8}$	$3\frac{1}{8}$— $3\frac{3}{8}$	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	...	...	$\frac{1}{2}$— $\frac{3}{4}$	$\frac{1}{2}$— $\frac{3}{4}$	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	...	...	$\frac{1}{2}$— $\frac{3}{4}$	$\frac{1}{2}$— $\frac{3}{4}$	...	...
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	$10\frac{1}{2}$%	...	9 — 11	9 — 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	6 %	8 %	10 %	20 — 21	$20\frac{1}{2}$ — $21\frac{1}{2}$	$21\frac{1}{4}$	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	$18\frac{1}{2}$— $19\frac{1}{2}$	$18\frac{1}{2}$— $19\frac{1}{2}$	...	...
50,000	Do. do. do. $4\frac{1}{2}$ Mort. Deb. Stock	Stock	...	$4\frac{1}{2}$%	$4\frac{1}{2}$%	110 —115	110 —115	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	$23\frac{1}{2}$ — $24\frac{1}{2}$	$23\frac{1}{2}$— $24\frac{1}{2}$	$23\frac{5}{8}$	...
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	103 —107	103 —107	107	...
37,500	†Liverpool Overhead Railway, Ord.	10	$1\frac{1}{2}$%	$2\frac{7}{8}$%	$2\frac{7}{8}$%	$11\frac{7}{16}$— $11\frac{9}{16}$	$11\frac{7}{16}$ — $11\frac{9}{16}$	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	16 — $16\frac{1}{2}$	16 — $16\frac{1}{2}$	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	15 %	36 — 39	36 — 39	$39\frac{1}{8}$	39
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	101 —104xd	101 —104	...	...
54,000*l*	Waterloo and City Railway, Nos. 1 to 54,000	10	...	...	...	$12\frac{1}{2}$— 13xd	$12\frac{1}{2}$— 13	$12\frac{7}{8}$	$9\frac{9}{16}$

Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50 % for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0 %§; 1891—7 %§ 1890—8 %

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

* Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), $7\frac{7}{8}$, £5 (fully paid) 11.

Electric Construction Corporation, 6 % Debentures, 104—106.

House-to-House Company, $4\frac{1}{2}$% Debentures of £100, 109—111.

Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 15—$15\frac{1}{2}$; 1st Preference Cumulative 6 %, £5 (fully paid), $8\frac{1}{4}$—$8\frac{3}{4}$. Dividend, 1896, on Ordinary Shares 7 %.

London Electric Supply Corporation, £5 Ordinary, $2\frac{1}{2}$—$2\frac{3}{4}$.

* T. Parker, Ltd., £10 (fully paid), $11\frac{5}{8}$—$12\frac{1}{4}$.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8—$8\frac{1}{2}$. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount 3 per cent. (October 14th, 1897).

THE APPLICATION OF VECTOR ALGEBRA TO ALTERNATING CURRENTS.

By W. G. RHODES, M.Sc., Royal Technical Institute, Salford.

(*Continued from page* 25.)

Circuits Containing Resistance and Capacity Only.

14. Suppose that a potential difference e is applied between the terminals of a circuit having a resistance r and a capacity C in series. If i is the current flowing through the circuit, and p has the usual meaning, the potential difference must have a component $r\,i$ in the direction of the current to drive the current against the ohmic resistance of the circuit, and a component $-\frac{k\,i}{p\,\text{C}}$ lagging a right angle behind the current, to balance the capacity E.M.F. $+\frac{k\,i}{p\,\text{C}}$ (see proposition 3, Section 9). We therefore have the vector equation

$$r\,i - \frac{k\,i}{p\,\text{C}} = e. \qquad (6)$$

This equation is represented graphically in Fig. 8, in which O P is the vector $r\,i$, O Q[1] the vector representing the E.M.F. due to capacity, P Q the vector representing the E.M.F. necessary to balance that due to capacity, and O Q that representing the applied potential difference.

The magnitude of e is by Section 3 given by

$$e = \sqrt{r^2 + \frac{1}{p^2\,\text{C}^2}}\,.\,i.$$

Equation (6) may be changed into a current vector equation, thus—

$$i = \frac{e}{r - \frac{k}{p\,\text{C}}} = \frac{e\left(r + \frac{k}{p\,\text{C}}\right)}{r^2 + \frac{1}{p^2\,\text{C}^2}}$$

or

$$i = \frac{r}{r^2 + \frac{1}{p^2\,\text{C}^2}}\,.\,e + \frac{\frac{1}{p\,\text{C}}}{r^2 + \frac{1}{p^2\,\text{C}^2}}\,.\,k\,e. \qquad (7)$$

This is the current vector equation, and is represented in fig. 9, which shows the components of the current along and at right angles to the potential difference, e.

Either the equations (6) and (7), or figs. 7 and 8 show that the current leads before the potential difference by an angle θ where

$$\tan\theta = \frac{1}{p\,\text{C}\,r}. \qquad (8)$$

Circuits containing Resistance, Self-Induction, and Capacity.

15. Consider a circuit consisting of a coil of wire, having a resistance r, and self-induction L, placed in series with a condenser of capacity C. Let an alternating potential difference e, of frequency n, be impressed between the extreme terminals of the circuit, causing an alternating current i to flow through it, and let $p = 2\,\pi\,n$.

The potential difference must have a component, $r\,i$, in the direction of the current, to drive the current against the ohmic resistance r, a component $k\,p\,\text{L}\,i$, to balance the E.M.F., $-k\,p\,\text{L}\,i$, of self-induction, and a component $-\frac{k\,i}{p\,\text{C}}$, to balance the E.M.F. $\frac{+k\,i}{p\,\text{C}}$, due to capacity. We therefore have the vector equation of E.M.F.s,

$$r\,i + k\,p\,\text{L}\,i - \frac{k\,i}{p\,\text{C}} = e,$$

or

$$r\,i + k\left(p\,\text{L} - \frac{1}{p\,\text{C}}\right)i = e. \qquad (9)$$

This equation is graphically represented in fig. 10, where O P is the vector $r\,i$, O L the vector $-k\,p\,\text{L}\,i$, O C the vector $\frac{k\,i}{p\,\text{C}}$, P Q the vector $-(\text{OL} + \text{OC})$, and O Q the vector e.

If O L is greater than O C, the current lags behind the potential difference by an angle θ, where

$$\tan\theta = \frac{\left(p\,\text{L} - \frac{1}{p\,\text{C}}\right)}{r}.$$

If O C is greater than O L, the current leads before e by an angle given by

$$\tan\theta = \frac{\dfrac{1}{p\,\mathrm{C}} - p\,\mathrm{L}}{r}.$$

If O L equals O C, that is, if

$$p\,\mathrm{L} = \frac{1}{p\,\mathrm{C}},$$

the current and potential difference are in phase.

16. We shall denote the quantity $p\,\mathrm{L} - \dfrac{1}{p\,\mathrm{C}}$ by the letter s, and call it the *reactance* of the circuit. Equation (9) then becomes

$$r\,i + k\,s\,i = e. \tag{10}$$

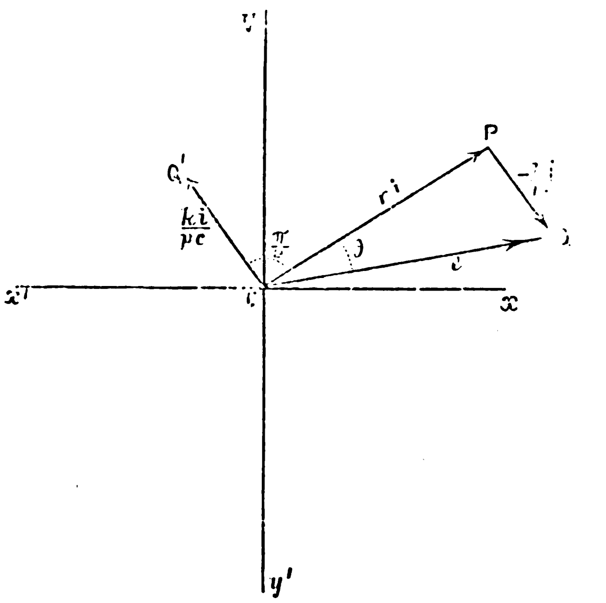


Fig. 8.

From this we get

$$i = \frac{e}{r + k\,s}$$

$$= \frac{e\,(r - k\,s)}{r^2 + s^2}$$

that is
$$i = \frac{r}{r^2 + s^2}\,.\,e - \frac{s}{r^2 + s^2}\,.\,k\,e. \tag{11}$$

Equations (10) and (11) are equations (1) and (3) extended to the case in which the circuit contains both self-induction and capacity, the former being an equation of E.M.Fs. and the latter an equation of currents.

It should be noticed that the magnitude of e is given by equation (10) to be

$$e = \sqrt{r^2 + s^2}\,.\,i,$$

whence
$$i = \frac{e}{\sqrt{r^2 + s^2}} \tag{12}$$

the quantity $\sqrt{r^2 + s^2}$ being the impedance of the circuit.

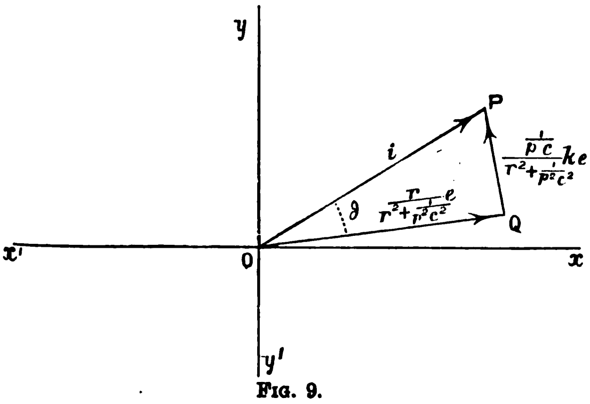


Fig. 9.

Combination of Circuits.

17. (*a*) *Series Circuits.*—Suppose that m reactive circuits are connected in series, and that a potential difference e is applied between the extreme terminals of the combination. We propose to determine the equivalent resistance, R, and the equivalent reactance, S, of the combination.

Let the resistance of the circuits be respectively $r_1, r_2, r_3, \ldots . r_m$, and their respective reactances $s_1, s_2, s_3, \ldots . s_m$; and let the potential differences between the terminals of the respective circuits be $e_1, e_2, e_3, \ldots . e_m$, and i the current common to all the circuits.

We then have, by applying equation (10) to each circuit in succession,

$$r_1\,i + k\,s_1\,i = e_1$$
$$r_2\,i + k\,s_2\,i = e_2$$
$$r_3\,i + k\,s_3\,i = e_3$$
$$\ldots\ldots\ldots$$
$$\ldots\ldots\ldots$$
$$r_m\,i + k\,s_m\,i = e_m.$$

Therefore
$$e = e_1 + e_2 + e_3 + \ldots . + e_m$$
$$= (r_1 + r_2 + r_3 + \ldots . + r_m)\,i +$$
$$k\,(s_1 + s_2 + s_3 + \ldots . s_m)\,i. \tag{13}$$

But, applying equation (10) to the combination, we have

$$e = \mathrm{R}\,i + k\,\mathrm{S}\,i \tag{14}$$

Thus, by comparison of (13) and (14), we see that

$$\left.\begin{aligned} \mathrm{R} &= r_1 + r_2 + r_3 + \ldots . + r_m \\ \text{and}\quad \mathrm{S} &= s_1 + s_2 + s_3 + \ldots . + s_m \end{aligned}\right\} \tag{15}$$

that is, the resistance and reactance of the series combination are, respectively, the sums (algebraic) of the resistances and reactances of the constituent circuits.

18. (*b*) *Parallel Circuits.*—Suppose that m reactive circuits are connected in parallel, and that is required to determine the equivalent resistance and reactance of the combination. It is better to subdivide this problem into two distinct cases, according as mutual induction is not, or is, taken into consideration.

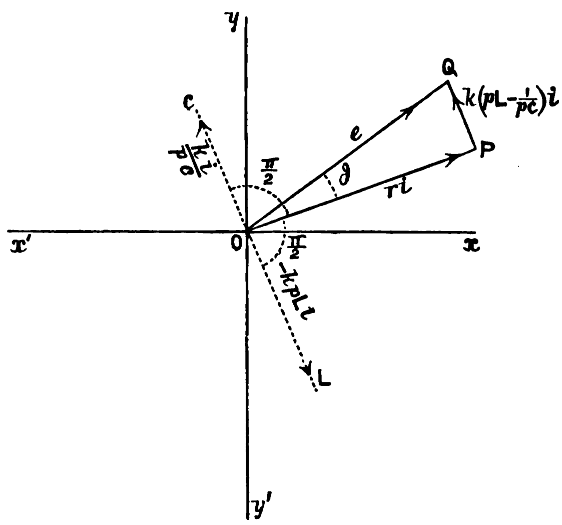


Fig. 10.

19. *Case I.—Mutual Induction Neglected.*—Let the resistances and reactances of the individual circuits be $r_1, r_2 \ldots . r_m$ respectively, and $s_1, s_2 \ldots . s_m$ respectively; and let the potential difference common to each circuit be e — a vector, the currents in the respective circuits being $i_1, i_2 \ldots . i_m$ — all vectors.

Then applying equation (11) to each circuit in succession we have the vector current equations

$$\left.\begin{aligned} i_1 &= \frac{r_1}{r_1^2 + s_1^2}\,.\,e - \frac{s_1}{r_1^2 + s_1^2}\,.\,k\,e \\ i_2 &= \frac{r_2}{r_2^2 + s_2^2}\,.\,e - \frac{s_2}{r_2^2 + s_2^2}\,.\,k\,e \\ &\ldots\ldots\ldots \\ &\ldots\ldots\ldots \\ i_m &= \frac{r_m}{r_m^2 + s_m^2} - \frac{s_m}{r_m^2 + s_m^2}\,.\,k\,e \end{aligned}\right\} \tag{16}$$

But the current i in the main circuit is the *vector* sum of the currents in the several branches of the parallel circuit, therefore we have the vector equation

$$i = i_1 + i_2 + \ldots . + i_m$$
$$= \left(\frac{r_1}{r_1^2 + s_1^2} + \frac{r_2}{r_2^2 + s_2^2} + \ldots . + \frac{r_m}{r_m^2 + s_m^2}\right) e$$
$$- \left(\frac{s_1}{r_1^2 + s_1^2} + \frac{s_2}{r_2^2 + s_2^2} + \ldots . + \frac{s_m}{r_m^2 + s_m^2}\right) k\,e$$

Or, writing A for

$$\left.\begin{aligned} &\frac{r_1}{r_1^2 + s_1^2} + \frac{r_2}{r_2^2 + s_2^2} + \ldots . + \frac{r_m}{r_m^2 + s_m^2} \\ \text{and B for}\quad &\frac{s_1}{r_1^2 + s_1^2} + \frac{s_2}{r_2^2 + s_2^2} + \ldots . + \frac{s_m}{r_m^2 + s_m^2} \end{aligned}\right\} \tag{17}$$

we get

$$i = \mathrm{A}\,e - k\,\mathrm{B}\,e$$
$$= (\mathrm{A} - k\,\mathrm{B})\,e$$
$$= \frac{(\mathrm{A}^2 + \mathrm{B}^2)\,e}{\mathrm{A} + k\,\mathrm{B}}$$
$$= \frac{e}{\dfrac{\mathrm{A}}{\mathrm{A}^2 + \mathrm{B}^2} + k\,\dfrac{\mathrm{B}}{\mathrm{A}^2 + \mathrm{B}^2}} \qquad (18)$$

and by comparison of this with the equation for the combination,

$$i = \frac{e}{\mathrm{R} + k\,\mathrm{S}} \qquad (19)$$

We see that the equivalent resistance and equivalent are repectively given by

$$\left.\begin{aligned} \mathrm{R} &= \frac{\mathrm{A}}{\mathrm{A}^2 + \mathrm{B}^2} \\ \text{and} \quad \mathrm{S} &= \frac{\mathrm{B}}{\mathrm{A}^2 + \mathrm{B}^2} \end{aligned}\right\} \qquad (20)$$

Also, the equivalent impedance, I, of the multiple circuit is given by

$$\mathrm{I} = \sqrt{\mathrm{R}^2 + \mathrm{S}^2}$$
$$= \frac{1}{\sqrt{\mathrm{A}^2 + \mathrm{B}^2}} \qquad (21)$$

where A and B are defined by (17).

20. An interesting particular case of the above is that in which the parallel arrangement consists of two circuits, one of which contains a resistance, r, and a self-induction, L, only, while the other contains a capacity, C, only.

In this case $r_1 = r$; $s_1 = p\,\mathrm{L}$; $r_2 = 0$; $s_2 = -\dfrac{1}{p\,\mathrm{C}}$; so that

$$\mathrm{R} = \frac{r}{r^2 + p^2\,\mathrm{L}^2}; \quad \mathrm{S} = \frac{p\,\mathrm{L}}{r^2 + p^2\,\mathrm{L}^2} - p\,\mathrm{C}.$$

Also if i_1 and i_2 are the currents in the two branches

$$i_1 = \frac{e}{\sqrt{r^2 + p^2\,\mathrm{L}^2}}; \quad i_2 = p\,\mathrm{C}\,e,$$

therefore

$$\frac{i_2}{i_1} = p\,\mathrm{C}\,\sqrt{r^2 + p^2\,\mathrm{L}^2},$$

which shows that for high frequencies the greater part of the current passes through the condenser circuit.

Also if i is the main current

$$i = \frac{e}{\sqrt{\mathrm{R}^2 + \mathrm{S}^2}}$$
$$= \frac{e}{\sqrt{\left\{\dfrac{r^2}{(r^2 + p^2\,\mathrm{L}^2)^2} + \left(\dfrac{p\,\mathrm{L}}{r^2 + p^2\,\mathrm{L}^2} - p\,\mathrm{C}\right)^2\right\}}}$$
$$= \frac{e\,(r^2 + p^2\,\mathrm{L}^2)}{\sqrt{\{r^2 + p^2\,(\mathrm{L} - \mathrm{C}\,r^2 + p^2\,\mathrm{L}^2)^2\}}}$$

21. *Case II—Mutual Induction taken into Consideration.*—This case is somewhat complicated since, if we consider any particular branch of the parallel circuit, the E.M.F. which drives the current against its ohmic resistance is the resultant of $m + 1$ distinct E.M.Fs.; viz., the applied potential difference, the E.M.F. due to the reactance of the circuit and the E.M.Fs. due to the mutual inductions between it and the remaining $m - 1$ branch circuits.

Let the mutual inductions of the several pairs of circuits be M_{12}, M_{13}, ... M_{pq} ...., where the suffixes denote the two circuits to which the M refers. Since the mutual induction between two circuits is a reciprocal relation, $\mathrm{M}_{pq} = \mathrm{M}_{qp}$, where p and q are any different integers from 0 to m. Let the rest of the notation be as in Case I. Then considering the circuit 1, the applied potential difference must furnish $m + 1$ components, one equal to $r_1\,i_1$, to drive the current against the ohmic resistance of the circuit; a second given by $k\,p\,s_1\,i_1$, to balance the reactive E.M.F. of the circuit; a third given by $k\,p\,\mathrm{M}_{12}\,i_2$ to balance the E.M.F. due to the mutual induction of the circuits 1 and 2 (see Proposition 2); a fourth given by $k\,p\,\mathrm{M}_{13}\,i_3$ to balance the E.M.F. due to the mutual induction of the circuits 1 and 3, and so on.

Thus the vector equation of E.M.Fs. in circuit 1 is

$$\left.\begin{aligned}
&r_1\,i_1 + k\,s_1\,i_1 + k\,p\,\mathrm{M}_{12}\,i_2 + k\,p\,\mathrm{M}_{13}\,i_3 + \ldots + k\,p\,\mathrm{M}_{1m}\,i_m = e \\
&\text{Similarly for circuit 2:} \\
&k\,p\,\mathrm{M}_{21}\,i_1 + r_2\,i_2 + k\,s_2\,i_2 + k\,p\,\mathrm{M}_{23}\,i_3 + \ldots + k\,p\,\mathrm{M}_{2m}\,i_m = e \\
&\text{Similarly for circuit 3:} \\
&k\,p\,\mathrm{M}_{31}\,i_1 + k\,p\,\mathrm{M}_{32}\,i_2 + r_3\,i_3 + k\,s_3\,i_3 + \ldots + k\,p\,\mathrm{M}_{3m}\,i_m = e \\
&\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot\quad\cdot \\
&\text{Similarly for circuit } m: \\
&k\,p\,\mathrm{M}_{m1}\,i_1 + k\,p\,\mathrm{M}_{m2}\,i_2 + k\,p\,\mathrm{M}_{m3}\,i_3 + \ldots + r_m\,i_m + k\,s_m\,i_m = e
\end{aligned}\right\} \qquad (22)$$

These are m simultaneous simple equations from which to determine the currents i_1, i_2, i_3 .... i_m, whence, by substitution, the current, i, in the main circuit can be obtained from the vector equation

$$i = i_1 + i_2 + i_3 + \ldots + i_m.$$

In this way we shall arrive, in any particular case, at an equation of the form

$$i = \mathrm{P}\,e + k\,\mathrm{Q}\,e,$$

where P and Q are independent of k. Having obtained this equation the equivalent resistances and reactances can be found in the usual manner.

As the solution of the general case is too complicated for the present paper, we will illustrate the process by the simple example of two mutually inductive circuits.

22. In this case the vector equations to be solved are

$$\left.\begin{aligned}
(r_1 + k\,s_1)\,i_1 + k\,p\,\mathrm{M}_{12}\,i_2 &= e \\
k\,p\,\mathrm{M}_{21}\,i_1 + (r_2 + k\,s_2)\,i_2 &= e \\
\text{and} \qquad i &= i_1 + i_2
\end{aligned}\right\} \qquad (23)$$

whence, on putting $\mathrm{M}_{12} = \mathrm{M}_{21} = \mathrm{M}$

$$\left.\begin{aligned}
\{(r_1\,r_2 - s_1\,s_2) + k\,(r_1\,s_2 + r_2\,s_1)\}\,i_1 &= \{r_2 + k\,(s_2 - p\,\mathrm{M})\}\,e \\
\text{and} \qquad & \\
\{(r_1\,r_2 - s_1\,s_2) + k\,(r_1\,s_2 + r_2\,s_1)\}\,i_2 &= \{r_1 + k\,(s_1 - p\,\mathrm{M})\}\,e
\end{aligned}\right\}$$

which by multiplying both sides of the equations by $(r_1\,r_2 - s_1\,s_2) - k\,(r_1\,s_2 + r_2\,s_1)$, and simplifying, may be written

$$\left.\begin{aligned}
(r_1^2 + s_1^2)\,(r_2^2 + s_2^2)\,i_1 = [&r_1\,(r_2^2 + s_2^2) - p\,\mathrm{M}\,(r_1\,s_2 + r_2\,s_1) \\
&- k\,\{s_1\,(r_2^2 + s_2^2) + p\,\mathrm{M}\,(r_1\,r_2 - s_1\,s_2)\}]\,e \\
\text{and} \qquad & \\
(r_1^2 + s_1^2)\,(r_2^2 + s_2^2)\,i_2 = [&r_2\,(r_1^2 + s_1^2) - p\,\mathrm{M}\,(r_1\,s_2 + r_2\,s_1) \\
&- k\,\{s_2\,(r_1^2 + s_1^2) + p\,\mathrm{M}\,(r_1\,r_2 - s_1\,s_2)\}]\,e
\end{aligned}\right\} \qquad (24)$$

These are the vector current equations giving the components of i_1 and i_2 along and at right angles to e. By addition we have

$$\begin{aligned}
(r_1^2 + s_1^2)\,(r_2^2 + s_2^2)\,i = [&r_1\,(r_2^2 + s_2^2) + r_2\,(r_1^2 + s_1^2) - 2\,p\,\mathrm{M}\,(r_1\,s_2 + r_2\,s_1) \\
&- k\,\{s_1\,(r_2^2 + s_2^2) + s_2\,(r_1^2 + s_1^2) + 2\,p\,\mathrm{M}\,(r_1\,r_2 - s_1\,s_2)\}]\,e, \qquad (25)
\end{aligned}$$

which gives the components of the main current along and at right angles to e; thus the component in phase with e is

$$\left\{\frac{r_1}{r_1^2 + s_1^2} + \frac{r_2}{r_2^2 + s_2^2} - \frac{2\,p\,\mathrm{M}\,(r_1\,s_2 + r_2\,s_1)}{(r_1^2 + s_1^2)\,(r_2^2 + s_2^2)}\right\} e,$$

and the component at right angles to e, or the wattless component, as it is called, is

$$\left\{\frac{s_1}{r_1^2 + s_1^2} + \frac{s_2}{r_2^2 + s_2^2} + \frac{2\,p\,\mathrm{M}\,(r_1\,r_2 - s_1\,s_2)}{(r_1^2 + s_1^2)\,(r_2^2 + s_2^2)}\right\} e.$$

Multiplying and dividing the right-hand side of equation (25) by D where

$$\begin{aligned}
\mathrm{D} = r_1\,(r_2^2 + s_2^2) + r_2\,(r_1^2 + s_1^2) - 2\,p\,\mathrm{M}\,(r_1\,s_2 + r_2\,s_1) + k\,\{&s_1\,(r_2^2 + s_2^2) \\
&+ s_2\,(r_1^2 + s_1^2) + 2\,p\,\mathrm{M}\,(r_1\,r_2 - s_1\,s_2)\},
\end{aligned}$$

we get, after some reductions,

$$i = \frac{\{(r_1 + r_2)^2 + (s_1 + s_2)^2 - 4\,p\,\mathrm{M}\,(s_1 + s_2) + 4\,p^2\,\mathrm{M}^2\}\,e}{\mathrm{D}}$$

which shows that the equivalent resistance, R, and reactance, S, of the parallel circuit are given by

$$\left.\begin{aligned}
\mathrm{R} &= \frac{r_1\,(r_2^2 + s_2^2) + r_2\,(r_1^2 + s_1^2) - 2\,p\,\mathrm{M}\,(r_1\,s_2 + r_2\,s_1)}{(r_1 + r_2)^2 + (s_1 + s_2)^2 - 4\,p\,\mathrm{M}\,(s_1 + s_2) + 4\,p^2\,\mathrm{M}^2} \\
\mathrm{S} &= \frac{s_1\,(r_2^2 + s_2^2) + s_2\,(r_1^2 + s_1^2) + 2\,p\,\mathrm{M}\,(r_1\,r_2 - s_1\,s_2)}{(r_1 + r_2)^2 + (s_1 + s_2)^2 - 4\,p\,\mathrm{M}\,(s_1 + s_2) + 4\,p^2\,\mathrm{M}^2}
\end{aligned}\right\} \qquad (26)$$

and the equivalent impedance, I, is given by

$$\mathrm{I} = \sqrt{\mathrm{R}^2 + \mathrm{S}^2}$$
$$= \frac{\sqrt{(r_1^2 + s_1^2)\,(r_2^2 + s_2^2)}}{\sqrt{(r_1 + r_2)^2 + (s_1 + s_2)^2 - 4\,p\,\mathrm{M}\,(s_1 + s_2) + 4\,p^2\,\mathrm{M}^2}} \qquad (27)$$

(To be continued.)

GAS PRODUCERS.

A suggestive letter appears in *Engineering* from Mr. Alleyne Reynolds dealing with the working of gas producers. Adverting to the usually accepted action in a gas producer, namely, that the entering air is first reduced to CO_2 and that this is afterwards reduced to CO in its passage upwards through the fuel, the writer argues that this assumption is incorrect. His reasons against this theory are (1) that the scaffolding of slag in producers points to the hottest zone being near the top; (2) that a strong lambent flame (the flame of carbon monoxide) will issue from a leak only a few inches above the air inlet of a blown producer; (3) that in producers, more especially those worked by a forced draught, a moderately shallow fire produces the most combustible gas. Divested of a good deal of unnecessary frilling and verbiage, the contention of Mr. Reynolds appears to be that the temperature of the first combustion of carbon to CO is sufficient to prevent further oxidation to CO_2 even in the presence of free oxygen; that, in fact, the dissociation temperature has been reached, and further oxidation can only occur as the temperature is reduced. In the upper zones of a producer the slag is fused and the dissociation temperature exists, and if there be any oxygen present when the gaseous products finally emerge on the top of the fuel, the gases will pass forward to the flues on their way to the holder, and will burn as their temperature is reduced by radiation, and the whole of the excess of oxygen will be converted to CO_2. Obviously, therefore, the amount of oxygen supplied to a producer ought to be just so much as will disappear entirely to the formation of CO, a little below the upper surface of the fuel.

If a producer be so over-blown that oxygen comes out uncombined above the fuel the gas produced will be low in CO_2, because of the temperature being high and dissociation prevailing, rich in CO and in O, and this O, which should not be present, will burn some of the CO to CO_2 as the temperature falls, and the final result will be a gas rich in CO_2. If, however, a producer be worked slowly, under-blown, CO_2 may be formed at once because the walls of the producer will radiate heat and keep the temperature below that of dissociation. There is thus a happy medium of working and of fuel depth which will secure best results, and if the views advanced be correct it ought to be arranged that the gas passages can be inspected for flame. Any flame would indicate over-blowing or too small a depth of fuel.

The theory applies of course equally to the blast furnace. If y represent the calories necessary to reduce 1 unit of the oxygen from the ore, and z be the calories absorbed by 1 unit of the oxygen for other endothermic chemical and mechanical actions, then the number of carbon units will be $\frac{12\ (y\ +\ z)}{32}$ and from this the consumption of fuel per ton of iron made can be found.

Mr. Reynolds' arguments appear reasonable and if investigation and observation proved them to be correct a step forward would be possible in the working of gas producers.

Blast furnace action certainly does not contradict the new theory. In the blast furnace the ore as it travels down the furnace is reduced by the CO formed from the fuel and CO_2 results. If the temperature be above the dissociation point no insurmountable difficulty is introduced, because it is possible, and, indeed, likely, that the CO_2 would be promptly reduced to CO by the surrounding mass of incandescent carbon. The very freeing of the oxygen from its combination with a solid would require heat, and would, therefore, reduce the temperature and render possible the formation of CO_2, which would exist as such until it got away from the zone of ore reduction. It seems impossible to produce gas entirely free from CO_2. This may be due to the mass action, as are many other chemical reactions which defy all efforts to carry them to a desired completion in the sense of an entire elimination of an undesired constituent.

COLLECTIVE BARGAINING.

Engineering makes a note that the present trade dispute has brought forward a new term, "collective bargaining," which it describes as something that workmen are believed by some people to be in vain asking from the tyrant Capital, whilst others believe it to be a dangerous Socialistic doctrine. It really amounts to the desire which exists among a large number of workmen that their wages shall be fixed by bargaining between their employer and their trade union executive, so that the man when he seeks employment, and gets it, need not himself bargain for a given wage, but will receive it exactly as a shopkeeper naturally expects and receives one penny for a penny bun. A good deal may be said on the workman's side of the matter in favour of the idea of collectivism. Workmen are often little able to look after their own interests, and if faced up with an employer of considerable strength of mind, the more simple of the workmen would often be found to be receiving less than they were really entitled to receive perhaps as first-class workmen. We believe it is largely to this feeling that they cannot face up for themselves that men have joined trades unions, and though we do not see they have any right to object to the equally collective action of employers, many of these being often quite as unable to stand their corner as the most modest of the men, we do not feel disposed to unduly blame the men for their collectivism if not carried too far as it has been.

Also in respect of the policy of the trades unions in claiming a sort of vested interest in work they have been accustomed to do, we are disposed to think that such claims are but natural. The barrister who draws his fees for three different cases coming off in three separate courts at one time has a protection against the possibly better outsider who has not a license. So the lawyer and the doctor who are all savagely protected against outsiders, and even among engineers do we not find that the growth of the professorial interest is tending to confine the very title of civil engineer to examination-tested men! The workman does but copy the example of his so-called betters, and when we see boiler makers and engine fitters fighting over who shall do this or that bit of work, it might be well to consider what sort of a row there would be if the solicitor to a railway company were to proceed to harangue the Parliamentary Committee upon the clauses of a Bill, of which every detail was at his finger's ends, and of which he knew of necessity 50 times as much as the Q.C., whose study of his brief had only begun five minutes before he entered the room, yet whose right to speak the solicitor cannot gainsay. Who of us has not seen the man who did know, biting his lips with vexation as the counsel drivelled away a case which he could not master. May we not assume an equal feeling in humbler circles. Where, however, men make a mistake is in their objections to the non-union men. Because a man is a non-unionist it does not by any means follow he is not an equally good man with the unionist. Indeed, the latest tactics in filling up the ranks of the unions has very considerably lowered the expectation of securing good men from their ranks. Collective bargaining so far has been all on one side, and when an agreement has not been come to the works of an employer have been struck against and picketted, and men seeking work have been roughly handled. The tendency of all monopolies is evil. Clients who have paid barristers large fees have often felt hurt when their counsel leaves the case to a junior in whom he has "every confidence," and some of us may have had the painful experience of suffering under the malpractice of some careless medical man against whom it is practically impossible to secure a remedy. The question is one of great difficulty, but let it not be overlooked when we condemn the action of the men in joining these unions, that to them their work and living may be as important as the work of the doctor appears to himself. There is a good deal to be said for trades unions, and for even collective bargaining, and the only way out of the difficulty that we see at present is, that the union executive should be composed of men of considerable intelligence and honest intention. In comparing the monopolies of workmen with those of professional men we omit one huge difference. The lawyer or the doctor is never found making his brother professional's life a burden to him because he does more work than other men do. But in the workshop that man who works quickly and turns out a fair day's work is made miserable by his fellows. A day's work has been reduced and reduced so steadily and for so long, that a good workman finds his hardest work in spinning out his jobs.

These details, says our contemporary, of shop work are unknown to bishops and dons and mere closet students—the *dilettanti*. To ordinary men a minimum irreducible wage implies obvious reduction of output and equally obviously in abandoning a right to reduce wages, the employer loses his principal, if not only, check upon what is euphemistically described as undue leisurelyness.

THE MIDLAND RAILWAY COMPANY'S ELECTRIC LIGHT PLANT AT LEICESTER.

The lighting plant at Leicester station is gas driven, the engines being of Crossley's high speed electric type, the larger ones equal to 50 B.H.P. on Dowson gas, and running at 200 revolutions. The cylinders are 16 inches × 21 inches. To render capable of continuous running, they have been fitted with efficient oiling arrangement, and to catch waste oil the foundations are sheeted in lead and piped to suitable receptacles. They have also been improved by the addition of counterweights upon the cranks, an addition which, we think, ought to form a portion of the original design of all gas engines, but which is omitted, we believe, because of the cheapness of the bent crank in some cases. These weights cannot but reduce the crank stresses set up by weights in the double fly-wheels which are otherwise required, but not always put in.

In case of failure of the gas apparatus, the engines are arranged for changing quickly to the use of Corporation gas, an expensive luxury, which demanded a minimum consumption of 1,500 thousand feet annually before the Corporation would connect their mains.

The gas generators are two in number, each set comprising generator and boiler of a capacity of 100 H.P. at the engines, and there are similarly duplicate coolers, hydraulic box, coke scrubber and sawdust filter. One boiler, however, will provide steam for two generators. These have a diameter of 3 feet inside the lining, but the grates are only 30 inches diameter (a contemporary's figures are a little dubious at this point, it not being clear whether areas or diameters is intended, but we assume diameters as the more probable).

The generators have fire-bars, as usual, we believe, in Dowson plant, and they consume anthracite coal, and obtain the best gas when using small coal, the quality of the gas being 25 per cent. better in power production per generator as well as more even, while the small fuel is cheaper, and the generator requires less time to start, good gas coming over in 10 minutes. With large coal some of the air blown in comes over unaltered. This proves that the fuel depth in a generator, as in a boiler furnace, must vary with the size of the fuel.

In the first half-year's work to December, 1895, the cost per unit was 3·30d., and 4·6 lbs. of coal were consumed for each B.T unit developed. During the next half-year the cost was 3·09d., and the consumption 3·66 lbs. For the first half of last year the figures were respectively 2·8d. and 3·03 lbs. The improvement due to experience and cheap coal has thus been 34 per cent. The small fuel costs 5s. to 9s. at the pit. It is machine-washed anthracite Pea coal, and it works best with an 18-inch fire as compared with a 4-foot fire used with the ordinary anthracite of more mixed sizes.

The above figures of cost are total, the fuel cost being ·32d. for the first half of 1896 and ·18d. for the corresponding period of 1897. For this latter period a unit cost 1·42d. when town gas was used. This, we take it, is the fuel cost only. The steam plant at Derby shows a total cost of 2·7d. per unit, and a coal cost of ·38d., while at Sheffield the costs are 2·64d. total, and ·54d. for fuel.

If no town gas were used at Leicester, the cost would only come to 2·67d., but we presume the minimum quantity charged for will always be used. The dynamos are belt driven. It would appear that a saving is thus made in using producer gas in place of steam for motive power. The costs, however, do not seem to include the coal used in the boiler furnace, as special note is made as to fuel cost *at generator*. The use of a boiler always seems somewhat superfluous in a gas producer plant. If more steam is needed than can be taken off in vapour from the gas engine, cooling tanks, or a water hearth, could it not be obtained from a boiler heated by the gases from the generators, which now part with their heat of manufacture in condenser pipes. In the illustration of the plant, the boiler has its separate chimney, and we conclude a separate but probably unnecessary fire also, which must add to production costs, and might be saved.

SOME PRACTICAL POINTS ON THE DESIGN OF A SHUNT DYNAMO.

By V. ZINGLER, A.I.E.E.

(*Concluded from page 7.*)

Core.—This is at once obtained from the difference of magnet bore and air-gap = 17 inches − 1·56 inch = 15·44 inches or, say, $15\frac{3}{8}$ inches to allow for irregularities. Hence the actual air-gap is

$1\frac{5}{8}$ inch = 1 625 in.

Now we can determine the actual number of bars to go on the core as follows :—

Diameter of core	=	15·375 inches
Insulation of core = ·05 × 2	=	·100 inch
Diameter of finished core	=	15·475 inches.

Then

$$15{\cdot}475 \times \pi = 48{\cdot}62 \text{ inches.}$$

This is the net winding circumference. Dividing this by the width of bar we get

$$\frac{48{\cdot}62}{{\cdot}324} = 150 \text{ nearly.}$$

This number of bars would, however, be too great, as there is no room for pegs. These are, say, $\frac{1}{8}$-inch wide, and are fixed every eight bars; our number of bars should also be divisible by eight.

Let us try 144 bars.

144 × ·324 ...	=	46·5 inches
18 pegs, $\frac{1}{8}$-inch wide	=	2·25 „
Space required	=	48·75 inches.

This is obviously too close, and we must take 136 bars.

136 × ·324 ...	=	44 inches
17 pegs, $\frac{1}{8}$-inch wide	=	2·125 „
		46·125 inches.

This leaves about $2\frac{1}{2}$ ins. all round for slack, but when it is compared with the net winding circumference it will be seen that it is only 5 per cent.

The size of the limbs can now be fixed, and for convenience centimetre measure will be used.

$$N = \frac{80 \times 60 \times 10^8}{136 \times 320} \quad \ldots \quad \ldots \quad = 11{\cdot}03 \times 10^6$$

Add for armature losses 2 per cent. ...		·22
„ „ demagnetisation 8 per cent. ...		·88
Total flux	=	12·13 × 10^6

Dimensions of Polar Arc.—This will of course depend on the bore of magnets and on the distance between the limbs. The angle θ (see figure) is frequently fixed so that it is unit angle, *i.e.*, 57°·29—that is when the arc subtending it is equal to the radius. It is, however, near enough to make the distance between limbs half the magnet bore, that is in this case 8·5 ins.

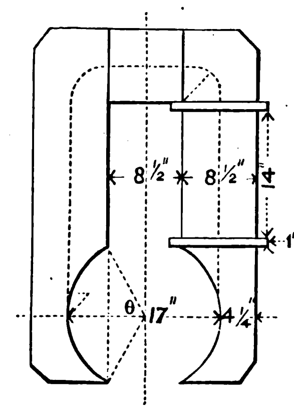


Fig. 1.

Then $\cos\theta = \frac{8{\cdot}5}{17} = {\cdot}5$ which is the cosine of 60°. The radian measure of 60° = 1·047; therefore the total length of polar arc

$$= 1{\cdot}047 \times 8{\cdot}5 \times 2 = 17{\cdot}79 \text{ ins.} = 45{\cdot}14 \text{ cms.}$$

Assuming now that **B** = 5,000 for the air-gap, the polar area will be

$$\frac{12{\cdot}13 \times 10^6}{5{,}000} = 2{,}426 \text{ sq. cms.}$$

Making the usual correction for fringing,

Air-gap 1·56 in. = 3·96 cms.

This multiplied by ·8 ...	=	3·168 cms.
Length of arc	=	45·14 cms.
Corrected arc	=	48·308 cms.

The equivalent length of polar surface will be therefore

$$\frac{2{,}426}{48{\cdot}308} = 50 \text{ cms.}$$

and the actual length will be

$$50 - 3{\cdot}168 = 46{\cdot}832 \text{ cms. or } 18\tfrac{1}{2} \text{ ins.}$$

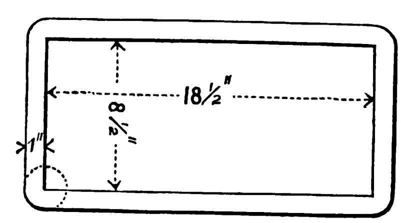


Fig. 2.

Width of Magnet Limbs.—Assuming an induction

B = 16,000

and the coefficient of leakage as 1·3 we get

$$\frac{12{\cdot}13 \times 10^6 \times 1{\cdot}3}{16{,}000} = 985 \text{ sq. cms.}$$

The width of iron therefore is

$$\frac{985}{46{\cdot}832} = 21 \text{ cms.} = 8\tfrac{1}{4} \text{ ins., say } 8\tfrac{1}{2} \text{ ins.}$$

The dimensions of magnet limbs are, therefore, $8\frac{1}{2} \times 18\frac{1}{2} \times 17$ bore.

It only remains to fix the length, which depends almost entirely on the bobbins, the ampere-turns required for the iron circuit being small compared to those necessary for the air-gap. As a rule, if the dynamo is well proportioned, the length of limb from yoke to armature should not be longer than the diameter of the armature, and this space should include the bobbin cheeks, which are, say, 1 inch in thickness. Let us then take 14-inch bobbins. If a line is drawn round the frame in the centre of the limbs, this will be the approximate mean path of the magnetic lines, and can be summed up as follows:—

Bobbins and cheeks, 16×2	=	32 inches.
Yoke	=	8·5 inches.
Top circles $\frac{8\cdot5\,\pi}{4} \times 2$ ...	=	13·35 inches.
Bottom circles $\frac{4\cdot25\,\pi}{4} \times 2$...	=	6·67 inches.
Balance $\left(8\cdot5 - \frac{4\cdot25}{2}\right) \times 2$	=	12·75 inches.
Total length of magnetic path	=	73·27 inches
= 186 cms.		

Ampere-Turns.—The method often employed is to work out the magnetic reluctances of the different parts, and the products of these and the total flux N give the respective ampere-turns required. This can, however, be done in one operation.

The fundamental C.G.S. formula is

$$\text{M} = \text{N R},$$

where M = magnetomotive force and R = magnetic reluctance. Or, if we require ampere-turns, we must multiply by

$$\frac{10}{4\pi} = \cdot7958.$$

R is, however, equal to $\frac{l}{\mu a}$,

or the length of material divided by the area and the coefficient of permeability, just as in electricity where μ is replaced by the specific conductivity.

We therefore have

$$\text{Ampere-turns} = \frac{\text{N}\,l}{\mu\,a} \times \cdot7958$$

and, as $\frac{\text{N}}{a}$ = B or the induction per square centimetre, we simply have

$$\text{Ampere-turns} = \frac{\text{B} \times l}{\mu} \times \cdot7958.$$

Taking the air-gap first, it is still necessary to get B for the effective polar area.

This is

$$45\cdot14 \times 46\cdot832 = 2{,}100 \text{ sq. cms.}$$

$$\text{B therefore} = \frac{12\cdot13 \times 10^6}{2{,}100} = 5{,}750.$$

Hence

$$\text{Ampere-turns for air-gap} = \frac{3\cdot96 \times 5{,}750 \times \frac{10}{4\pi}}{1} = 18{,}000$$

$$\text{Ampere-turns for iron} = \frac{186 \times 16{,}000 \times \frac{10}{4\pi}}{\text{say } 300} = 8{,}000$$

$$\text{Total ampere-turns} \quad \ldots \quad \ldots = 26{,}000.$$

The ampere-turns for the armature may in this case be neglected, as with a small induction, and a high permeability as is usually the case now, they only run into hundreds.

Winding Field Magnet Bobbins.—This is perhaps the most troublesome operation in designing a dynamo, and unless the designer has some experience, the calculations have often to be repeated two or three times. Our object is not only to get on the necessary ampere-turns, but also to see that the watts are in such proportion to the radiating surface that they do not cause overheating. In order to attain this end, the watts per square inch of radiating surface should not be higher than 1·5, and in calculating the radiating surface the two sides of the bobbins inside the magnet limbs should be neglected. The whole point is to be able to gauge the right depth to which we shall wind.

Let the bobbins in this case consist of iron sleeves slipped over the limbs, of a total thickness, including the insulation, of ·3 inch, or 1·2 inch all round (four sides).

As we have to put on 26,000 ampere-turns, the resistance of a mean turn will obviously be

$$\frac{80}{26{,}000} = \cdot003077 \text{ ohm.}$$

Let us try winding to a depth of 2 inches.

Referring to fig. 2, the length of a mean turn will be:

$$2\,(18\cdot5 + 8\cdot5) + 1\cdot2 + 2\,\pi = 61.48 \text{ ins.}$$

Assuming that the designer has a table of resistances and wires before him, we proceed—

$$\text{Resistance of 1,000 feet} = \frac{\cdot003077 \times 1{,}000 \times 12}{61\cdot48} = \cdot6005 \text{ ohm.}$$

On referring to a wire table, we see that copper wire, ·1299 inch diameter, has a resistance of ·60647 ohm per 1,000 feet. This is near enough.

Number of Turns in one Layer:—

Diameter of copper wire	·1299	inch.
d.c.c. insulation	·016	„
	·1459	„
Allow for slack, 5 per cent ...	·0073	„
Gross diameter of wire ...	·1532	„

Our bobbin is 14 inches high, therefore the number of turns $= \frac{14}{\cdot1532} = 91$ turns.

Number of Layers:—

Diameter of copper wire	·1299	inch.
d.c.c. insulation	·016	„
	·1459	„
Allow for slack, 20 per cent. ...	·0292	„
Gross diameter of wire	·1751	„

The winding is 2 inches deep, therefore the number of layers is

$$\frac{2}{\cdot1751} = 11 \text{ layers.}$$

Total number of turns $= 11 \times 91 \times 2 = 2{,}002$, say, 2,000 turns.

Now the resistance of a mean turn will be

$$\frac{\cdot60647}{2{,}000} = \cdot00303 \text{ ohm,}$$

and the total resistance of the shunt winding = 6·06 ohms. The watts lost in the shunt will be

$$\text{E C} = \frac{\text{E} \times \text{E}}{\text{R}} = \frac{80 \times 80}{6\cdot06} = 1{,}056 \text{ watts.}$$

The radiating surface is arrived at thus: Length of outside turn $= 2\,(18\cdot5 + 8\cdot5) + 1\cdot2 + 4\,\pi = 67\cdot76$ inches.

Subtracting one side, $67\cdot76 - 18\cdot5 = 49\cdot26$, we get for total radiating surface $49\cdot26 \times 14 \times 2 = 1{,}375$ sq. ins.

The square inches per watt will therefore be:

$$\frac{\text{turns} \times \text{radiating surface}}{\text{volts} \times \text{ampere-turns}} = \frac{1{,}375 \times 2{,}000}{80 \times 26{,}000} = 1\cdot32 \text{ sq. inches,}$$

which is a figure that will give good results.

We can inquire further into the electrical efficiency; the shunt current will be $\frac{80}{6\cdot06} = 13\cdot2$ amperes, or about 3 per cent. of the armature current; the watts lost in the shunt are $80 \times 13\cdot2 = 1{,}056$, and therefore the electrical efficiency

$$= \frac{32{,}000}{33{,}056} = 97 \text{ per cent. nearly.}$$

This neglects the armature losses which may be a further 2 per cent., and which are easiest to measure after the machine is finished. The total actual ampere-turns will now be $13\cdot2 \times 2{,}000 = 26{,}400$ which is only about $1\frac{1}{2}$ per cent. higher than what we require by calculation.

To recapitulate and conclude; these notes only refer to the materials and the size and type of machine herein set forth, and are intended more as a demonstration of the method of winding a machine in practice, than of the calculations of the size and magnetic properties of the dynamo, albeit these have also been touched on so as to make the whole complete. In actual practice however, and after a certain number of dynamos have been built, it is the winding only which requires re-calculation (within limits) the other properties being proportioned from existing types.

THE MONTAUK MULTIPHASE FIRE CABLE.*

The United States have won a well deserved reputation for the high state of efficiency to which they have brought their appliances for fire extinguishment. It is generally admitted that the best fire departments of other countries are greatly inferior to the splendid institutions which are maintained in our leading cities. Not only is our equipment for "fighting fire" practically perfect, but there has been a wonderful amount of ingenuity displayed in the invention of devices for automatically locating and announcing an outbreak of fire. These inventions have taken the form of thermostats, which automatically close an electric circuit when the local temperature passes a certain point. The thermostats are scattered throughout a building in various places, which in the judgment of the owner are most likely to be visited by a fire. If the outbreak should occur immediately below a thermostat, the circuit will be closed and the alarm rung in immediately. If, however, the fire should start at a point intermediate between two thermostats, there would be more or less delay until the temperature reached the proper degree to operate the alarm.

The ingenious and well-thought-out system of fire alarm which we illustrate in the accompanying engravings, is the logical development of the usage of the thermostat above referred to. In place of a set of wires connecting a number of isolated thermostats, the whole wire itself is so sensitive that the mere heat of a lighted match (see fig. 3) applied at any point of the wire will cause the metal to fuse and ring in an alarm. As the value of a fire alarm consists chiefly in the rapidity with which it will act, upon the outbreak of a fire, it is evident that the efficiency of the "fire cable" is enormously increased over that of ordinary systems.

The construction of the cable and the details of the wiring are shown in the accompanying figures. The cable, fig. 1, is made up of an inner copper wire, which is coated with a metal that fuses at the low temperature of 374°. The fusible metal alone would serve to carry the current, but the copper is introduced to increase the conductivity. Around the fusible metal is wrapped a suitable insulation, and over this again is wrapped a series of smaller wires with insulations between them, as shown in the sketch, the whole being covered with an outer protective wrapping. One of the outer wires serves the fire alarm, another the burglar alarm, another may be used for the servants' call, and others may be added to serve a multiplicity of electric connections.

* *Scientific American.*

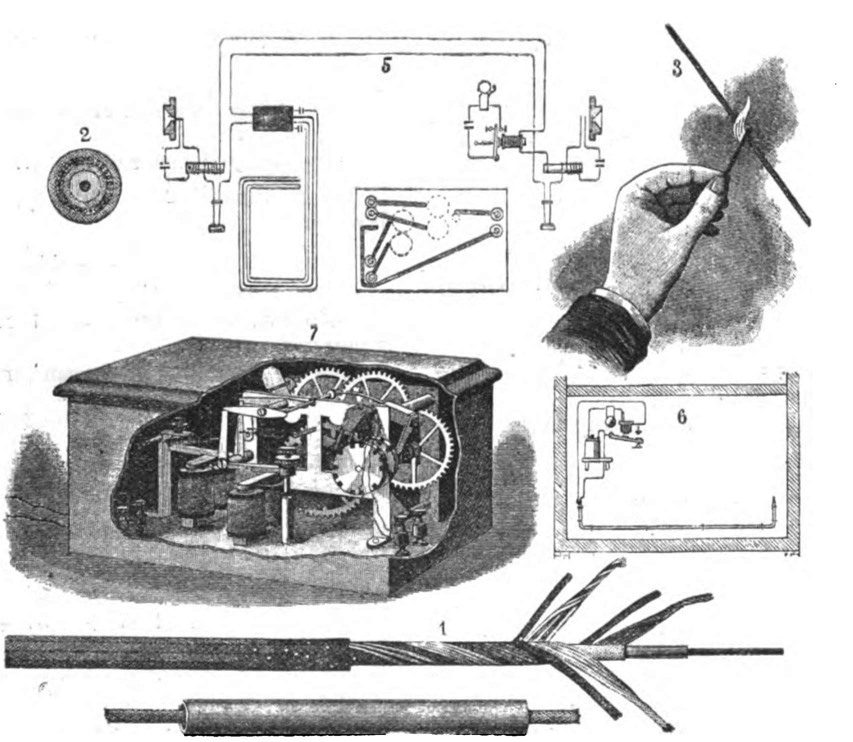


Fig. 4.

When a fire breaks out in the neighbourhood of the wire, the heat fuses and expands the inner fusible coating and forces it out through the insulation into contact with the overlying return wire, thus forming a metallic contact between the inner and outer wire, closing the circuit and turning in an alarm. Fig. 6 shows the cable laid in a room and connecting with an audible fire alarm in the house. Fig. 5 is a diagram showing the cable connected to an automatic circuit-controller in the house or on the street, through which the alarm is automatically forwarded to the central fire station.

When the circuit is automatically closed by an outbreak of fire, the current energises the magnets in the controller (fig. 7), which then act upon a system of small levers and release a clock mechanism. The latter serves to rotate the two controlling discs, which, by means of make and break contacts, ring up the call corresponding to the location of the fire and show the corresponding number in the annunciator. The discs are so arranged that they repeat the alarm at the central station.

A valuable feature of this cable is that it forms an effective burglar alarm; for if a burglar should attempt to destroy the ordinary window alarm by breaking the window glass and cutting the wires, the pliers will form a metallic connection between the inner and outer wires of the cable and close the circuit. To avoid error in connecting up the return wires they are made in different colours. Thus the fire alarm wires are of copper, another set are copper wires tinned, and a third will consist of alternate tinned and copper wires (see fig. 1). To keep down the bulk of the return wires each set consists of several fine wires whose aggregate cross section is sufficient to make up the necessary conducting area, and they are wrapped in ribbon fashion around the insulation. Considering the complicated nature of the cable and the duty that it performs, its bulk is remarkably small.

The advantages of the cable are obvious. Not only does it provide a building with continuous lines of protection, but the sensitive wires themselves are so small as to attract no more attention than ordinary house wiring. It may be laid along the moulding, across a window or door, within the cornice, above the shelves in a store, without attracting the eye, or in any way interfering with the decorative features of the building. For detecting a fire, due to spontaneous combustion in the coal bunkers or hold of a ship, the wires would be laid in pipes, fig. 4, which would protect them from rough usage but leave them exposed to the action of heat. The various patents which cover this device are owned by the Montauk Multiphase Cable Company, 100, Broadway, New York, to whom we are indebted for the particulars given above.

Banquet.—From the *Western Mail* of Cardiff we learn that a banquet was given on Friday night last at the Whitehall Club to Mr. Samuel Insull, of the Chicago Edison Company, by Messrs. Arthur Wright and W. L. Madgen.

THERMIC EQUILIBRIUM IN ELECTROLYSIS.

By M. D. TOMMASI.

The problem that we propose to solve is as follows:—*Given a chemical compound capable of being oxidised or reduced, find out how it behaves when it is brought at the same time into the presence of a reducing and an oxidising substance, which are considered to be equal and contrary forces.*

Theoretically, only two cases are possible.

1. The two forces neutralise one another, and the compound evidently remains in equilibrium.

2. One of the forces overpowers the other.

According to thermic data this is what should happen:—

Let the compound, for instance, be termed A B; we subject it to a chemical action ($H^2 + O$); three cases may present themselves for consideration:*

(*a*). The compound A B will not be subjected to any action if

$$c\,A\,H^2 + c\,B\,O = c\,A\,O + c\,B\,H^2,\dagger$$

i.e., if the compound A B gives off the same quantity of heat when becoming oxidised as when being reduced.

(β). The substance A B will be reduced if $c\,A\,H^2 > c\,B\,O$.

(γ). The substance A B will be oxidised if $c\,A\,H^2 < c\,B\,O$.

For the sake of clearness, let us take an example: we will subject nitric acid to the action of ($H^2 + O$). In this case the reduction of the nitric acid can only take place if the hydrogenisation of this acid gives off more heat than the oxidisation of ammonia. Now, according to thermic data the formation of ammonia by the reduction of nitric acid gives off more heat than the oxidisation of ammonia.

In fact

$$N\,O^3\,H + 4\,H^2 = N\,H^3 + 3\,H^2\,O\,;\ 179{\cdot}2 \text{ cal.}$$
$$N\,H^3 + 4\,O = N\,O^3\,H + H^2\,O\,;\ 96{\cdot}8\ \text{,,}$$

Therefore, the nitric acid will be totally reduced by (H^2+O) unless an opposite reaction can take place; which conclusion is fully borne out by experiment. The mixture ($H^2 + O$) is obtained by the electrolysis of water, with the aid of three bichromate of potash Bunsen elements.‡

The gases are thus liberated in the ratio of their molecular weight, and under the same chemical and physical conditions.

The electrodes are of platinum and very close together. The liquid which is being experimented upon is frequently stirred and the current is reversed alternately.

We can sum up in the following table the results at which we arrived by subjecting various chemical compounds capable of being reduced or oxidised by the simultaneous action of electrolytic hydrogen and oxygen.

Action of ($H^2 + O$) on different chemical compounds:—

Original compound.	Final compound.
Nitric acid	Ammonia and nitrite.
Nitrate of potassium.	———
" sodium	
Nitrite of potassium	Ammonia.
Chlorate of potassium	Perchlorate.
Arsenical acid	No change.
Arseniate of potassium	———
Arsenious acid	Arsenical acid.
Arsenite of potassium	Arseniate.
Ferrous sulphate	Partial oxidisation.
Ferric sulphate	Partial reduction.

From the results of these researches we can deduce the following laws:—

1. *When a body is subjected to two equal and contrary chemical actions, the reaction which gives off the greatest quantity of heat will be most likely to be produced, provided that it can be begun.*

Examples: The oxidisation of the arsenious acid and of the alkaline arsenites. The reduction of the nitric acid and of the vegetable nitrites.

2. *With two chemical reactions, the one that requires the least heat to begin will always be produced in preference, even if it gives off less heat than the other reaction.*

Examples: The oxidisation of the chlorate. The partial reduction of the ferric sulphate and the partial oxidisation of the ferrous sulphate.

In the case of the chlorate of potassium, for instance, the heat or energy required to effect the union of the hydrogen with the oxygen of the chlorate must be greater than that required for producing the combination of the oxygen with the chlorate, and this is no doubt the reason why the chlorate was transformed into perchlorate rather than chloride, although the oxidisation of the chlorate gives off less heat than its reduction. For the same reason, if the ferric sulphate* is reduced by ($H^2 + O$), it is due to the fact that the heat or the energy required to effect the union of the hydrogen with the oxygen of the ferric sulphate is greater than that given off by the combination of the electrolytic oxygen with the ferrous sulphate,† and if the reduction is not total, but partial (60 per cent.), this is due to the fact that having arrived at this point a sort of equilibrium is established between the reduction of the ferric sulphate on the one hand and the quantity of ferrous sulphate formed on the other hand, an equilibrium similar to that which is observed when we electrolyse a mixture of varying proportions of nitrate of copper and nitrate of silver.‡ We may mention, in conclusion, the following fact, which will show indisputably that the principle of the maximum work and its reciprocal Sprague's law§ are only true on the express condition *that the reaction between the bodies brought together can be begun.*

If we acidulate a solution of bioxide of hydrogen ($H^2\,O^2$) with sulphuric acid, we get at the negative pole an abundant escape of hydrogen, due to the decomposition of the water without this hydrogen reducing the bioxide of hydrogen. Now, how can we explain the fact that this nascent hydrogen‖ which, although it reduces a number of substances the decomposition of which absorbs heat, has no effect on the bioxide of hydrogen, the decomposition of which takes place with a liberation of heat?

In other words, why does the electric current decompose the water, the heat of decomposition of which is − 69 cal., rather than act on the bioxide of hydrogen, the heat of decomposition of which is + 21·6 cal. We observed¶ a similar fact with the following couple:—

Zinc, acidulated water; porous jar, bioxide of hydrogen, with the addition of a drop of solution of sulphate of copper. Platinum.

In this couple, in fact, the deposit of copper on the platinum is produced as soon as the circuit is closed and long before the bioxide of hydrogen has been decomposed.

We observe, then, in this couple the singular fact that the hydrogen given off by the decomposition of the water reduces the sulphate of copper (an exothermic compound), the decomposition of which absorbs heat rather than the bioxide of hydrogen (an endothermic compound), the decomposition of which, on the contrary, is attended by giving off of heat.

* It is supposed, in all three cases, that the same quantity of heat or energy is required to commence the chemical reactions.

† c = heat of formation.

‡ For fuller details see "Treatise on Electric Batteries," by D. Tommasi, p. 200 (published by G. Carré, Paris).

* $(S\,O^4)^3\,Fe^2$.

† $S\,O^4\,Fe$.

‡ See "Traité théorique et pratique d'électro-chimie," by D. Tommasi, p. 25 (published by Bernard, Paris).

§ The substances liberated at the electrodes are those which, in escaping, absorb the least specific energy.

‖ The researches that we made in 1877 showed that if hydrogen in a nascent state is a powerful reducer, it is due solely to the fact that this body, at the moment it leaves, a combination is accompanied by all the heat produced at its escape. Consequently nascent hydrogen is synonymous with H + cal. (hydrogen + ealories) and the differences observed between hydrogen given off by different chemical reactions, are due to the fact that these reactions do not develop the same quantity of heat.

¶ See "Traite théorique et pratique d'électro-chimie," by D. Tommasi, p. 526.

SHIELDED CONDUCTORS.

By W. A. PRICE.

Mr. Mordey's paper on "Dynamos," read on May 20th, before the Institution of Electrical Engineers, has produced a long series of articles and letters in different periodicals, proposing and solving a number of paradoxes and puzzles of more than usual interest. Some of these are curious and excellent examples of magnetic problems that can be dealt with sufficiently by the application of first principles, though complete solutions would be difficult mathematical exercises. The first puzzle proposed was not new, having been described years ago by Mr. James Swinburne; but its interest was revived by an experiment described by Mr. Mordey. The difficulty is to explain how a conductor buried in the iron of a slot-wound armature experiences very little mechanical force, though it is equally as efficient in developing electromotive force in a dynamo, as if it were exposed on the surface of an ordinary drum armature, and has just the same effect in producing torque in a motor.

The electromotive force developed in a conductor is simply proportional to the number of lines of force crossing it in a given time. The mechanical force on a conductor is proportional to the product of the current, and the density of the magnetic field in its own substance; and the difficulty lies in seeing how the magnetic field in the body of the slot-wound conductor can be so small that no appreciable force is exercised on the conductor, while, at the same time, it is cutting a field of sufficient intensity to generate a large electromotive force. The answer is, of course, that in a slot-wound armature the conductors are so shielded by the iron body in which the slots are cut that only a very small part of the total magnetic flux passes through them at any given instant, and the force acting on the conductor is correspondingly small; while at the same time the total flux cut by any conductor in the course of the revolution of the armature is not affected.

Figs. 1 and 2 are diagrams of the usual character, showing the distribution of the lines of magnetic flux near the air gap in a slot-wound armature. The upper part in each

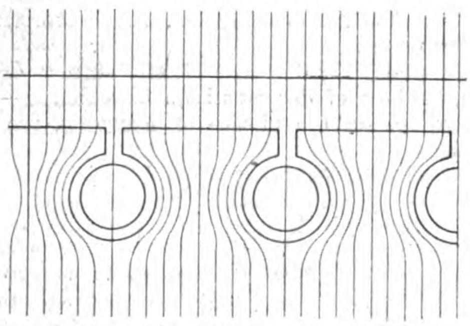


Fig. 1.

figure represents parts of a magnet pole, while the conductors are shown in round slots cut in the body of the armature. The air-gap is shown straight instead of an arc of a circle for convenience in drawing. Fig. 1 gives the arrangement of the lines of magnetic flux when there is no current in the conductor. The field in the body of the conductor is extremely weak, but as the armature is rotated the lines of flux are carried across the conductor, moving slowly in the mass of the iron, but flashing across the slot at great

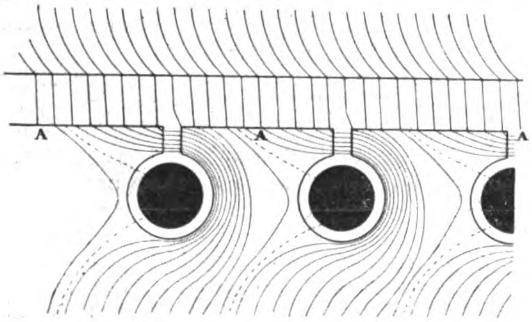


Fig. 2.

speed. But no figure explains the movement as well as Mr. Swinburne's comparison of the action to the appearance of a row of railings passing behind a knot in the window of a railway carriage, producing an appearance similar to fig. 1.

Fig. 2 gives the arrangement of the lines when a current is passing in the conductor. It is obtained by imposing on fig. 1 a system of magnetic forces, circular about the conductors, producing distortion of the field. The distortion does not affect the reasoning already given about the forces acting on the conductors, and the electromotive forces developed; but the figure shows how it is that the weakness of the field in the body of the conductor does not affect the torque on the armature. The points of application of the forces which produce the torque lie on the surface of the armature, where the lines of force enter it from the ether, viz, along the surface, A A A. In fig. 1 these lines enter the surface normally, and produce no torque; but when a current is started in the conductors, the lines of force in the air-gap become slightly oblique, as shown in fig. 2, in consequence of the circular systems of magnetic forces about the conductors, and a torque is developed. The whole of the useful effect is obtained from the slight displacement in the air-gap. The large displacement of the lines in the body of the armature serves no useful purpose. The magnetic force in the air-

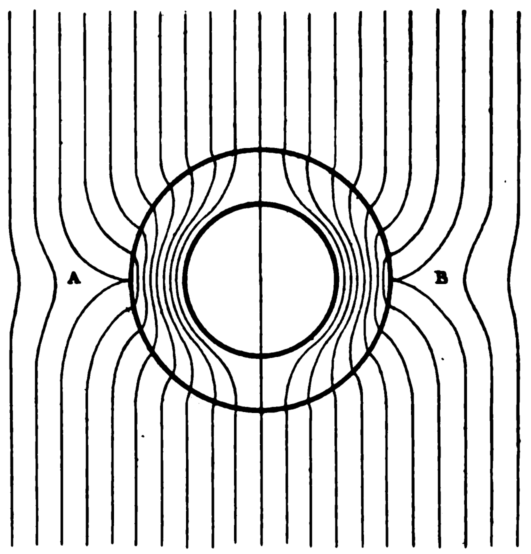


Fig. 3.

gap, due to the current in the conductor of circular section, is at all points inversely proportional to the distance from the axis of the conductor, and is in no way shielded by the iron body of the armature.

Another advantage possessed by slot-wound conductors, that they are less heated by eddy currents than surface conductors, can only be due to a very steady movement of the lines of flux across the slots, so that all parts of any conductor are cutting lines at the same rate. It is no explanation to say that, since the field in which the conductor lies is weak, even large percentage variations in its density are immaterial; for the absolute density has no relation to the generated electromotive force. The exact explanation of what is undoubtedly the fact, viz., the freedom of slot-wound conductors from eddy current heating, is not very clear.

A remarkable statement has been made by Prof. du Bois, from whose article in the *Elektrotechnische Zeitschrift* we extract the following passage:—

"A ring magnet experiences a side thrust when in an external field, whose lines of force are in the same plane as the ring; and conversely it exerts a thrust in the opposite direction upon the supporter of the external field. This deduction, so astonishing at first sight, I have proved to be verified by experiment."

Though not expressly stated, it seems to be implied that the field is uniform, except so far as the ring distorts it, the ring homogeneous and uniformly magnetised, and the thrust experienced a continuous one, and not merely impulsive or ballistic on completing the connections. We take "side thrust" to mean a thrust in the plane of the ring, at right angles with the field, but it may mean a thrust in the direction of the axis of the ring. Each construction presents the same difficulties. Such a field and ring may be realised by permanent magnets, and by arranging the ring to turn about an axis "perpetual motion" is obtained.

Mr. James Russell disputes the truth of this "deduction" on experimental evidence, while it is totally opposed to conclusions drawn from the ordinary premises, which would lead us to reason somewhat thus. If an iron or steel anchor ring, unmagnetised, be introduced into an uniform magnetic field, the field is distorted from its previous form in some way depending on the permeability of the ring and its position in the field. If the ring is placed with its plane parallel to the field, it will experience no force tending to move it in space. There will be forces tending to elongate it into an oval, but these would not produce any such effect as that discovered by Prof. du Bois. Now, without moving it, suppose the ring to become circularly magnetised. This magnetisation, though it produces a new distortion of the field in the body of the ring, produces none in the field outside the ring, which retains the same form and distribution as before, so that the ring experiences no force.

Figs. 3 and 4 show the character of the field near the ring before and after its magnetisation.

In these diagrams we have taken no account of the effect on the permeability of the different flux densities on the two

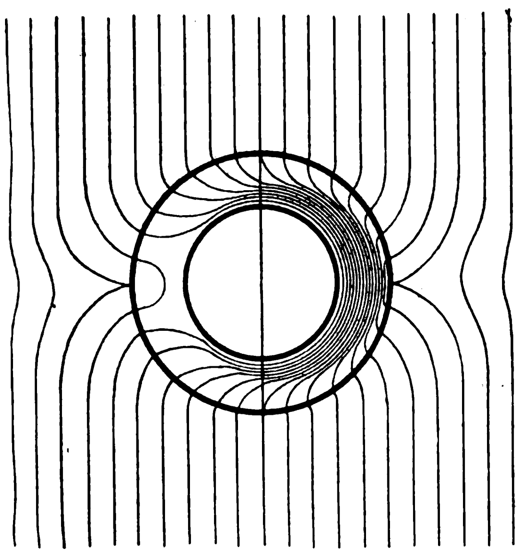


Fig. 4.

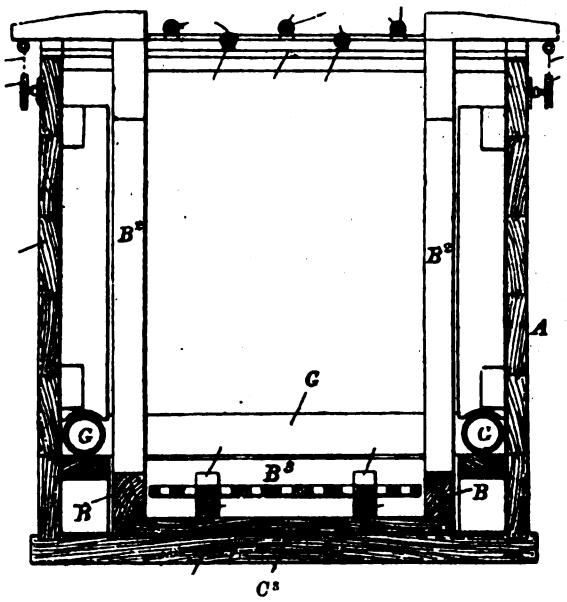
sides of the ring. This would change the field distribution to a form that would be produced by an unmagnetised ring which is non-homogeneous, but symmetrical about the axis A B of fig. 3, being less permeable on the side B than on the side A. This change of field taking place when the ring is magnetised, would produce a sudden and transient force acting on the ring in the direction B—A, and it is possible that this is the effect Prof. du Bois has observed. His words do not exclude such a construction. The action would not occur with a circular or ring solenoid.

(*To be concluded.*)

REMOVAL OF MILL SCALE BY ELECTROLYSIS.

By SHERARD COWPER-COLES, M.I.E.E., Assoc.M.Inst.C.E.

The removal of mill scale from forgings and plates has always been a matter of considerable difficulty, the scale in many cases being $\frac{1}{32}$-inch in thickness, and very adherent. The usual practice is to place the iron in a solution containing 1 part of hydrochloric or sulphuric acids to 10 parts of water, for a period varying from 2 to 24 hours. Many attempts have been made to quicken the process and to reduce the cost. One of the first experiments was to make the iron to be pickled, the anode in an acid bath; but this was found to pit the plates, as the iron which was not protected by the mill scale was more readily dissolved than that covered by the magnetic oxide. To overcome this difficulty the current was reversed, the iron being alternately made anode and cathode. The illustration shows a transverse section of a pickling vat constructed for such a process, the work being suspended on the bars placed across the vat. To quicken the process and reduce the electrical resistance of the solution, it is found advantageous to heat the pickling solution or electrolyte, which is done by means of a lead pipe, G, through which exhaust steam is passed. In the illustration a tray or false bottom, C^3, is shown, capable of vertical movement between guides provided on the inside of the vat; the object of the tray being to catch the heavy mill scale which falls from the plates. The tray at the end of the day's work is allowed to float by releasing the paul from the winch to the top of the solution so that the mill scale collected on it can be removed. To sink the tray when necessary, extensions, B^3, are provided at each corner, and these extensions are connected to flexible connections which pass round guide sheaves, and are connected to a drum or winch which is rotated when it is desired to sink the tray.



Cross Section.

Another device for catching the scale soon after it is removed from the plates, so as to prevent the further unnecessary consumation of acid by dissolving the mill scale after removal has been tried with most satisfactory results. The solution is circulated by means of a small pump through a lead-lined box or chamber, behind which are placed electromagnets, the result being that as the solution flows past the poles of the magnets the magnetic iron in suspension is retained and can be removed from time to time.

In America an electrical pickling process has been tried. The solution used being sulphate of soda or sulphuric acid. The plates to be cleansed form the negative electrode and an iron plate the positive electrode. The hydrogen set free from the surface of the plate reduces the oxides on the surface, and decomposes any grease that may be present.

Attempts have been made to remove the mill scale by drawing it away from the plates with powerful electromagnets, the scale having been previously loosened by a short immersion in an acid bath, or by heating.

THE PROPER CONSTRUCTION AND USES OF ECONOMISERS.

The word economiser has a general meaning, but in steam using parlance an economiser has come to mean a special piece of apparatus, to wit, a flue feed heater, made of tubes, and every engineer who speaks of an economiser almost invariably means one with vertical pipes of the Green type. These are so common in England that they may be said to be universal in the textile districts, and, as stated by Mr. Brinckerhoff in a paper read before the New England Cotton Manufacturers' Association, they are in use all over Europe, and in the mills of India or the mines of South Africa, and have already been widely adopted even in the United States.

It appears that economisers have rather been failures in the United States in many instances, this being due to the use of material other than cast-iron, which alone seems to have the power to resist the corrosive action of sulphurous gases. In this respect an economiser differs somewhat from a boiler. The latter is hot and does not condense on its surface steam from the gases passing over it.

The economiser is fed with cool or cold water, and the tendency to condensation of acid vapours on its surface is much greater, and even cast-iron pipes suffer much at their lower ends, as we have pointed out years ago. Indeed, Messrs. Green now provide against this by using a part of the economiser as a first section to warm the water before passing it on to the remaining lower boxes. In this way they save the lower ends of, say, five-sixths of the pipes by allowing the whole of one-sixth of the pipes to be attacked.

Another cause of failure has been the lack of capacity. An economiser requires to be of such size that the water passing through it should take from 30 to 50 minutes. This gives time for heat absorption. Many economisers have not been fitted with automatic cleaning gear, and soot being so poor a heat conductor, a few hours are sufficient to render an economiser nearly useless if not automatically cleaned. Attention to the three essentials—cast-iron, capacity, and cleaning—has made the success of Green's economiser. The further important items are, an absence of made or packed joints, the pipes being forced, metal to metal, in the sockets of the top and bottom boxes by hydraulic pressure, and finally tested to 350 lbs. A well-made economiser has a life of 20 years, and can be so repaired in sections as to become practically a new apparatus, while preserving its old identity like a repaired umbrella which contains nothing of its original parts.

But economisers require care; they should be blown out when the boilers are blow off; they should be periodically cleared of soot below, and yearly, at least, the top caps need removal for purposes of inside inspection. Also, we would add, they must be bored out when scaled. Boring out is quite a branch of the economiser business, and pipes can be bored clean of scale very easily by means of the special boring bars sent out for the purpose by the makers. It is the practical necessity of boring out an economiser which has prevented the success of many economisers constructed on different lines. We have seen economisers made in the form of a helix, most ingeniously cast, but quite incapable of being bored out. Again we have seen them with the water passages of the pipes made of segmental cross-section—also not to be bored out. Of course, water ought not to contain lime salts. But unfortunately it does, and no economiser maker can afford for long to ignore the fact. Apart from the *bonâ fide* saving effected by an economiser, the increase of the capacity of a plant afforded by it and the saving in repairs to boilers by reason of the abolition of cold feed, and the saving in cleaning because of the deposition of much scale forming matter in the economiser in the form of mud, the apparatus is specially useful when work fluctuates. A sudden demand for steam, of which a heavier feed is the obvious concomitant, is not followed by the drop in pressure which accompanies a large influx of cold feed. An economiser is, in fact, a species of thermal storage with a good system of circulation. It adds to the water space of a boiler and must be an immense benefit to water-tube boilers, whose chief fault is perhaps a deficiency of water capacity.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1897.

[*Compiled expressly for this journal by* W. P. THOMPSON & Co., *Electrical Patent Agents*, 322, *High Holborn, London, W.C., to whom all inquiries should be addressed.*]

30,572. "Improvements in joints for electricity conductors." G. C. FOWLER and THE MUTUAL ELECTRIC TRUST, LTD. Dated December 28th.

30,619. "Improvements in primary galvanic batteries or cells." J. W. BULLOCK. Dated December 28th.

30,622. "A combined manual and automatic switch for electric circuits." R. L. HAILEY. Dated December 28th.

30,626. "Improvements in the method of and means for regulating the phase relation between current and electromotive force in alternating current systems of electricity distribution." THE BRITISH THOMSON-HOUSTON COMPANY, LTD. (C. P. Steinmetz and E. W. Rice, jun., United States.) Dated December 28th. (*Complete.*)

30,627. "Improvements in and relating to electric railways." THE BRITISH THOMSON-HOUSTON COMPANY, LTD. (W. B. Potter, United States.) Dated December 28th. (*Complete.*)

30,628. "Improvements in induction watt meters." THE BRITISH THOMSON-HOUSTON COMPANY, LTD. (E. Thomson and W. H. Pratt, United States.) Dated December 28th. (*Complete.*)

30,678. "A new or improved method of retransmitting telegraphic messages and apparatus for use in connection with the said method and for other purposes." J. RYMER-JONES. Dated December 28th.

30,815. "Improvements relating to animated photographs." W. J. H. JONES. Dated December 30th.

30,832. "Improved arc lamp carrier." J. BROCKIE. Dated December 30th.

30,838. "Improvements in apparatus for use in the manufacture of accumulator plates." C. MARSCHNER. Dated December 30th. (*Complete.*)

30,841. "Improvements in electrolytic apparatus." G. C. MARKS (H. de Solages, France.) Dated December 30th.

30,846. "A method or methods for controlling a mechanism or mechanisms by means of electric or electro-magnetic waves of high frequency." E. WILSON and C. J. EVANS. Dated December 30th.

30,848. "Operating railway points by electro-motors." I. A. TIMMIS. Dated December 31st.

30,881. "A new or improved method of electrical signalling." S. J. MOTTON. Dated December 31st.

30,912. "Improvements in electrical resistance apparatus." H. A. MAVOR and MAVOR & COULSON, LIMITED. Dated December 31st.

30,997. "Improvements in electrically operated clocks." R. BURK. Dated December 31st. (*Complete.*)

30,923. "Improvements in electric elevators." H. H. LEIGH. (F. J. Sprague, United States.) Dated December 31st.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

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1896.

17,161. "The manufacture of an active material for the plates or electrodes of electric accumulators." S. HAMMACHER. Dated August 4th, 1896. Relates to the active material of secondary batteries, which consists of a lead oxide mixed with substances of the pyridine group in the presence of water.

17,187. "An improved electric cable or conductor for electric fire or other alarm systems." C. D. TISDALE and J. D. GOULD. Dated August 4th, 1896. Conductors are formed with a core of lead or lead on copper, surrounded by an inflammable insulating material such as India-rubber, or fibre and resin. One or more wires are then laid in long spirals over the insulation and further insulated if desired. The wires are fixed round a room and are connected to a bell magnet and battery. The action of the magnet is to form a short circuit across the leads when once the alarm is given. The contact between the wires may also be formed by pinching or cutting as in burglar, &c., alarms.

17,659. "Receptacle for electric and other wire." E. F. JONES. Dated August 10th, 1896. Conduits in the form of kerbs constructed as open-ended boxes, fitting together by rabbet joints. The outer side is strengthened, and removable lids are provided for inspection of the wires or tubes. The conduits may be of iron, wood, &c., and the joints are packed with pitch and the like.

1897.

13,107. "Improvements in electric arc lamps." S. BERGMANN Dated September 4th, 1897. Relates to arc lamps, especially where the arc is maintained in a small inner globe. The frame of the lamp is so constructed that the inner and outer globes can descend so far below the base of the lamp as to easily permit the introduction of new carbons without risk of breakage. A removable and adjustable electric contact making holder is provided for the upper carbon, by which the vertical length of the lamp is very much reduced, and a fusible conductor for leading the current to the upper carbon is avoided. The chamber enclosing the arc has a valve-shaped top seated in the portion of the lamp which supports the carbon feeding and regulating mechanism. This top has an opening for the passage of the upper carbon. There is a carbon-holder in the shape of a cylindrical tube provided with means for securing the carbon, and with adjustable springs for ensuring electrical contact between the directing tube and carbon-holder. With the supporting frame are a pair of tubes, with links pivoted on their ends. A pair of tubes within the former carry a yoke provided with off sets, with which the links engage, and a pair of wires within them carrying a support for the outer globe, with a releasing device. 7 claims.

THE

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CHEAP PRODUCTION.

IF we assume that the engineers' strike is now practically over, the best thing to be done is to push forward their rapid and well-paid re-employment as quickly as possible. Six months of idleness is in itself demoralising, and the men have gone through quite sufficient hardships, on the whole, fairly peacefully, to forbid any desire to extend further the sharp lesson of defeat. Now is the time, when they are thoroughly beaten, for the employers to step forward and drive home the arguments of the past half-year by deeds. They have the power in their hands to insist on better and more honest service. It is their duty to do it, and to do it so thoroughly that the men will assist to get back some of our lost trade. If this be done, there is good reason to suppose the country will be almost over-crowded with work. This will mean good wages, and, if this time of better wages arrives quickly, the men will learn, before they have become powerful enough to again indulge in skulking, that the system of work pays them better than the system of idling. As soon as they learn this lesson, the occupation of the agitator, who has lived on the doctrine of restriction and harassment, will have gone. Coming out as victors from the struggle, the employers have the right to insist on work being done for money paid, but they are equally bound to see to their own duties. Improved machinery and shop methods and an abandonment of all *laissez faire* notions must be faced. It is important that no loophole be left for the arrows of trades union criticism. Trades unionism is chameleon-like in its colours, and changes rapidly in its methods of attack. Unable to compel employers to its final outrageous demands for the maximum of wages for a minimum of work, it is by no means unlikely that future attempts at interference will be in the very direction the employers have practically been inviting it. Realising that the game of restriction is up, and perhaps having absorbed some of the scathing criticisms which have been levelled against unionism, as it has become, the leaders of reconstituted unionism may profess a willingness to increase output. They may make demands for men to attend several machines, and may lodge complaints as to the non-efficiency of old plant, and in various ways assume a virtue they do not feel, or have only lately acquired. Should events prove that the employers really have obtained the mastery, a very serious responsibility will be with them. In their hands lies the future of English trade. Their own weak concessions to the galling tyranny of trades unionism have done already much irreparable damage. True, the first offender has been unionism, and the employers perhaps did not foresee the result of their concessions; but *facile descensus averni*, and in this case the bottom has fortunately been reached the more quickly at the hands of Mr. Barnes than in milder hands. Great ends are sometimes accomplished by unworthy and unintentional means, and, it may be, Mr. Barnes has wrought better than he knew, for it is through him the end has come. Assuming, then, that further opposition to improved tools will now cease, English engineering firms are likely to require many new tools. For a time the Americans and their German copyists will profit, but English toolmakers, also released from bondage, should be prepared to meet the demand. Manufacturing engineering cannot be carried on with a general engineer's tools. It demands special tools and sub-division of operations.

It seems to be an axiom of repetition work that the greater the number of hands through which a piece is passed, the cheaper will be its production cost, for each hand performs a distinct operation, and does it quickly as the result of practice. What is known as the American method is but this. We question if, when Mr. Burns called for American methods, he really knew just what it was he was demanding. The so-called American methods are simply the methods of many of our free English shops. We know several such, and we have recently compared the prices and discounts of one such shop with the best German shop doing similar work. The German prices are 50 per cent. higher. This shows what can be done in England, where men and masters work together. Could he but see it, the present is Mr. Barnes's great opportunity. He is an adept at shunting issues. He may now turn about face, and claim to have started the present quarrel as a last resource to compel employers to advance, all other methods failing. His friend Burns has given him the cue. It will be easy to follow it, especially as it would afford an opportunity of worrying employers to buy new tools, and the employers will have to do so, and many of them are only waiting to do so until they can be assured of the power to work them up to their limits. Nor could employers complain at such new attitude on the part of unionism. We believe it is found in America, as well as in free English shops, that men push for the latest new appliances. Pushing tools up to their maximum production wears them out more quickly, but labour is a far bigger item than tools, and the time spent in taking care of a tool by easy work would pay for a new and improved tool very quickly.

It would just suit the executive of the A.S.E. to pose as the upholders of improved methods, and to claim for their past conduct a hidden spring of action in a desperate resolve to compel employers to bring themselves into line with new methods. This would be a repetition of the dishing of the Whigs which stirred political circles some years back. There is no such militant saint as a converted sinner, and trades unionism in a new guise of pushfulness would, indeed, be a refreshing and wholesome sight, and might, indeed, constitute a form of interference that would be not unwelcome. Certain American experience with English workmen, who were free to do as they wished in the way of pushing work, showed us some time ago that a certain manufactory, with English skilled men, could beat out of the field the other works in the same trade. There is value in skill and long practice, and in manufacturing engineering there is work which the labourer and the apprentice can do well enough on automatic machinery, but there is a field beyond their scope which will always require skill and superior intelligence. There are so many articles now imported from abroad simply because of the half-hearted manner of working in England, that to supply these goods alone will absorb all our surplus labour before very long. In the interim we fear that the men, who must remain for some time out of work before they can be reinstated, will be exposed to great hardship. The employers have been training others to fill their places, and have now got the very class, at the possession of which Barnes so girds. But it is to him that this new batch of men is due. He has been the kind giver. He also, and in referring to him we mean, of course, the policy of which he is the willing or unwilling mouthpiece, has been the destroyer of the union tyranny, and from him will probably date the new and improved condition of the engineering trades of Great Britain. It is possible—we think probable—that the strike has been a blessing in disguise. It need not have happened but for the complete tangle into which trades unionism has landed everyone. Out of the clearance it has made it is everybody's duty to see that the new buildings shall be on the new plan. As with the great City fire, we ought not to rebuild only, but to remodel.

Photo-Electric Phenomena.

About three years ago we described a form of electrode considerably more sensitive to light than any employed by previous investigators up to that time, and gave a few details of its construction. This electrode was described by H. Luggin, who contributed a paper on it to the *Zeitschrift für Physikalische Chemie*, Vol 14, pages 385—393. The electrode consisted of a platinum plate covered with bromide of silver, and, when used, is paired with a similarly coated silver electrode in a decinormal solution of potassium bromide. The rise of potential is determined by a quadrant electrometer, and, in some experiments, exposure to diffused daylight caused an increase of potential of 0·42 volt. The experiments show that when illuminated by a weak light, the rate of rise of potential is uniform and represented by a straight line until a maximum value is reached, after which it remains constant, or may fall slightly. With a stronger light the rate of increase is more rapid, but the final value is not greater; the rate, however, is not directly proportional to the intensity of the light, but is proportionately less than for weak lights, whilst it is also lowered by previous exposure to powerful light. Continuous and intermittent lights of the same mean intensity appear to have the same effect. The sensitiveness of the plate, however, does not remain constant, but, even after long rests, very different potential increases are obtained with the same light. Since the end of 1894, when Luggin first began to make experiments with this form of electrode, he has been carrying on the investigation with a sensitive electrode similar to that which we have described, but which could be raised to any definite potential above that of the liquid, and he describes his new results in the *Zeitschrift für Physikalische Chemie*, 1897, Vol. 23, pages 577—635. The current produced, or the photo-current, was measured, and it was found that an intimate connection exists between the strength of the photo-current and the depth of the darkening of the sensitive electrode. As the potential of the electrode is increased, however, the photo-current decreases; and ultimately a potential is reached where the current becomes zero, and, by increased exposure, may pass over to a current of opposite sign. Where the action of the current is to remove the halogen, and hence cause darkening of the electrode, the current is called normal or positive, currents which act in the reverse sense being known as solarisation current, and experiments show that both kinds of current may be produced with the same electrode, according to its potential and the light intensity. The solarisation current, in the case of silver chloride electrodes, more readily occurs with yellow light, whilst, on the other hand, blue light favours the production of the normal current, which, in contradistinction to the solarisation current, is coterminous with the exposure. The potential at which no normal current is produced is known as the equilibrium potential, and a linear equation is found to hold for the relation of the photo-current to the defect from the equilibrium potential, and in the equation the constant is probably dependent on the dissociation of the silver salt. Luggin endeavours to connect these results with the purely photographic phenomena, and considers that solarisation appearances are intimately and casually connected with the solarisation current, and, at any rate, with printing out papers the connection between the photo-electric and photographic phenomena is in the author's opinion established. The applicability of the halogen salts appears also to be connected with the value of the equilibrium potential, and the author finally discusses at some length the production of images by development.

SOME NOTES ON SINGLE-PHASE MOTORS.

By A. C. EBORALL.

(*Continued from page* 32.)

The stationary field magnet is of the ordinary multipolar form with inwardly radiating poles, the number of these being determined by the desired motor speed and frequency of supply. It is built up of sheet iron stampings bolted together and to a cast-iron frame work and bed-plate. The magnet poles have two windings; one, a thick winding of few turns, and used only at starting, the other a winding of smaller section wire and many turns, which is used when the motor is running synchronously. The armature is built up of core discs of the shape shown in fig. 3, and also has two windings. One, used at starting only, is an ordinary distributed drum winding wound in the slots, and connected to a commutator in the usual way; the other is a concentrated winding with flat rectangular coils wound in the holes, the coils being connected up in series, with the free ends connected to a pair of slip rings on the end of the shaft remote from the commutator. The number of these flat coils is equal to the number of magnet poles, and the number of slots for the starting winding is determined solely from considerations of sparking, &c. The third slip ring seen in the diagram has nothing to do with the action of the motor; inside it is a centrifugal device, which makes contact with the ring at a synchronous speed, causing a pilot lamp mounted near the motor to light up.

The starting of this motor is as follows:—A choking coil or resistance is inserted in the starting circuit, as shown, and the switch thrown over to the "start" position. The motor immediately begins to run up as an ordinary series motor, and at a synchronous speed the lamp lights up. Directly this happens the switch is put over, which puts the slip rings into direct connection with the supply mains, and the brushes on the commutator into connection with the fine wire winding of the fields, so that now the motor is running as a self-exciting reversed alternator. The number of windings on the choking coil, or the magnitude of the starting resistance, is determined by the torque required, the motor starting with any torque if enough current is given to it.

Through the courtesy of Messrs. Bergtheil & Young (London), who are the English agents for this motor, the present writer has been enabled to make some tests of its performance. These, though only of a workshop nature, came out very well indeed.

The 2½ H.P. motor provided was built for 100 volts, 133 ~, and ran at 1,500 revolutions per minute on the 100 ~ testing circuit. It started immediately without any trouble whatever at any load, and with a reasonable current consumption, this being about twice the full load current when exerting the full load torque. The efficiency above half load was high, averaging 70 per cent. The power factor of these motors for any particular load depends, to a large extent, on the field excitation, that is, on the magnitude of the resistance in series with the fields. With the resistance adjusted to give the best effect for three-quarter load, the power factor at this load came out at approximately 73 per cent., diminishing slightly as the loading was increased.

There was absolutely no sparking at the commutator either at starting or running, the carbon brushes remaining throughout in a fixed position. As a matter of fact, they are not mounted on a rocker, the holders being fixed.

This motor has, then, the following good points:—

1. It starts well on any load without any external complications, and without an excessive current consumption.
2. It stands considerable overload.
3. The power factor and efficiency are high.
4. Its speed is absolutely constant, with constant frequency.

Its defects are—

1. It is somewhat expensive.
2. It is noisy when running light or underloaded.
3. Its design is necessarily rather straggling.
4. The centrifugal service might fail to act, in which case the armature stands a chance of flying to pieces in the hands of a careless workman.
5. The "no load" current is rather high.

Owing to the absence of sparking and to the fixed brushes, the presence of the commutator is hardly felt. In the writer's opinion, the motor could be improved by diminishing the air-gap, this being somewhat excessive in the examples that have come under his notice. The superiority of these motors over others of similar design seems to lie in the fact that the armature and field windings are so adjusted that the maximum magnetic effects of each occur at the right times.

It is evident that such a motor would make a good rotary converter, continuous current being tapped off the commutator when the motor was running on alternate current mains, or *vice versa*.

II.—Alternating Magnetic Field Motors.

Owing to the fact that the direction of rotation of any ordinary direct current motor is the same irrespective of the direction of the current supplied to it, early attempts were made to adapt it for use with an alternating current by laminating the fields. But this simple modification is not enough in itself, the crude form having many serious faults, the chief of them being—

1. Low efficiency, chiefly due to the hysteresis and eddy current losses.
2. Large "no load" current, and very low power factor, due to the nature of the windings, large air-gap necessary on account of armature reaction, and to the very considerable magnetic leakage.
3. The heavy sparking, especially at starting and overloads, and which is due to the fact that as each armature coil is in turn short-circuited by a brush, it becomes the seat of very heavy induced currents, these reacting on the magnets, and causing great heating and sparking.
4. Low weight efficiency, which is caused by the impedance of the motor circuits not allowing sufficient current to get through, and principally due to the self-induction of the magnets; and in the case of shunt motors, it is found that besides this last difficulty, there are great differences of phase between field and armature currents, causing the maximum magnetic effects of each to occur at different intervals of time, this want of coincidence greatly diminishing the torque.

These inherent defects have not yet been overcome, and motors of this class are quite unsuitable for anything but the smallest work. Many attempts have been made to improve them, none of which have been successful up to the present. Thus to help bring the armature and field currents more into phase, condensers have been put in these circuits (Stanley and Kelly), or short-circuited demagnetising coils have been sunk in the pole-pieces (Stanley and Kelly). To minimise the sparking, double wound armatures have been used, so arranged that a coil is never actually short-circuited by a brush, this latter merely changing the resistance of the armature during rotation, according as one winding, or the two in parallel, came under it (Hutin and Leblanc).

The crux of the whole question is really the frequency; if this be lowered sufficiently (say to 15—20 ~), all the above defects are greatly minimised, and there is no reason why such motors should not be commercially successful.

III.—Induction Motors.

Single-phase motors of the induction type probably constitute 75 per cent. of all the single-phase motors running on the Continent at the present time, and are made by all the important firms, such as Brown, Boveri & Co., the Oerlikon Company, Kolben & Co., the A.E.G. (Berlin), and Siemens and Halske. They operate as follows:—

Let fig. 4 represent the elements of a single-phase induction motor. It consists of a stationary inducing system *or stator*, being built up of stampings with holes or slots stamped round the inner periphery, and a similarly constructed *rotor*, in the windings of which currents are induced. The stator winding consists of flat coils, wound in the holes in a manner to be more particularly described later, the number of coils depending on the number of poles required, these being given by the speed. The rotor winding is simply a number of copper bars, short-circuited at each end by means of copper rings. Now suppose the stator windings to be connected to the supply mains. An alternating multipolar magnetic field is produced round the stator, oscillating with the frequency of the supply current, and whose tendency is to produce an equal torque on the rotor in opposite directions, and hence no rotation occurs. But if the rotor is given a start in either direction, and its speed gradually increased by some external means, a point is soon reached when the rotor will go on revolving by itself with increasing speed, until nearly synchronous rotation is attained. Load can now be put on the motor, when the speed will drop slightly, just as in the case of a polyphase motor, but to a somewhat larger extent. This "slip" of the rotor increases from a minimum at no load up to a certain point, generally about twice full

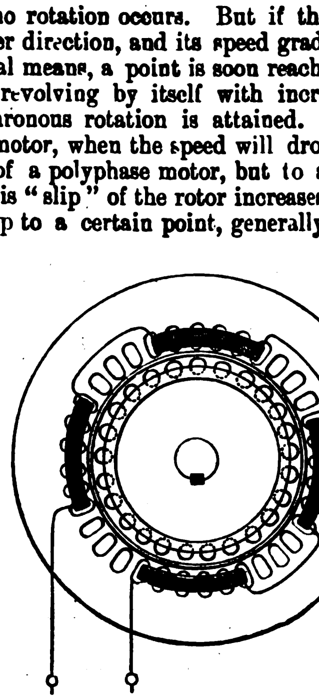


Fig. 4.—Simple Induction Motor.

load, when the motor runs out of step, and must be restarted. The slip is the frequency of the rotor currents, and hence the effect of loading the motor is to cause such a slip as will increase the rotor currents by such an amount as will correspond to the necessary increase of torque.

The theory of the single-phase induction motor is necessarily somewhat complicated. The best treatment of the subject is that of the late Prof. Ferraris, it consisting in considering magnetic fields as vector quantities, capable of being combined as ordinary vectors. According to this, an oscillating magnetic field may be considered as being the resultant of two rotating fields of constant and equal strength, and rotating in opposite directions with the same frequency as that of the oscillating field. If the oscillating field follows a sine law, then such a field of maximum strength N, and with p poles, oscillating with frequency n, may be represented by two sinusoidal rotary fields of p poles and maximum strength $\frac{N}{2}$, the one rotating forward, and the other backwards, with a speed of $\frac{n}{2p}$ revolutions per second.

It is not difficult to show that any distribution of field of p poles may be decomposed into a number of multipolar sinusoidal fields. There would be (1) a fundamental sinusoidal field of maximum strength N_1 of p poles, (2) a first harmonic sinusoidal field of maximum strength N_2 with $2p$ poles, (3) a second harmonic sinusoidal field of maximum strength N_3 with $3p$ poles, and so on. Hence it follows that any oscillating field, such as might be produced in any form of single-phase induction motor whatever, may be decomposed into a number of multipolar sinusoidal fields of different maximum values with different numbers of poles, and rotating, some forward, some backward, with velocities inversely proportional to the number of poles.

It is to the forward rotating field or fields that the rotation of the motor of a single-phase motor is due; this forward rotating field acting on the rotor in every respect just as the rotating field produced by a two or three-phase current acts in multiphase motors. That is to say, the torque on the rotor is due to the fact that the rotor field produced by the induced rotor currents follows up the forward rotating field, never quite catching it up, but having a certain slip with regard to it, this slip, as previously pointed out, increasing with the load, and is, of course, equal to the difference between the frequencies of the forward rotating field (frequency of the supply current), and the rotating field of the motor $\left(\text{which is } \frac{\text{number of motor poles}}{2} \times \frac{\text{revolutions per minute of rotor}}{60}\right)$.

Now this mode of treatment readily lends itself to the solution of the usual problems connected with induction motors. Some years ago it was shown by Mr. M. B. Field that it could be extended to the ordinary Kapp diagram for multiphase motors,* and that by constructing such a diagram with the forward and backward fields, the performance of the single-phase induction motor in regard to efficiency, power-factor, torque, &c., can be predicted if certain constants are known. The present writer hopes shortly to be able to go fully into this method of Mr. Field's in another place, as it should prove of considerable value to all those having an interest in this class of alternate current plant.

(*To be continued.*)

Erratum.—In fig. 2, which appeared last week, a slight error occurred. We reproduce the block below with the cor-

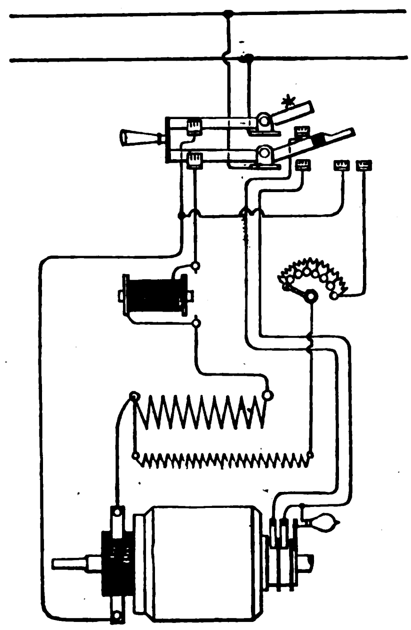


Fig. 2.

rection made. The top right-hand switch blade marked * was omitted from last week's block.—Eds. Elec. Rev.

SHIELDED CONDUCTORS.

By W. A. PRICE.

(*Concluded from page 63.*)

Mr. Mordey's suggested explanation of Prof. du Bois' observation published in the *Phil. Mag.* for December† is difficult to understand. He attributes it to the fact that a ring solenoid is equivalent magnetically, so far as the external field is concerned, to a single turn laid along the circle that forms the axis of the helix, but how such a ring can experience a side thrust in a magnetic field is not easy to see. One would expect only a tendency to turn into a plane perpendicular to the field.

Mr. James Russell describes also a number of interesting experiments on the forces exerted on a conductor carrying current in a magnetic field, when shielded by an iron cylinder. In one of these an iron tube is placed in an uniform magnetic field perpendicular to the tube, and a conductor is placed in the axis of the tube. On starting a current in the conductor, the iron shield tends to move sideways, *i.e.*, at right angles to the field and to its own length, while the conductor experiences little or no force. Considered in connection with the action on the magnetised ring (fig. 4) the result seems paradoxical, *i.e.*, if this action be what we suppose, and Prof. du Bois is mistaken; for the effect of the current on the iron tube is to magnetise it circularly, and to produce motion sideways, while no such motion occurs with a permanent ring magnet of the same form.

* See Kapp's "Power Transmission," page 346.

† See Electrical Review, January 7th, 1898.

The explanation lies in the action of the current on the field outside of the iron tube, which is distorted by the current exactly as if the iron shield were absent, and is not affected by the circular distribution in the ring itself. In fact, though the iron tube shields the conductor inside it from the action of the outside field, and prevents any force from acting on it, it does not shield the outside field from the action of the current in the conductor. It seems possible that Prof. du Bois, in his experiment on the magnetised ring, may have led his current in such a way as to distort the field, and so produce the action on the ring, an action which would be more intense if the ring were not permanently magnetised, and more permeable.

Fig. 5 shows the character of the distribution of the field

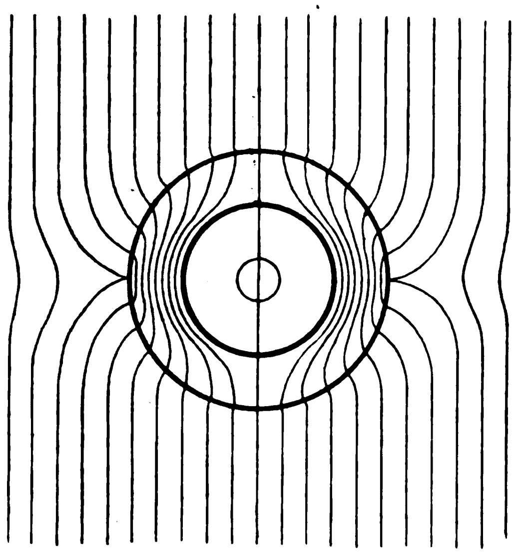


Fig. 5.

when no current is passing in the conductor. It is, of course, similar to fig. 3. Fig. 6 shows the field when a current is passing, and the field is disturbed outside the shield, tending to move it in the direction of the arrow. Comparisons of figs. 4 and 6 shows the difference between the conditions of

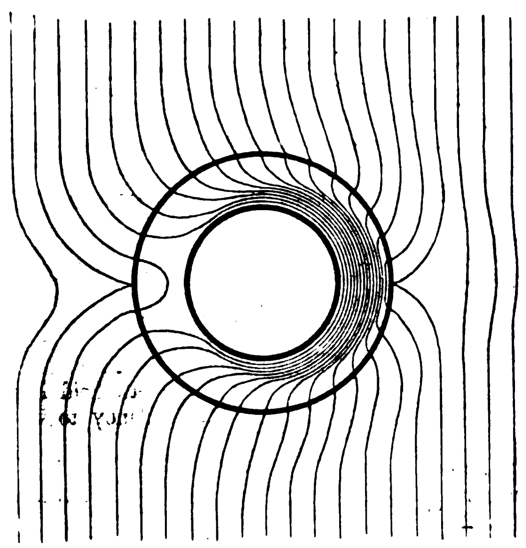


Fig. 6.

Mr. Russell's experiment and the one we understand Prof. du Bois to describe.

Another point requires notice. A law of refrangibility has been repeatedly referred to, viz., that the ratio of the tangents of the angles made by a line of magnetic flux with the normals on two sides of a surface separating two different media is equal to the ratio of their permeabilities. This only applies when neither medium is coercive, and the field of magnetic force is continuous at the surface in question; *e.g.*, suppose in diagram fig. 7, A A, B B, are infinite plane current sheets, A A coming up, B B flowing down normally to the paper. The space between A A, B B, is an uniform magnetic field in the direction of the arrow. Now, if the whole be placed in an uniform field perpendicular to the sheets, the lines of flow will take the direction shown in

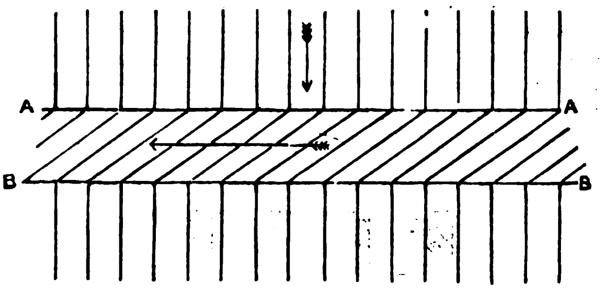


Fig. 7.

the figure, each of them bending sharply where they cross the current sheets, though the whole space is equally permeable.

So where lines of flow enter hard magnetised steel the law does not apply, and since all iron is coercive, and other materials have practically the same permeability, the law is little more than a guide in drawing freehand certain classes of diagrams.

It is not suggested that the writers who have referred to this law are not familiar with its limitations, but when laws are formally stated one is apt to think the statement is also complete.

I am tempted to suggest another paradox. A space is enclosed by a shield formed of bar magnets placed side by side with all their north poles outside, and all their south poles inside. There can be no flux, and they consequently cease to be magnets.

For a simple case, consider the space enclosed between two infinite plane magnetic shells (fig. 8). Along N N, N N,

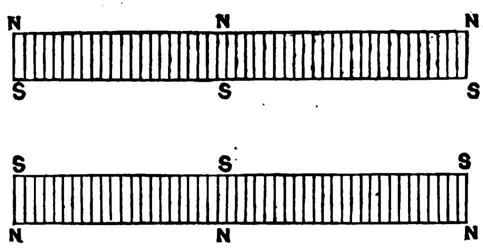


Fig. 8.

are north poles, and along S S, S S, south poles, the shells being made of small bar magnets placed side by side. There is no magnetic field anywhere. Have the bars ceased to be magnets?

WINDINGS OF POLYPHASE ARMATURES.*

By J. P. STONE.

With the introduction of polyphase apparatus, a number of different windings have necessarily been developed, although all of them have the same general features. Since they are slightly different, it may be thought that they are of essentially different character. It is the object of this paper to

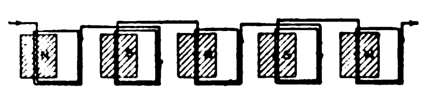


Fig. 1.—Single-Phase Winding.

illustrate how these windings are made, and to show that it is rather unessential what type of connections are used as far as behaviour and output of machines is concerned.

* *American Electrician.*

The single-phase winding in its simplest form consists of a number of coils connected up so as to give alternate polarity all round the surface of the armature. Assume that an alternator has 10 poles, we could thus have a winding consisting of 10 coils, as illustrated in fig. 1, each coil connected in reverse direction in regard to the preceding; or we could have a winding as illustrated in fig. 2, consisting of five coils, which coils are connected so as to give the same polarity, but separated from each other by the pitch of the poles—that is, by the distance between two adjacent poles.

Necessarily, if all coils are connected so as to give the

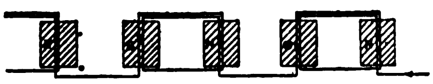


Fig. 2.—Single-Phase Winding.

same polarity, the space between the coils will have the opposite polarity to that given by current passing through the coil.

A two-phase generator could be made from a single-phase generator by adding a set of new coils placed midway between the first coils and wound in identically the same way as the first winding. Since the distance in phase

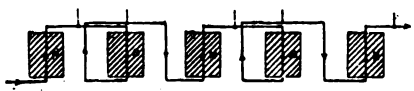


Fig. 3.—Two-Phase Winding.

between two adjacent poles is 180°, it is evident that the beginnings of the two independent windings will be 90° apart; thus, if the two windings have the same number of turns, the generator will have two independent sources of power of same magnitude, one displaced 90° from the other, that is, we have a two-phase generator with independent

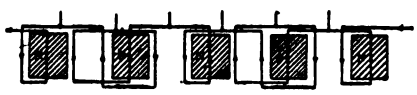
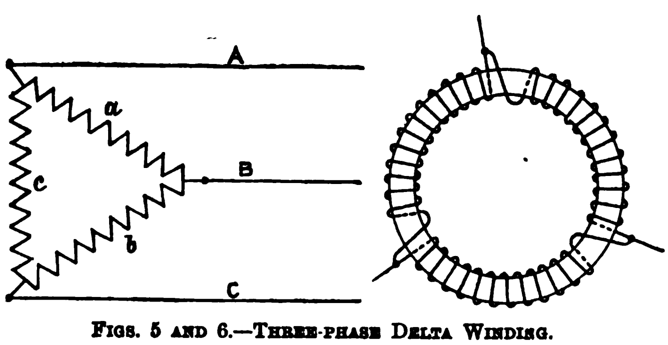


Fig. 4.—Three-Phase Winding.

windings. Such a machine would then, of course, have four collector rings, two for each of the windings. By connecting two adjacent collector rings together, a two-phase relation still remains, and we have a two-phase machine with interlinked windings.

The same results can also be obtained from a distributed single-phase winding by proper connections, provided that the number of coils between each pair of poles is divisible by two. Such a winding is illustrated in fig. 3, and is, as can be

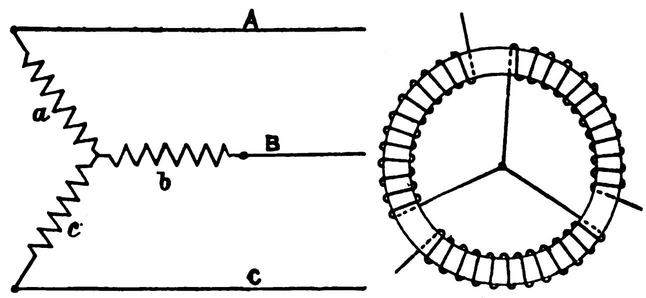


Figs. 5 and 6.—Three-phase Delta Winding.

seen, essentially a direct-current winding in which four taps are taken out to four collector rings (bipolar machine). Thus no new features in winding are introduced in making a two-phase generator.

A three-phase generator is made on essentially the same plan. It consists primarily of three independent single-phase windings, such as are described in fig. 1 or 2, each starting 120° in phase from the preceding; that is, since the distance between two pairs of poles is 360°, if the first winding starts midway under one pole, the second winding, wound identical with the first should start at one-third of the distance between two poles and the third at two-thirds the distance between the poles. Thus we see how a three-phase generator can be wound. If these circuits are not joined, six collector rings are necessary, two for each phase. Since, however, each winding has a point of equal potential with either of the other two, that point can be connected on all three.

That is one end of each of their windings is brought to a



Figs. 7 and 8.—Three-phase Y-winding.

common junction, from which they branch out starwise, and the remaining ends are connected to the three line wires. The three lines thus serve in turn as outgoing and return circuits, the maximum current shifting from one to the other in succession. We thus obtain a Y-connected machine which necessitates three collector rings only.

Similar to what was stated regarding the two-phase winding, the three-phase winding can be obtained from the distributed single-phase winding by tapping the winding at suitable points; that is, points differing in phase by 120°. Such a winding is illustrated in fig. 6, and is called the delta winding. This is also shown diagrammatically in fig. 5. Here the coils form a closed mesh, the six terminals being united two and two, the lines being connected to the windings at the three points of junction, forming a triangle. In order to make such connections, however, it is, of course, necessary that the single-phase winding should have at least three slots per pole and phase (for a full pitch winding) or a multiple of 3. Such a winding is illustrated in fig. 4.

The three-phase windings can also be shown as simple Gramme windings, having only one coil per phase, as in figs. 6 and 8, which are shown delta and Y-connected, respectively. Thus it will be seen that a direct-current winding may be connected into a three-phase delta-connected winding by tapping it at equidistant points, the number of leads being governed by the number of poles.

Denoting the E.M.F. induced in each winding by E, it is evident that the E.M.F. between the lines in a delta-connected armature must be E, since the lines are connected directly to the ends of the winding. In a Y-connected armature, however, one end of each of the three windings are connected together, and the other three ends are connected to the lines, as in fig. 7; but since the E.M.Fs. induced in each winding are not in phase with each other, the E.M.F. at the terminals is not the sum of the E.M.Fs. induced in each winding; that is, it is not 2 E, but is the geometrical sum of the E.M.Fs. in the two phases—that is $E \sqrt{3}$.

The output of a polyphase generator is that of the sum of each individual phase; that is, denoting the current in each wire in a Y-connected motor by C, and the E.M.F. induced in each phase as before, by E, the power of the three-phase generator is $3 \times C\,E$. Since, however, the E.M.F. between the lines is $\sqrt{3}$ times the E.M.F. per phase—that is $E \times \sqrt{3}$—we find that the power of a three-phase generator expressed by the line E.M.F. and line current must be $\sqrt{3} \times C_1 \times E_1$, where E_1 and C_1 and the E.M.Fs. and the currents, respectively, between the lines and in the lines. In a delta-wound motor, in the same manner, we find the power delivered to be expressed by the same equation.

(*To be continued.*)

THE TRANSFORMATION OF ENERGY IN THE ELECTRIC ARC.

The mechanism of the conversion of electric energy into heat in the electric arc still evades the inquiries of experimenters, but papers are from time to time published dealing with the subject, and new suggestions made, and new conclusions reached, without any conspicuous approach to an explanation of what occurs. Mrs. Ayrton's laborious and systematic observations are in recent years the most important of these contributions. Of course, "explanation" in such a case as this means no more than that the phenomena are shown to be subject to laws and conditions which are ascertained and well recognised in other cases, even though the mode of action in the latter may be quite obscure. The reference of the planetary motions, and the weight of terrestrial bodies, to one law of the attraction of gravitation, is called an explanation of these phenomena, though the mode of attraction is not less obscure than the phenomena it explains, and the very idea of action at a distance may be abandoned as a misleading fiction. Following a course of this kind, one experimenter after another has attempted to find laws for the behaviour of the electric current in the arc, similar to those which it obeys in a metallic conductor.

Electricity flowing through a metallic conductor generates heat at a rate proportional to the square of the current, and the independence of that coefficient, which is called the resistance, of the amount of current passing, is so conspicuous a property of metals and their alloys that it seems to indicate some marked characteristic in the mechanism of their conduction. So when a current of electricity flows through a junction of two different metals heat is developed, or absorbed, at a rate directly proportional to the current; and here again the coefficient involved, viz., the electromotive force of contact, is a physical constant not less significant than the resistance. The molecular structure of metals is unaltered by the passage of the current, and no transfer of matter takes place.

This last property clearly differentiates the mode of conduction by metallic conductors from that by the arc, where disruption and transfer of matter occur. The *primâ facie* improbability is very great that conduction by the arc is regulated by laws similar to the peculiarly exact and simple ones which apply to metallic conductors. All attempts to represent the heat developed in the arc, as due to a resistance and a back E.M.F.—or, in other words, to express it as the sum of two terms containing the first and second powers of the current respectively—have been futile, and it appears unwise to persist in attacking the question on these or similar lines.

If the arc consists of molecules, torn from the positive carbon, employed in the incessant to and fro bombardment of the poles, carrying positive charges to the negative, and negative charges to the positive carbon, the mode of transference of the charges is by convection and not by conduction; and an attempt to represent the action in terms of the ideas used for metallic conduction, is analogous to an attempt to enter the statistics of a town supply by water carts on printed forms arranged for the data of a pipe supply.

An observation that under certain circumstances an increase of current in the arc is accompanied by a diminished potential difference between the carbons led the observer, drawing too closely the analogies with metallic conduction, to the absurd conclusion that the arc possesses negative resistance. No portion of the heat generated in the arc has been traced to a distinct cause involving transformation of energy proportional to the square of the current; and we have no ground for assigning resistance to the arc.

Prof. Fleming, in a letter to the *Electrician* of January 7th, considers the probability of the existence of a "counter electromotive force in the arc," and makes an interesting suggestion as to its possible source. It is not quite clear what idea is expressed by the words "counter electromotive force." They must mean something more than a means whereby electrical energy is converted into heat in direct proportion to the current, and seem to imply that the action is reversible, and to some extent elastic, so as to produce an E.M.F. in the reverse sense, if only for a very short time, on the sudden cessation of the main current. Such an action has been looked for repeatedly in the arc, but never, we believe, detected. It occurs in every other case we can call to mind, to which the term "counter electromotive force" is applied. It is not obvious why it should be looked for in the arc at all. An elastic action implies a return from a more to a less strained condition, and if the energy in the arc is employed in the disruption and mutual bombardment of the carbons, no reversible effect is to be expected.

Prof. Fleming suggests that the current may generate heat in direct proportion to its amount when passing from a hot point to a cooler one in carbon vapour, by analogy with the Thomson effect in copper, or solid carbon; the existence of a difference of temperature in the carbon vapour being inferred from the difference of temperature in the carbon rods at the arc. The explanation requires carbon vapour and solid carbon to be in contact at two very different temperatures at the same pressure, and to have very different thermo-electric gradients; since if the gradients were the same, the total development of heat, by a Thomson effect, between the distant ends of the carbons, which are at the same temperature, would be zero. The latter condition may be satisfied: we have no knowledge of the matter; but it is hard to see how two very different temperatures can be found in a small body of vapour, presumably saturated. The existence in hot gases of an effect similar to the Thomson effect in solid conductors is only guessed at, but it offers an interesting subject for experiment. If this effect is found in carbon vapour, electromotive forces between the solid and gaseous carbon might exist at the contact surfaces, similar to the Peltier effect in metals, and the energy converted at those points might be expected, by analogy, to be considerably greater than that due to a difference in the thermo-electric gradients in the solid carbon, and in its vapour.

It may be observed here that the reduction in the potential difference of the carbons for a given current, by heating the negative carbon, is explained by the bombardment hypothesis, as well as by Prof. Fleming's.

Observations on the distribution of potential in the arc are difficult to interpret, but it appears that the difference of potential between the central part of the arc and the negative carbon is small or zero, and that the whole fall of potential in the arc takes place at or near the positive crater. At this point disruption of matter is taking place, and the generation of heat under these conditions and the generation of heat by a Peltier or Thomson effect, where no change occurs in the condition of the matter concerned, seem phenomena, *primâ facie*, to be placed in very different categories. It would seem that little assistance in this question is to be expected from analogies drawn with the phenomena of electric conduction in solids. The phenomena seem rather allied to those of discharges in rarified gases, and movements in electrolytic solutions.

CHEAP ELECTRICITY.

The presidential address of Mr. Raworth to the Northern Society of Electrical Engineers comes in for a good deal of satire from the *Engineer*, which is rather solemn in its treatment of most questions, and is very severe upon Mr. Raworth. Perhaps it is that the writer has a sneaking envy for the optimistic breeziness of Mr. Raworth. Our contemporary, however, cannot at all put up with such breeziness, which is even in parts of doubtful seemliness in its humour. The comparative absence of figures does not meet with approval. In a presidential address figures are not much wanted. Too many such addresses are but at best gracefully connected recapitulations of well-known facts.

It is with such few figures as were given that the *Engineer* falls foul. Mr. Raworth suggests a 50,000-H.P. power plant to earn £200,000 a year gross, or at the rate of £4 per H.P. We are asked to see how much each horse-power will cost. Coal will run to 3 lbs. per E.H.P., so that 1 ton would yield 750 H.P. hours, and a year of 7,300 hours—rather a long year, for it means 20 hours a day—will cost 9·73 tons of coal, or, say, 10 tons, costing £2 10s., which is too high a proportion of the selling price of current to warrant much hope of a profit after other expenses are paid. But after all, did Mr. Raworth mean days of 20 hours.

If not, and 10 hours' days were meant, the coal would be reduced to £1 5s.

The *Engineer* considers 5d. per unit as a low limit of price. Yet one London company is now offering current for power purposes at rates of as low as 2½d. per unit, so that there are those who consider 5d. an excessive price. The *Engineer* begs the question, when it cavils at the claim that electricity will be produced more cheaply than now. How can there be much reduction when dynamos already have an efficiency boasted of at 90, or even 98 per cent. Yet even the *Engineer* admits a possible cost so low as 1½d. per unit, with engine and dynamo alone. For ourselves, we look upon the future of electricity very hopefully. Its chief objection is its first cost of installation for small units. The rules and regulations, the claimed rights and arbitrary privileges of electrical supply companies, more than vie with any gas company. Especially is the power of cutting off supply without notice a clause which ought to be carefully considered. The small prospective consumer is apt to be scared off by the ponderosity of the demands upon him. True, he may be going to effect an economy by using electricity, yet, for all that, he does not relish being treated by a new electrical company as though they were conferring a huge favour on him by selling him current.

Electricity may not be so cheap as Mr. Raworth would make it out to be, but it will not be so dear as the *Engineer* would have us believe, but in either case the Leeds figures, which we publish in another part of this issue, are instructive. As we write we have in mind a works where steam is now the motive power, and is costing anywhere from £50 to £100 per annum. It costs this whether one or six machines are run. As a rule, one, and that the smallest, is the machine most run, and that only for half the day. At 6d. per unit, it ought not to cost above 6d. daily to run that machine, or, say, £8 annually. It is hardly likely that such a user would not gradually extend the system to all his machinery, besides becoming also a customer for light and even for heating. It is impossible to read what has been effected in electrical driving in America to perceive that it is in the electricity which is not used that the saving comes. It is the shaft that is not revolved, the boiler feed-pump stopped, the forge-fan which stands still when the work is on the anvil, the grindstone which stands when not being used, the long steam pipe not condensing steam, the oil, the belting, the waste, the dirt and inconvenience, it is all these negatives which show a commercial economy in expensive electricity. Doubtless Mr. Raworth sees this, and feels breezy about the prospects.

For large powers, we do not think it likely that electricity will be generated very far from the centres of coal production. Long distance transmission is not yet perfected, nor are line losses yet minimised. The use of gas engines with producer gas, or worked by the waste gases of huge blast furnaces, may change the whole condition of the industry. To use gas from a blast furnace demands a much smaller outlay than the preparation necessary to use a Niagara or a Foyers. Our contemporary is too apt to look on things as they are, in place of as they are becoming. It may not be wise to prophesy until we know, but the determination to have things as we wish them to be is almost akin to prophesy. Indeed, a clear perception of existing facts may warrant an expression of opinion that is not so much prophetic as far seeing.

AN ELECTRICAL HYPOTHESIS FOR THE SOLAR AND PLANETARY SYSTEMS, AND SOME OF THEIR ASSOCIATED PHENOMENON.

By DELTA.

When great astronomers so widely differ in their hypotheses to explain the solar and planetary systems as to lose their good manners—instance Lockyer's reflections on Huggins—the audacity of an outsider in suggesting an explanatory theory quite distinct from either that of the waste by combustion or the nebulæ or meteoric hypothesis, will perhaps be forgiven. Merely as highly speculative hypothesis, it may, perhaps, be considered as at least interesting if only from the evidence of coincidence and correlation collected to explain the effect of electricity in producing many of the phenemenon that cluster around a subject of surpassing grandeur.

It is usually accepted by both schools of solar explanation that the sun is in a state of magnificent conflagration,* and that there is by its assumed contraction †—or by its internal combustion—a gradual waste of energy proceeding, that will ultimately close the sun's glorious mission as a centre of light and heat.

It is also assumed that such is the inconceivable effect of combustion or contraction in luminous and heat-producing intensity, that both light and heat rays are transmitted to the glittering planetary and stellar elements suspended in celestial space, some of which are computed to be hundreds of millions of miles from the solar orb, the earth's distance from the sun being estimated to exceed 95,000,000 of miles. Now, anyone who, like the writer, has had great experience in the production of relatively enormous fusion temperatures, will know that although the luminosity resulting from masses of molten metal, such as very low carbon steel, will project a beam of light extending, under certain atmospheric conditions, over a distance of five miles; nevertheless the sensible heat transmitted to any body that chances to intercept such a luminous beam, will not be perceptibly felt at a distance of even, say, 50 yards.

So that if this ratio of as 50 is to $(1,760 \times 5)$ were applied to the proportion of heat and light transmitted from the assumed burning solar orb, no heat, sensible to human life, could possibly be transmitted through all the enormous gulf of space that divides our planet earth from the sun.

It was this *à priori* reasoning that led the writer to doubt the *rationale* of existing hypotheses presuming to explain the solar and planetary system, and the doubt found expression in a communication, published in a technical contemporary several years back. In this it was suggested that although light and heat of the earth had their origin in the sun, it was quite inconceivable to the writer that there could be a loss of energy and drop of potential, mile by mile of the 95,000,000 of luminous and thermal passage, through which the solar rays have to traverse before they reached the earth. On the contrary, it was suggested that there would be no loss of the energy (producing heat and light at the earth) between the outer fringes of the atmosphere (or photosphere, chromosphere, and corona) of the sun and the atmosphere of the earth or any other of the planetary or stellar bodies in the celestial space, and that only in proportion to the actual sum of luminous and thermal energy entering the planetary atmosphere, and also in some ratio depending upon the density of such atmosphere—was such energy expended in the production of light and heat. To assume that light and heat is uselessly expended all through the distance intervening between the sun and the planets appeared to be quite inconsistent with any rational conception of the laws of the conservation of energy, and the hypothesis that all the enormous heat waste that must as a consequence follow the acceptance of such a theory, could be derived from the assumed burning out or contraction of the sun, or of the planets, appeared to the writer quite inconceivable and utterly impossible.

There are many other objections to the acceptance of the existing theory; for instance, it would involve the assumption that beams of light are emanating from the solar orb to all the planets, and these beams would be seen traversing the dark interplanetary space, exactly as we see the beams of an arc light projected from the lantern of a lighthouse at sea, even when the source of the light itself cannot be seen. The author's audacious experiment of forming an alternate and entirely electrical hypothesis is based on the suggestion already described, to the effect that there is *no loss of energy* between the solar and planetary atmospheres; the suggestion is amplified and extended as follows:—

(*a*) The solar orb is accepted as constituting the great distributing centre of light and heat, which is, however, not only generated in an *electrical* form, but is transmitted to the planetary and other celestial bodies electrically, and in *no* other kind of energy.

* The sun is assumed to be gradually burning itself up, but as such a combustion would involve a supply of oxygen, it is difficult to accept this theory as in any degree rational.

† There is no absolute proof of any reduction of the bulk of the sun's sphere.

(*b*) The entire interplanetary and interstellar or celestial space may be considered to be an electrical ocean of assumed low intensity potential (and constituting a magnetic field), permitting electrical currents of assumed high intensity and frequency to flow to all the planetary bodies in direct lines from the great central solar generating station.

(*c*) The planetary and stellar spherical bodies are assumed to be secondary conductors of a system in which the solar orb is the primary.

(*d*) The secondary spherical conductors are of a polar character.

(*e*) The planetary spheres absorb at their surfaces opposite the sun or facing the direction of the electrical flow the positive and high intensity electrical energy projected from the sun across the celestial interplanetary ocean of low electrical intensity. The surfaces of the planets that in their rotation are illuminated are those that absorb the high intensity electrical energy.

(*f*) The surfaces of the spheres away from the sun give up again the electrical energy (transformed down to low intensity) to the celestial ocean of low electrical energy of low intensity, the electrical ocean acting as the agent of compensation in the cycle of the conservation of energy. The surfaces of the planets that in their rotation are in darkness, are those from which the electrical energy is *given up* by the *planets* to the electrical ocean.

(*g*) The low intensity electrical energy of the celestial electrical ocean is, by the law of compensation, constantly being absorbed by the sun, or in proportion to the electrical energy of high intensity that is being projected by the sun to the different spherical, planetary, stellar and other conductors that dot the great immensity of the celestial electrical ocean.

Now let us consider the effect of this hypothetical cycle of electrical energy movement in its effect on the planetary bodies and on the sun.

Both the sun and the planets are, and with good reason, assumed to possess atmospheres or gaseous envelopes of varying density.

The electrical energy of high intensity or frequency flowing from the sun will be met, first, by the resistance set up by its photosphere or corona (which are merely atmospherical envelopes of varying density). The resistance set up by the sun's atmosphere promotes the grandly resplendent luminosity of the solar orb. Immediately the high intensity current passes over the extreme fringe of the resisting solar corona, or outer solar atmosphere, it flows unrestrictedly across the low potential electrical ocean, until it meets with the atmosphere of the planets, or other celestial bodies, stellar and otherwise.

From the time it leaves the solar atmosphere to the time of meeting that of the planets, no energy is assumed to be expended, and the electrical ocean is consequently neither illuminated nor heated,* and two conditions therefore follow the acceptance of this essential condition: the interplanetary space, or electrical ocean of low intensity is non-luminous, and is of low temperature†. Were it not so, and if the interplanetary space offered resistance to the flow of electrical energy, there would be a solar beam of light, and we should see such effects in vivid lines of light stretching from the sun to the planetary and stellar bodies.

(*h*) As soon as the electrical currents of high intensity enter the earth's atmosphere, *luminosity is produced*, and of an intensity and colour depending upon and controlled by the density and chemical character of such atmosphere.

* Exact evidence.—On July 29th, 1878, and under satisfactory conditions, there was observed in North America a total eclipse of exceptional duration. Although no exceptional prominences were visible, the corona had a pair of enormous equatorial streamers that stretched east and west of the sun. They were best seen with the naked eye.

The solar poles were also equipped with straight *electric-looking brushes of luminous rays*. The sun at this time of the observation was in a state of profound tranquility.

Grooch noticed in 1867 the same equatorial extensions and polar electric-looking brushes of light.

† So from the extremely low freezing temperature of the interplanetary space it is very necessary to say that the Cirrus clouds, only some 5½ miles distant from the earth's surface, are composed of snow particles.

Comets have been discovered coated with ice, and in some instances internally frozen, although the outer surface had been heated up by their frictional contact with the atmosphere when travelling at a terrific velocity.

(*i*) Associated with the production of luminous energy there is the generation of heat, and of actinic or chemically stimulating energy, both effects depending upon the density and chemical character of the atmosphere.

Thus the surfaces of the earth, and those of other planets that absorb by their *vis-à-vis* position to the sun the high intensity electric currents, are covered with an illuminated atmosphere, the luminousness of which is dependent upon the density of the atmosphere at any point.

For instance, the equator is in direct line, and consequently the atmosphere at this point offers less length of passage to the flow of the electrical current, and the luminous and thermal production effect is thus *pro tanto* more concentrated than in the distances away from the line of least resistance.

The tendency of electrical currents to flow along lines of least resistance will have, in its effect on the direction of the current, the influence that refraction is assumed to have upon the direction of light rays.

The high intensity electrical energy, lessened somewhat by expenditure in producing heat, light, and chemical effects, flows into the earth,* and it is then by some internal and intermolecular influence, and perhaps by resistance culminating in internal fusion, converted into low potential, and in this form it flows to the opposite surface to that which it entered, or to the poles, and finally flows from the dark surface of the earth into the great compensating element, the electrical ocean of low intensity. Owing to its low and partly-expended intensity, it is incapable of elevating the resisting atmosphere to a condition of a luminosity sensible to the human retina, hence the phenomenon of night.

The expenditure of electrical energy is assumed to be exactly compensated for by thermo-dynamic electrical influences, by electro-chemical effects, and by thermo-electrical influences. The low intensity electrical ocean entirely surrounds the planetary and stellar bodies, so that any cause effecting a supply of the primary energy is absorbed into and assists in compensating for its expenditure.

The degree of the luminous effect is directly proportionate to the density or resistance of the atmospheric obstacle.

We know that if it were possible to produce an absolute vacuum between two separated terminals of opposite polarity, that an electric current would flow from one to the other, without involving any loss of energy, and consequently neither produces luminous or thermal effects.

The high intensity electrical currents as they flow into the earth in a circumscribed area, the centre of which does not correspond with an imaginary line drawn across the centre of the sun and the earth, might be imagined as capable of setting up the rotative action of the sphere, in some way similar to the tangential influence of an electric current on the drum armature of an electric motor (*vide* notes on wind currents). If the electrical energy of high intensity met the earth in equal intensity on both sides of a line imagined as drawn across her axis there could be no rotation, but we know, by the marvellous scheme of the Great Creator, that this is not the case.

The double planetary rotation might be explained in the same way.

The electrical, or magnetic, attractive influence of the sun, which we shall call gravity, on the earth is assisted by the suggested theory outlined.

It has been suggested that there are dynamo-electrical influences that are producing electrical energy to compensate for that absorbed on reflecting the rotation of the celestial planetary spheres, so that the loss of energy by rotation does not interfere with the completion of the cycle of conservation of energy. We know that the electric energy flows across a vacuous space without producing light or heat, but as soon as a gaseous intervening medium is introduced *heat* is produced, and with it a luminosity of varying colour and beauty, corresponding to the specific density of the intervening or interpolating gaseous medium. A gamut of colours is produced until the density corresponding to that of the atmosphere is reached, then the colour is daylight white. A

* That electrical energy flows through and not merely over the surface of the earth would require evidence of an electric flow through siliceous material of which the earth is composed; recently Hertz rays have been sent through large cliffs of rock. It is, however, well known that a large portion of this, the substrata of the earth, constitutes an aqueous reservoir—an excellent agent of electrical energy distribution.

simple but imperfect example of this is the arc light, the flash and the fork lightning. All the colours that one sees in experiments with vacuum tubes are reproduced in the earth's atmosphere. The celestial blue of the heavens, the violets, the amber-yellows, the strange and ghastly greenish tints associated with lunar effects, the colours of the fixed stars and those emitted from the solar corona, all can, it is believed, be produced by varying the density and gaseous character of the gaseous environment and intervention of two terminals of opposite polarity, and across which then flows a highly intense electrical current.*

That the earth, being a polarised conductor, is a distinctive magnet, and acts as such in its relations with the moon, is very likely, and as the instance of the earth's magnetic field in an electric ocean of low intensity can be compared to the magnetic field of an ordinary alternating dynamo, in an electric environment of low intensity there should be little difficulty in imagining that the rotative influence of the earth might set up incidental movements of rotation of the moon—movements, however, that may be influenced by the magnetic attraction of the great central solar electrical influence.

The peculiar ghastly luminosity of the moon can be easily produced by effecting an electrical discharge, through a highly tenuous gas, it can also be seen as a reflection of the almost invisible brush currents leaving one of the terminals of an electrical (plate) or other frictional machine.

There is no evidence to *disprove* that the moon is surrounded with a highly tenuous atmosphere corresponding to that by which the lunar brilliance can be imitated in a Crookes's or Geissler's tube.

It may be argued that the sun constantly transforming, as it is assumed to do, sufficient of the surrounding low intensity electricity of the electrical ocean into currents of high intensity, must show *non*-luminous evidence on her surface of the entrance into the great solar transformer and conductor of such compensating low intensity currents, because, inasmuch as the low intensity electrical currents flow into the sun, the sun's atmosphere at the points of absorption would be *non-luminous*. Unfortunately, the surface of the sun is radiating current of high intensity to innumerable points in the celestial electrical ocean, and the reflecting influence of the luminosity of the corona would illuminate some portion of the solar surface which is absorbing electrical energy of low intensity, in some degree commensurate with that which it is transforming and emitting at a high intensity; but even allowing for this incident reflection, one may point to the evidence of dark places on the sun's surface, which may be spots and blemishes on an otherwise grandly luminous face; but if this theory were accepted as correct, they would be spots sustaining a never-ceasing energy fecundity, and would constitute the most sublime *blemishes* of beauty ever conceived by man.†

The *periodicity* of the *sun spots*, and the fact that they influence the electrical (or magnetic) condition of the earth's atmosphere, are evidence that the writer's theory has some basis of fact.

The flashes of light that are thought by some to be tongues from a colossal combustion, are suggested to be merely evidences of variation in the density and extent of the solar atmosphere (photosphere and corona). The flashes, or ragged atmospheric edges, may be merely evidence of the projecting influence that the emission of the outflowing currents has upon the sun's atmosphere.

Whatever the constitution of the solar envelope illuminated by its resistance to the outward flow of electrical energy may be, the spectroscope should show its character, should it not? That is, if such an instrument can be relied upon for this purpose, it should show that the gas giving a specific colour tint, owing to its resistance to high intensity currents, should have a specific density, if it is assumed to be *hydrogen*, then red is the *tint* that should be shown when this gas intercepts the high tension rays flowing between two terminals of opposite polarity. We know that this is the tint, so here we have a coincidence of spectroscopic and electrical resistance effect of some value.

* A high potential or intense electrical discharge produced by a Holtz machine or a Ruhmkorff's coil shows that the luminosity of such discharge varies in colour in some definite ratio as to density; for instance, ordinary atmospheric air gives a white light with a blue image, the latter not unlike the celestial blue of a clear day. Nitrogen gas, which constitues some 75 per cent. of the atmosphere, gives a blue tint, whilst hydrogen gives a red one, and carbon dioxide a green tint. It is strange that this latter gas, that feeds plant life, should give the green tint of leaves. The incandescent vapours of gases giving characteristic Frauenhofer's dark lines, would, it is thought, give the same lines if rendered luminous by resistance to the passage of electrical energy of high intensity. In June, 1897, Sir William and Lady Huggins by artificial means had shown that calcium vapour when sufficiently attenuated radiates, under electrical stimulation, H and K lines alone, and this precisely coincided with the spectrum of the solar prominencies.

† Evidence.—Prof. Langley diagrammatically shows the correlation of sun spots with great magnetic variations in the earth.

Exact correspondence has been noticed between the sun spot influences in producing violent commotions in the sun and electric storms in the planet earth.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

At the meeting of the Institution of Electrical Engineers, held last Thursday, the 13th inst., at the Institution of Civil Engineers, a numerous company assembled to listen to the address of the new president, Mr. J. W. Swan. We noticed many faces which are not usually to be seen at the meetings. Chemists and physicists mustered strong in numbers to hear what an able chemist and electrician had to say on matters lying in the borderland between the sciences of chemistry and electricity. Nor were they disappointed, for the address suggested that electrical engineers have now a wide field for the disposal of plant in the domain of electro-chemical operations, which it is as much to the interests of the profession to work as the older business of lighting and the later outlet for electrical traction appliances.

The first serious business of the evening was the presentation by Mr. Latimer Clark to the Institution of a series of volumes containing important papers relating to the early history of submarine telegraphy and the work and labours of the late Mr. Jacob Brett. In offering these volumes to the members, Mr. Latimer Clark desired to draw attention to their contents and give some idea of the importance of certain memoirs included in the set. The remarks occupied a few minutes, which certain members present seemed to begrudge because the time was devoted to telegraphic rather than electric light interests. It was a great pity that any unseemly conduct should ever be permitted to mar the harmony of an offering to the library, but Mr. Alexander Siemens stepped into the breach, and at the right moment pointed out that to many of those present such things were of very great interest. He might have added that the meeting was one of electrical engineers, and not merely of electric lighting experts. Major Flood Page suggested that the presidential address was of first importance, but the majority evidently realised that there was ample time for both matters to be laid before the Institution.

Prof. Ayrton in a pithy speech characterised the best of Mance's methods as being Mance's method of filling the presidential chair, while the vote of thanks to the retiring President, Sir Henry Mance, was well seconded by Mr. A. A. Campbell Swinton in a few appropriate words, and the meeting settled down to listen to Mr. J. W. Swan, who took the chair.

Like most addresses, this may perhaps best be appreciated by a quiet study of the numerous points raised, when it is in print. The ground covered was so large, and the topics introduced so numerous, that the listener could merely follow the reader, without fully realising the truth and importance of much that was said.

As was anticipated, the first reference was to the meeting of 16 years ago, when, with Mr. W. H. Preece in the chair, one of the very first practical exhibitions of incandescent lamps was given, with the then Society of Telegraph Engineers and Electricians as audience, Mr. Swan as demonstrator, and Mr. Radcliffe Ward as engineer-in-charge of a farmyard engine and Gramme dynamo, the enthusiasm of the members was raised to a high pitch as the lamps lighted up. That occasion was the beginning of a movement that has always gone on, and has incidentally given an impulse to a larger and more general use of electricity.

The beneficial change from depressing darkness to brilliance almost rivaling that of day has, of course, partly been due to the arc light, but the unwonted brightness is not distantly connected with the insignificant looking bulbs that are such familiar objects now. The entire space between the early demonstration and the present day has been crowded with electrical invention and electrical work. Successful electric lighting and improvements in machines gave an impulse to a broadening of the applications of electricity. Telegraph engineering continued to grow up, while traction and power came more and more into prominence. Another growing industry is that of electro-chemistry, and this Mr. Swan regards as being of especial interest to young electrical engineers, as, in his opinion, aspirants would choose wisely in making a special study of the applications of electricity to chemical manufactures. A small portion of the field only has yet been cultivated, but this has already yielded good results. Copper, aluminium, gold, chlorine and soda are now obtained electro-chemically, while many other successful processes besides those employed in connection with the substances mentioned are at work on an electrical basis.

The importance of electrical processes is great and constantly increasing, either as an improvement upon known or existing machinery, or in the way of new methods being invented: in the one case, to do better what was already being done, and in the other, to achieve something previously unattempted. Considering the importance of the subject, Mr. Swan thought that the time at his disposal would not be ill spent in considering the rise and progress of electro-chemical industries.

The main portion of the address was now to follow. After briefly referring to the early work of Carlisle and Nicholson, Davy—"fortunate in almost everything, was supremely fortunate in his assistant"—and that assistant, Faraday—"the inheritor of Davy's methods and work"—Mr. Swan mentioned that in 1842 there were at work in Birmingham machines supplying current for the electro-deposition of silver and gold. At the time the "dynamo had not issued from that mint, which by the coinage of a word seems to create the thing signified." Passing on the various processes for the refining, extraction, and deposition of copper, zinc, nickel, gold, silver, aluminium, and production of soda and chlorine, the production of phosphorous, carborundum, and carbide of calcium, a bird's-eye survey of the whole field was taken, and much matter likely to stimulate thought was presented. Due acknowledgement was made—as might be expected from Mr. Swan—that electric lighting has largely contributed to the degree of success which has been reached in electro-chemical work. Many points were casually mentioned which serve to attract attention to original researches. Thus the president has found that current densities of from 1 to 1,000 amperes per square foot of cathode surface may be used in copper deposition, provided that the condition of the solution and proper circulation be noted; the regularity and smoothness of the deposit depending principally upon the absence of solid particles in the electrolyte.

The descriptive portion of the address necessarily partook to some extent of the nature of a catalogue of known processes; as an index it must be highly useful, notwithstanding all that has recently been written on cognate subjects. In fine, everyone must admit that in choosing electro-chemistry as the principal subject matter of his remarks, Mr. Swan chose wisely, and did good service to those who have placed him in the highest position within their gift.

THE N.C.S. LOW RESISTANCE MEASURER.

THE object of this apparatus, which is shown in general view and in diagrammatic form by figs. 1 and 2, is to supply a simple means of measuring very low resistances, which can hardly be determined by an ordinary bridge, owing to the difficulty of making the contacts, and other reasons. The method of working is to pass a current (which does not require to be known) through the resistance to be measured and a thick stretched wire on the instrument in series with it. The fall of potential over the unknown resistance is then balanced against the fall of potential over more or less of the thick stretched wire; the differential galvanometer mounted on the board being used for the purpose. The resistance to be measured when the balance is obtained is read direct by a pointer on a scale set at the back of the stretched wire. The length of the scale is one metre, and is

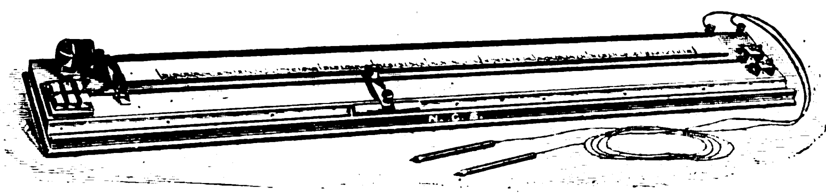


FIG. 1.

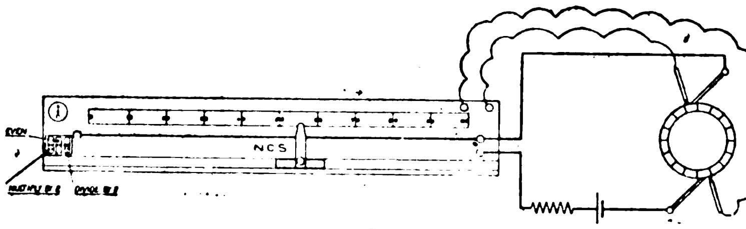


FIG. 2.

exactly equivalent to $\frac{1}{10}$th of an ohm; it is divided into a thousand parts, each of which is equal to $\frac{1}{10000}$th of an ohm. By shifting a plug the values may be multiplied or divided by 2, thus making the top read $\frac{1}{5}$th or $\frac{1}{20}$th of an ohm. (These plugs are in the galvanometer circuits; they are not in any way shunts on the main wire).

In using the instrument the terminals are joined in series with the resistance to be measured, and with a cell capable of giving, say, 10 amperes, a resistance, if necessary, being introduced to bring the current down to about 10 amperes.

The switch-key on the left, being depressed, closes the battery circuit. The sliding key is then slid along the wire, and manipulated as in the ordinary metre bridge, until balance is obtained on the galvanometer; the sliding key then points to the value of the resistance under test.

The whole length of the wire is ·1 ohm. The scale is numbered from 0 to 100, the readings being in thousandths of an ohm; each thousandth being again divided into 10. For example, if the read is (as in the figure) 56, the resistance is 56 thousandths of an ohm, or ·056 ohms. In the same way a read of 56·4 would be 56·4 thousandths, or ·0564 ohms; these are if the plug is in "equal." If the plug is in "multiply by 2," the resistance is $56{\cdot}4 \times 2 = 112{\cdot}8$ thousandths, or ·128 ohms. If in "divide by 2" it is $\frac{56{\cdot}4}{2} = 28{\cdot}2$ or ·0282 ohms.

It may be added that the resistance of connections does not affect the test in any way if a reasonably clean contact is made.

The whole instrument is certainly a very practical and serviceable one.

CORRESPONDENCE.

Practical Points in the Design of a Shunt Dynamo.

In your issue of 7th inst., No. 1,050, is first number of an article entitled "Some Practical Points on the Design of a Shunt Dynamo."

In the fundamental equation for finding the size of armature, having given the output, n is given as revolutions per *second.*

In the next equation, figures are substituted for letters, but the author then gives the revolutions per *minute*, viz., 320.

Will you kindly clear this point in one of your subsequent issues?

W. J. Axworthy.

In reply to Mr. Axworthy's letter, I regret that an error should have crept into my article. The first equation is of course wrong, as the 60 should have been omitted.

n = revolutions per second, and the second equation is multiplied by 60 for that reason.

V. Zingler.

On the Cause of Death by Electric Shock.

In the paper on this subject by Prof. Oliver and Dr. Bolam, which appears in the *British Medical Journal* of January 15th, the authors give tracings of blood pressure and respiration curves to show that death by electric shock is due to arrest of the heart's beat and not to respiratory failure. I, therefore, beg leave to draw your attention and that of your readers to the fact that this very matter was fully dealt with by me in a paper in the *British Medical Journal* of March 2nd, 1895. Anyone referring to that number will see that the experiments, the tracings, and the deductions drawn from them, all correspond exactly with those of the present paper, the only exception being that Prof. Oliver and Dr. Bolam used an alternating current, while I used a continuous. Although my paper has been overlooked by them, it is noteworthy that the authors refer to the existence of an opinion that death in these cases might be due to heart failure. That opinion was put forward in 1890 by Dr. Tatum, after experiments made by him, and it was supported and confirmed by the experiments reported in my paper of March, 1895, at a time when the profession generally was accepting the view of Prof. D'Arsonval that death in these cases was due to respiratory failure. It is gratifying to me to find that the experiments by Prof. Oliver and Dr. Bolam confirm so fully the results which I published in 1895, and show that alternating currents act in the same manner as continuous.

My paper was printed in the *British Medical Journal*, reproduced in the Electrical Review, embodied in a short paragraph in the second edition of my book on "Medical Electricity," and made the subject of a communication to the Physiological Society. Therefore no great amount of research is required to discover it.

H. Lewis Jones, M.D.

9, Upper Wimpole Street.
January 17th, 1898.

Dynamo Sparking.

Re the letter dynamo sparking, I think that "W. H. B." is wrong in adopting any such device as he explains for the automatic shifting arrangement for the brush rocker on his dynamo which he is using to supply current for motors. If he uses a solenoid with a movable armature, which in turn moves the brush rocker, I am of opinion that the same sparking will ensue as formerly. If the dynamo be running at a light load, and a motor is switched into circuit, a large current will have to traverse the coils of the solenoid to move the rocker, and during that moment sparking will ensue.

Now sparking between the gauze brushes and commutator will roughen the strips, and so make collection bad, accompanied with sparking, which increases as time goes on; and in a short time it will not stop, owing to the increased roughened surface of strips. Now I think it would be better for "W. H. B." to adopt carbon tips to the end of the brushes. The carbon will offer increased surface to collection (which will tend to decrease the volts, but not more than a fraction per cent.), and so render collection easier, with less sparking, and is less detrimental to the strips, as it takes over the sparking, and does not produce the burning and scoring effect as takes place with gauze brushes alone.

The tip need not cover more than a strip, or, if this will not suit, it would be as well to substitute the present brushes by those of carbon only, which I am sure if properly set and adjusted there would not be the least trouble with them.

There might be signs of sparking, but it will not be detrimental to the machine.

Carbon brushes need no little skill in adjustment; and if they are not properly set, they will prove worse than those of gauze.

I am sure if "W. H. B." would substitute for his brushes those of carbon he would be greatly relieved from trouble and anxiety by having sparking reduced to a minimum, and so by working his machine under fairer conditions, as carbon brushes allow of a large variation of load without altering the lead.

Charles Whinsa Nicholl.

"Dynamo-Electric Machinery."

May I draw attention to an error in Prof. Silvanus P. Thompson's valuable work? On page 434 of the fifth edition, it is stated that Mr. H. F. Parshall's 150 k.w. street-car generator has a duplex armature winding. From the other data given, however, it is evidently a single-winding; for, applying the formula given in Hobart and Parshall's "Armature Windings" (a formula, by the way, in which $\frac{n\,C\,N}{10^8}$ is reduced to more convenient terms) we find that for a single winding

$$\text{volts} = 5 \times 6{\cdot}16 \times 2 \times 8{\cdot}7 = 536,$$

which is approximately the required amount, whereas with a duplex winding

$$\text{volts} = {\cdot}25 \times 6{\cdot}16 \times 2 \times 8{\cdot}7 = 268.$$

I notice that nearly all the plates in the book have the scale given, which greatly enhances their value. Had this been done in the case of Plate X. (illustrating the machine referred to) one could have got at the induction and current densities, which would have enabled one to make interesting comparisons with other machines.

W. Casson.

January 14th, 1898.

[Should not ·25 in the second example (it is so in the MS.) be 2·5, otherwise the working out is wrong.—Eds. Elec. Rev.]

Lampholders.

As the expiration of the Ediswan patents on lampholders is coming on, it occurs to me it will not be out of place to sound a note of warning to fire insurance companies, through the medium of your columns, and I shall therefore be glad if you will give this letter a corner in your valuable Journal. Already samples of what we may expect are being put on the market, and as I write, I have before me the letter of a Government official, who says ever since the patents for the Edison screw holders expired, their department have had the greatest difficulty in getting satisfactory holders of this type.

My business takes me all over the country, so that I see work of all sorts, and I can assure you I have seen hundreds of lamps installed, both as to workmanship and material, in such a manner as would make Mr. Heaphy's hair stand on end.

The invariable answer I receive when I venture to point out the danger is, "Oh! the fire office have passed it," and with the general public, who know nothing of the danger they run, this appears to me to be a guarantee, in their opinion, as good as a certificate from a consulting engineer superintending the work on their behalf.

Much has been written about jerry workmanship, but in my opinion jerry material is quite as much to be condemned, and the fire offices having set themselves up as "authorities" on the subject, should do the thing thoroughly, as at present their clients are in many instances resting in false security.

The fire offices would do the electrical profession a valuable service and reduce their risks if they collected together a number of specimens of electrical accessories of all classes and makes, and classify them, so that the uninitiated could go to the office of the company they are insured in and see what they should have put in their buildings, and what they should avoid.

Plenty of the public pay good prices for jerry work through ignorance, and the more the fire offices do to dissipate this the better for themselves and the better class manufacturers, who have to fight against it.

Let them start on lampholders; they will have a busy time shortly.

Walter Blenkarn.

January 18th, 1898.

THE ENGINEERS' STRIKE.

The chief anxiety of the A.S.E. this past week seems to have been that the *status quo ante bellum* should be secured. Juvenile copy-books once contained a line stating that "Time which has past will never return." There can be no return to the ante-strike period; the men cannot go on where they left off. The hours' question—that "popular" breeze to which the A.S.E. so gaily spread their summer sails, has died away into a very dead calm, only to be succeeded by the cyclone of management questions, and a veritable tornado of bottled up grievances on the points of restriction and loafing, which, though it may be marked by wreckage, will undoubtedly clear the air, and leave an open way for a different future. Now that the men are beaten, the greatest kindness that can be shown them is to see to it that future concessions have nothing of the element of weakness in them; no giving way to unreasonable demands for peace sake, and no bending before the ignorant demands of self-appointed agitators. Let Mr. Burns be followed in his cry for American methods, albeit he spoke better than he knew.

It was reported on Friday that the hours' demand had been unconditionally withdrawn. This was denied by Mr. Barnes, but it was not thought he was in a position to know. Telegrams came from Manchester and Glasgow to the effect and Mr. Barnes gave somewhat indirect denials. He was busy at his trade, however—getting out a fresh manifesto. What a charm there is in these huge words for the agitator! Half the dispute seems to have been so much mouthing of long Latinised words. Manifesto, conference, delegate, come in shoals, and help to impress the simple workman.

Anyhow, Mr. Ferguson, the Glasgow local organising delegate, made a statement as to the hours' demand being withdrawn, and he confirmed the statement publicly to a reporter. The Employers' Federation, on the other hand, do not accept a simple withdrawal of the 48 hours' demand as closing the question. They do not intend to start any men who will not toe the mark on the basis of the amended proposals of the Federation, and there can be little doubt but that the men who accept will soon find the benefit of honest effort in increased pay, and will not countenance a return to skulking methods. The active of the strikers have been probably almost to a man youngsters who have not any remembrance of the times before restriction set in. They have been brought up on restriction, and possibly before long will be astounded at their own folly in listening for a moment to the commands of such leaders as have compelled them to such exhibitions of ignorance.

The Fairfield lock-out was a great blow to the strike leaders, who did not, as formerly, at once withdraw the 75 per cent. not locked out. This was generally considered a sure sign of weakness, not to be glossed over by all the financial juggling with figures as to funds available. Mr. Barnes keeps harping on his willingness to arbitrate, on the eight hours' question, and indignantly denies the charges as to connivance at restriction. Now this is really too bad, when all the country knows that restriction has been everywhere; the shop delegate has been pushing the accursed thing in every union shop; foremen have been interfered with in their duty, and for months chance labourers and apprentices have been beating the old hands by large percentages.

Mr. Barnes is fighting in the last ditch, and demanding to exercise the right of interference. Had Mr. Barnes won the day, he would have demanded eight hours, would have restricted output still further, and most probably he would have insisted upon there being a recognised trade union official in every shop—paid by the employer, of course—to interfere at every turn. Mr. Barnes' one and only mistake in the whole quarrel has been of the sort that expects to pour a quart of ale out of a pint pot. Of course he would have failed, but he would have smashed the pot. As it is, the pot has smashed him, and he is simply making himself ridiculous by his present attitude. We may admire a man who fights because of his pluck; we may pity him for his ignorance in fighting for a bad cause, or despise him if he does not fight fair, but when a man becomes the object of ridicule he is lost.

Sir E. J. Reed writes a capital letter to the *Times*. He recalls how the late Sir Joseph Whitworth, at one of the Paris exhibitions, foretold the present conditions when pointing out how foreigners, by means of Sir Joseph's own inventions, were rendering competition keen. The danger, said he, will lie with the men, who will be a long time learning that they will have to compete with cheaper men.

Sir Edward instances numerous articles he has seen which have been made abroad which he has come across in recent visits through English workshops. Without any special sympathy with employers, he sees that trades unionism, in striking at them, really strikes at the poor working man, who is the dupe of his leaders. He sees how the workmen get as much as a hundred times in wages what the employer gains as profit. He sees thousands starving as a result of a war, of which the first shot was fired by the men in London, who were working for shorter hours than millions of their fellow countrymen, women and children are working for much barer subsistence. The naked hideousness of the struggle appeals to him as to any other open-eyed man. Yet he says the men's leaders see nothing but a vulgar contest with employers and capital, as though, we may suppose, capital were a source of evil. He has not much sympathy with employers. They should have combined long ago, and kept the unions sane and reasonable and considerate. Sir Edward, in fact, repeats what we have urged, that it is the weakness in making apparently expedient concessions has caused the frog to blow himself out. The unions have, in fact, gone altogether beyond their legitimate sphere of wholesome influence, and this has ruined them by enticing them into their domineering and arbitrary attitudes. Sir Edward concludes a thoroughly sound letter with these words:—

"I have no scheme of settlement to suggest. The unhappy employers, while facing the fire of competition, are, it seems to me, attacked from behind by the representatives of the very people for whom they are making the fight. For, if I may, I will repeat that we have to-day to fight foreign competition in many countries, over many manufactures, and in many forms, and the people whom we have first to protect are the working classes of this country. The men who are in the forefront of this battle, and who must remain there, are the employers; but they are few, and for them, in themselves, we need not be greatly solicitous. It is by them and through them, however, that the interests of the working people of this country have to be maintained, and these ought to be maintained at all costs. Is it too late to ask, or is it too much to ask, that a contest which has become as ruinous as it is unnatural may be forthwith ended and a new chance be given to our own people and our own country in the international struggle?"

Probably for this letter Sir Edward Reed will be fiercely attacked when he next contests a seat in Parliament, by the very men whose real interests he has at heart. Such is the working man of to-day.

In the meantime the Manchester shops have opened their doors to non-unionists who were prepared to accept work under conference rules, and it is also understood that unionists may be employed who have definitely left the union. Very few of the latter had done so up to Saturday last, and of course they could not be taken on as unionists while their unions still maintained the 48 hours' demand.

A trades unionist writing to a contemporary denounces the so-called new unionism, which he calls upon all solid unionists to exterminate. He denounces also so much federation of unions. But for this he considers that the London struggle would not have extended to the country. It was the federation of trades union that compelled the Employers' Federation. He calls for home rule. Let every district stand alone, and so avoid the national calamity of wide-spread strikes and equally of widespread lock-outs. But it is 25 years since the last great strike. There have been numerous smaller ones in between, but the accumulation of wrong doing and error and weakness which have brought on the present struggle has been of 25 years' growth.

Before another such period has gone by we may hope that an advanced intelligence and a better knowledge of the facts of foreign competition will prevent so suicidal a thing again taking place. That some kind of benefit is desirable is the opinion of everyone. In a letter to the *Times* Mr. Maudslay suggests what seems a likely scheme. By it every workman would have control of his own funds, and if he elected to use them for purposes of a strike he would be at liberty to withdraw them for the purpose, subject simply to the safeguard that he could not draw them by proxy, but must himself draw the money before handing it over to the agitator of strikes.

Mr. Maudslay considers that the handling of the cash in solid sovereigns would usually be sufficient to induce at least a very careful consideration of the case before handing the coin to the strike fund. At present, the workman has no control over his funds, and the actuarial basis of the A.S.E. is considered by men versed in such matters to be far from sound, as, indeed, has been shown more than once by a reduction of promised benefits. The Society, in fact, promises more than it can carry out. How it will now get along is very doubtful, and the present would be a very good time to start a men's benefit fund on some such lines as Mr. Maudslay indicates; a fund from which each member could withdraw if he chose to do so, and officered by men amenable to strict commercial law, and under the guidance of properly appointed trustees. If apart from the benefit fund the men desired to keep up a strike fund they would be at liberty so to do, but it ought to be made illegal to employ any benefit fund for strike purposes, and the law should forbid the carrying on by one executive of the two functions of benefit and strikes or disputes, and should forbid the transfer from one fund to the other of money in any shape or form, except only as the man personally withdrew the money in coin, and carried it away himself. And even this we would make a matter of some days' notice, the man to be first shown the money he is to draw in gold, and then given it so many "thinking" days afterwards, during which he would have time to consider matters before making a leap in the dark, and he could consult those at home, who have the brunt to bear when dealings commence with the pawnshop. Mr. Maudslay's letter has roused the ire of Mr. Barnes, who throws all the blame on the workmen, of whom he is simply the innocent and harmless mouthpiece. This is good.

Since writing the foregoing it is publicly announced that the eight hours' demand has been withdrawn. It was so reported last week, and the report described as a fairy tale by Mr. Barnes, and as a canard by Mr. Brown. What Mr. Burns said we know not. It is reported, however, that "for the suffering they have undergone, the men demand compensation;" but from whom is not clear. They have suffered voluntarily for 28 weeks, refused good wages, and plunged the trade of the country into a pit, and ask for compensation. Many trades union leaders admit that the sole result of the half-year's struggle has been to raise a rival power, which will make it impossible in future to dictate terms to individual employers. There is one other result—the ruin of the A.S.E., morally and financially. Union folly was never so clearly manifest as now, when the nominal *casus belli* has been formally withdrawn, war is declared still to be the order of the day, because the employers insist on being victors in respect of the true *casus belli*—the question of management. Sanguine local leaders are saying that there is no reason why the men should not at once resume their places, as though it were but the second week of last July. But it is the third week of the following January, and it is certain that the new men are not going to be sacked to suit the strikers' convenience. If the new men are discharged, we should hope the employers who do so, or even permit them to be worried away, will receive due retribution. On this point there are bound to be troubles. The bellicose unionists will do their worst to render the lives of the new men miserable, and this must not be. The employers are bound to see to it that peace shall prevail, and that disturbers of it get the run out quickly. In the meantime large numbers of men are leaving the union, and going back to work. As we predicted early in the strike, the old hands are inclined to stick to the union for the sake of their old age benefits, and the young men, who have been the cause of the war in a large measure owing to their recklessness and a desire for a cheap summer holiday, are throwing the union over rather than face future levies. We condemned the strike as a cowardly robbery by the young men of the old men's funds, and we have proved correct. Some of the daily papers still plunge wildly in the dark as to facts. Among these the *Daily News* calls for a compromise.

What compromise can be possible that will be of the slightest value? There is but one issue, and that is summed up in the one word *output*. Are the men's "friends" still asking that there shall be restriction of output? It looks like it, or else it looks like ignorance. The whole British working man is permeated with the idea of restriction. A bricklayer does not set as many bricks in a week as he could easily set in a day without overworking himself or doing bad work. And this evil, which is eating out the heart of the country, is to be compromised. Away with such nonsense. Let the men get back to work, and show by decent honesty that we can beat any other nation if we choose to do so. Let them make up their minds to earn more money and to see that they get it.

Compulsory arbitration again is not likely to be acceptable. Arbitration so commonly ends in the granting of a part of any demand that the men would be making constant big demands in order to get a part by arbitration. This would land us in similar demands by the employers, so as to get something back again. There would be no finality. There is room for some such body as the Board of Arbitration and Conciliation of the Manufactured Iron and Steel Trades of North of England. This seems to have worked well, but has been fortunate in its men, from both sides. But compulsory arbitration or Parliamentary interference will not do. We are inclined to think that the Employers' Federation will steady matters for a time, and hope to see some suitable arrangement arrived at that will prevent future wars. The great lesson to be relearned is, however, that machinery is not of necessity an ouster of labour. If the men only learn this the end of nine-tenths of the recent troubles will have arrived. The other great cause of trouble is the question of demarcation. Nothing is to be done for this beyond the most drastic commandeering. The idea of demarcation has become absurd through being carried to absurd length. Anyone making trouble on this score ought to be severely dealt with.

ELECTRIC POWER DISTRIBUTION.

A few days ago the secretary (Mr. Lowe) of the Midland Electric Corporation for Power Distribution, Limited, approached Sir B. Hingley, Bart., chairman of the South Staffordshire Iron Trade, and Mr. J. B. Cochrane, chairman of the South Staffordshire Coal Trade, with the object of enlisting their sympathy, and the sympathy of manufacturers generally, in the scheme of electric power distribution which the Corporation have embraced in their provisional order. As a result a meeting of manufacturers was held in Birmingham yesterday (Thursday). In his circular Mr. Lowe states:—

"The Midland Corporation is prepared to enter into agreements to supply electrical energy for power or manufacturing purposes at as low a price as 1d. per Board of Trade unit, and for lighting at the rate of 6d. per unit for the first hour's use per day and 3d. per unit for each subsequent hour's use daily. The Midland Corporation is also prepared to lay a comprehensive system of mains throughout the district, and will supply motors for hire, so that manufacturers can secure the advantages of electrical power at the minimum of capital outlay."

Here follows a comparative statement of the prices charged in 15 towns—Blackburn, Bradford, Bristol, Cardiff, Coventry, Edinburgh, Glasgow, Halifax, Leicester, Liverpool, Nottingham, Stafford, Sunderland, Walsall, Wolverhampton—in which the local authorities own and work the electric lighting orders, and which have been selected as being favourably situated for coal supply. The secretary claims that this statement demonstrates the impossibility, on account of the limited area to be supplied, of any individual local authority (of approximately similar rateable value to the towns in the area applied for) being able to sell electrical energy at anything like the figures at which the Midland Corporation will undertake to supply it.

The secretary then goes on to state that in order to carry out its objects, the Midland Corporation has served statutory notices upon, and deposited plans, with all the 18 local authorities in their proposed area of supply. The secretary adds:—

"Of these authorities, the Councils of Dudley, Walsall, and Wolverhampton already possess electric lighting orders, under which they now have the sole right to supply energy for power purposes, while the Councils of West Bromwich, Oldbury, and Smethwick are applying for similar orders in the present session of Parliament. The Midland Corporation has had no wish whatever to interfere with the lighting of these boroughs or urban districts, except with the consent of the local authority, but it submits that it is hardly within the sphere of operations which should be under municipal management to start this business of power supply; in other words, it contends that risks which are inevitable in a new enterprise of this kind, and which a company may be justified in incurring are unsuitable for a municipal authority to embark upon, having regard to the fact that they must borrow money on the ratepayers' account to enable them to do so.

"In view of the opposition to the scheme from certain of the local authorities (without whose consent it is doubtful if the provisional order can be obtained), the promoters of the order feel that the time has come when the iron and coal masters, and the manufacturers generally in the district, should be made thoroughly acquainted with the scheme, so that they may bring their influence to bear in support of the application of the Midland Corporation and assist in the introduction of electrical energy as a motive power into the district."

BUSINESS NOTICES, &c.

Board of Trade Returns.—The foreign trade returns for the past year now completed, says the *Daily News*, show less satisfactory results than were at one time anticipated. For the first six months of the year the imports showed a gain of over 4 per cent., while there was a moderate reduction of 1½ per cent. in the exports. Owing chiefly to the effects of the increased American tariff, and of the strike in the engineering trade, the decrease in the exports for the year has reached £5,795,000, or 2½ per cent., while the increase in the imports is £9,429,000, or 2 per cent. The chief proportionate reduction in exports is under the head of machinery and mill work. Steam engines show a decrease of £124,000, and other descriptions £298,000. Among metals there were increases of £75,000 in copper, £53,000 in telegraph wires, and £33,000 in iron.

Business Announcement.—Mr. A. Alan Jenkins has joined Messrs. Lloyd & Read as a partner. The firm, now known as Lloyd, Read & Jenkins, has removed from 63, Broad Street, to more commodious premises at All Saints Chambers, High Street, Bristol. The lighting of the Bristol Commercial Rooms, and the new sanitary offices, Queen Square, has just been carried out by this firm.

Catalogues, &c.—Messrs. Bergtheil & Young, of 12, Camomile Street, E.C., who are the sole agents for the United Kingdom for the Bullock Electric Manufacturing Company, of Cincinnati, have sent us lists of that company's manufactures. The lists illustrate and particularise direct current dynamos of various types for belt and direct connection, and some detailed notes are given of the principal features of their method of winding armatures. There are also several photographs of printing presses of different makes, with their direct connected slow speed motors, and views are shown of motors connected to lathes, drills, and other machine tools.

Messrs. J. D. F. Andrews & Co., of Fulham, have issued an 1898 edition of their catalogue of their systems of concentric, double, and conduit wiring. Comparative estimates are given, showing the cost per 16-C.P. lamp wired on this system and on the wood-casing method. Joints, sockets, nipples, switches, fuse and switchboards, lampholders, pendants, and various other accessories for use with the system are described and priced.

A folding list with stiff green covers has been sent out by Messrs. Veritys Limited, describing the "Standard" main switchboards. There are several different types shown:—(*a*) for plain dynamo boards; (*b*) for extended dynamo boards; (*c*) for multiple dynamo boards; (*d*) for plain accumulator boards; (*e*) for extended ditto. There are also types of main distributing boards. The list is very nicely printed and is conveniently arranged.

Messrs. Cutting Bros., of Derby, are sending out a wall card, giving a useful discount table from 2½ to 50 per cent.

The Edison & Swan United Company's Section VI. catalogue, dealing with fancy fittings, electroliers, brackets, &c., has been issued. It is dated January, 1898, so is right up to date. The list, which, like all Ediswan catalogues, is nicely laid out and fully illustrated, shows many designs of plain and fancy brackets, some of which are very artistic. This remark also applies to a variety of fancy table and floor standards, ceiling fittings, pendants and electroliers. Special bronze and Doulton ware figures and elaborate candelabra are also illustrated.

Canada as a Mica Producing Country.—Since the application of mica for electrical purposes, the production during recent years has assumed considerable importance, and on account of its abundant occurrence in excellent quality in Canada the attention of capitalists has been attracted to mica properties in the dominion. Canada has long been known to be rich in economic mica deposits. More than 30 years ago, Sir William Logan ("Geology of Canada," 1863, pp. 494-5 and 795) referred to the deposits of "Muscovite" or "white" mica, then known to exist on Yeo's Island, Cape Tourmente, and other sections of Quebec. Mention is also made of the phlogopites or "amber" mica at Grenville, Quebec, and in North and South Burgess, Ontario. "In all of which," says Sir William, "the mica is obtained in large sheets, which being transparent and free from flaws, are wrought and employed for the same purposes as the 'Muscovite' or potash varieties." An early producer was the Sydenham property in the Kingston district, and an important deposit of "Muscovite," particularly referred to by Dr. Selwyn, director of the Geological Survey of Canada, in the Report of the Royal Commission on the mineral resources of Ontario, has been opened at Villeneuve, in Ottawa County, while at Templeton, about 16 miles from the city of Ottawa, several extensive deposits of first-class "amber" mica, notably on the Wallingford property, have been worked. Dr. Selwyn's high opinion of the Villeneuve "Muscovite" mica is fully confirmed by another well-known Canadian expert, namely, Prof. F. Cirkel, who has also reported in high terms on the Wallingford and the Lake Gerard properties. Referring to the output of the last named, it is recorded to have been as high as 122 tons in a month.

Concert.—On Friday last a concert was given by the People's Palace Electrical Class.

Contradiction.—We are authorised to contradict that portion of the *Westminster Gazette's* statement, published in our last issue, to the effect that Messrs. Easton, Anderson & Goolden, had entered into an arrangement with Messrs. Schuckert & Co. for manufacturing electrical plant under their patents, the rumour being without foundation.

Dissolution of Partnership.—Mr. W. H. Slater, of Slater and Spurgin, electrical engineers, of Holloway Road, wishes to notify that Mr. Malcolm A. Spurgin having left the firm, he will carry on the business in his own name.

Electric Pumping.—*Daily Tenders and Contracts* says that the Harrogate Corporation has decided to work the pumps at the Sewage Farm, Ripon Road, by an electric motor in place of a gas engine.

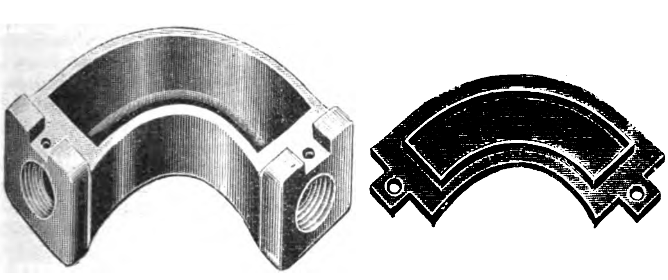
Fire.—On 13th inst. a fire broke out at Harrison's Electrical Engineering Works, Soho Street, Pemberton.

First Meetings.—The first meetings of creditors and contributors in the Ward Electrical Car Company will be held on January 26th at 11 and 11.30 a.m., at 33, Carey Street, W.C.

Gas.—A serious gas explosion occurred at the works of the English Gas Company, at Schoeneberg, Germany, on 13th inst., three persons being killed, and three severely injured.

German Enterprise in South America.—An indication of the enterprise of German firms is afforded by the formation in Berlin of the German Transmarine Electricity Company (Deutsch-Ueberseeische Elektricitats-Gesellschaft), under the auspices of the well-known Allgemiene Elektricitats Gesellschaft, the Deutsche Bank, and several other German banks. Mr. Emil Rathenau, of the Allgemeine Company, is one of the directors of the company, which has been constituted with a capital of 10,000,000 marks. The company propose to establish electrical installations of all kinds in America, and as a commencement, a lighting and power station is to be built at Buenos Ayres.

Interior Wiring.—Messrs. Newsome, Pinching & Co., of 1, Crutched Friars, E.C., are the sole agents for Russell's patent accessible bend, which we illustrate below, the drawings being self-explanatory. The bend is the device of Mr. C. N. Russell, the



electrical engineer to the Shoreditch Vestry, and it is largely used in connection with the lighting installation at the New British Gallery of Art, Grosvenor Road. The firm also makes a speciality of circular switch cases, circular four-way boxes, and Russell's straight box, all the fittings being screwed for iron gas barrel.

Kaye v. Croydon Tramways Company.—Mr. Justice Kekewich heard this case in the Chancery Division last week, it being a claim by a shareholder in the Croydon Tramways Company for an injunction to restrain the company from carrying into effect an agreement for the sale of the undertaking to the British Electric Traction Company. The injunction was granted. It appears that the principal ground for the application for the injunction was the provision under the said agreement for the payment of various sums, amounting in all to £3,250, to the directors and officers of the company for compensation for loss of their positions by the purchase.

Lazare Weiller.—Mr. Fernand Espir, the English representative of the well-known Compagnie des Etablissements Lazare Weiller, sends us a nicely framed view of the very extensive works of that company at Havre, also showing the dwellings of the workmen on the outskirts of the works.

Liquidation Notices.—A meeting of the Electrical Installation Company will be held at 135, Victoria Street, Westminster, on Friday, February 18th, at 2.30 o'clock, to receive an account of the winding up from Mr. O'Brien, the liquidator.

A meeting of the River Plate Electricity Company will be held at 78, Coleman Street, on February 23rd, for a similar purpose. Liquidators—Messrs. J. H. Duncan & T. S. Hamilton.

A meeting of the Acme and Immisch Electric Works will be held at 2, Clement's Inn, Strand, on February 4th, at 3 o'clock, to hear an account of the winding up from the liquidator.

Photographic Exhibition.—The Royal Photographic Society is organising an International Exhibition of Photographic Apparatus and Photographs, which will open at the Crystal Palace on April 27th. There will be extensive loan collections, illustrating the enormous scientific and commercial applications of photography, photographs in colours, photographs by means of the X rays, and kindred exhibits.

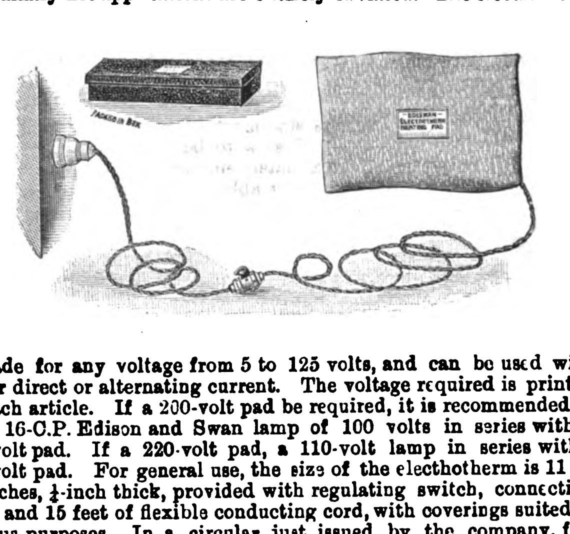
Soldering Paste.—Messrs. Beanland, Perkin & Co., of Leeds, are placing on the market Burnley's rozinal soldering paste, which is claimed to contain no acid or other substance injurious to wires or insulation. It is used for soldering armature connections, commutator bars, or field connections. By using this paste, it is claimed that wires can be soldered in half the usual time, and the finest wires can be united without oxidisation or injury to insulation.

South African Electrical Notes.—The *British and South African Export Gazette* has the following electrical items in its January issue:—Orders for various types of transformers and motors have been placed with European firms by the Rand Central Electric Works, Brakpan, Transvaal. The new electrical installation supplied to the Transvaal Gold Mining Estates was furnished by Messrs. Siemens & Halske. It is on the three-phase system and of a pressure of 3,000 volts. Part of the material for an overhead system of electrical traction for the Sheba mine has been shipped. The East London Town Council is, we understand, meditating an electric light installation. In the event of the electrical machinery for the Sheba mine not being recovered from the wreck of the *Clan Gordon*, duplicate orders for machinery will have to be placed. The second electric motor to complete the projected equipment of the Piggs Peak gold mine has been shipped. Two electric 25-H.P. locomotives have, we understand, been supplied to the Transvaal Gold Mining Estates.

South v. Lowenfeld.—This was an action heard at Westminster to recover £18 odd from the lessee of the Prince of Wales' Theatre, Coventry Street, W., balance of account for electrical work at the theatre. It was admitted that the orders were received through one Woods, the theatre electrical engineer, who was at one time also in the employ of plaintiff. On the other hand, plaintiff said that when he saw defendant at the theatre after the work was done, he said nothing about Woods not having authority to give the orders. The defence was that Woods had no authority to give plaintiff orders. Judgment was given for the defendant.

South v. Nathan & Summers.—On Thursday last week in the Westminster County Court, the case of South *v.* Nathan and Summers came before his Honour Judge Lumley Smith, Q.C. The plaintiff, Harry South, an electrical engineer, of Garrick Street, sought to obtain payment for making an electrical outfit for a lady, "The Wonderful Lamp." The defendants, music hall agents, employed Mr. South to fit a dress for Miss Hewitt, who was performing at the Palace Theatre in 1894 with electric bells, and her head-dress consisted of coloured electric lights. A battery was included in the apparatus. The account also contained an item for repairs. The defence was that Miss Florence Hewitt was the person liable. Judgment was given for the plaintiff for the amount claimed, with costs.

The Electrotherm.—The Edison and Swan United Electric Light Company is introducing the electrotherm, a patent heating apparatus, which has on several occasions been briefly referred to in our columns. We now illustrate the pad, which is composed of wires insulated and protected by asbestos, woven into a light and flexible sheet or pad, which, when attached to the ordinary incandescent lamp socket, offers sufficient resistance to the current to produce a constant and uniform degree of heat. The value and efficiency of the electrotherm are appreciated in cases of rheumatism, neuralgia, pneumonia, and other complaints, wherever the application of artificial heat is desired. By its use the risk and discomfort of frequent changes of temperature incident to the renewal of ordinary hot applications are entirely obviated. The electrotherm



is made for any voltage from 5 to 125 volts, and can be used with either direct or alternating current. The voltage required is printed on each article. If a 200-volt pad be required, it is recommended to use a 16-C.P. Edison and Swan lamp of 100 volts in series with a 100-volt pad. If a 220-volt pad, a 110-volt lamp in series with a 110-volt pad. For general use, the size of the electhotherm is 11 × 15 inches, ½-inch thick, provided with regulating switch, connecting plug, and 15 feet of flexible conducting cord, with coverings suited to various purposes. In a circular just issued by the company, full directions are given for use.

Utilisation of Water Power in Spain.—A proposal to put down plant to utilise water power in the Iguna Valley, in Santander province, in the generation of electrical energy, is at present under consideration. It is stated that 1,000 H.P. is available.

ELECTRIC LIGHTING NOTES.

Aberdeen.—The committee has agreed to consult Prof. Kennedy with regard to the proposals contained in the report by Mr. Blackman and Mr. Smith *re* proposed extensions before proceeding further in the matter.

Acton.—Mr. James de Lara Cohen does not propose to proceed further at present with his application to the Board of Trade for a provisional order giving power to light his estate at Friar's Place by electricity.

Alfreton.—An electric supply company has written to the District Council asking for consent to its proposal to supply the town with the electric light. The letter will lie on the table for six months.

Asylum Lighting.—The directors of the West Green Asylum, have, according to a Dundee paper, given a contract to the E.P.S. Company for maintaining the storage batteries at West Green and Gray House. The electrical plant at the asylum is now so far completed as to enable a 24 hours supply to be kept up.

Ayr.—The Burgh electrical engineer reports that for the month of December, through the heavy load of Christmas and New Year week, all demands for current were met. The machinery was overloaded but there was no trouble. The Commissioners will borrow—subject to the approval of the Secretary of State for Scotland—£2,000 for the purpose of wiring houses for the electric light on terms "similar to those of the London Electric Supply Corporation."

Balerno.—This Scottish village is now lighted by means of five arc lamps in the main roads. The Parish Council gave the contract to Messrs. Lowdon Bros., of Dundee, and current is taken from the Balerno Bank paper mills.

Bethnal Green.—The new infirmary is to be electrically lighted. At a recent meeting of the board it was stated that the architect's report on gas and electric lighting showed an expected saving of about £240 per annum by using electricity. Inquiries are also to be made as to whether the laundry machines shall be driven electrically.

Bexhill.—A Local Government Board inquiry was held on 12th inst. into the application of the District Council for a loan of £20,000 for electric lighting. The scheme was explained at considerable length. The plant would provide for 5,500 8-C.P. lamps for private use, as well as current for public lighting. There was some opposition.

Boston.—The Council has unanimously passed a resolution in favour of electricity. A scheme before the meeting was estimated at £20,000. The yearly expenditure was given at £800, as compared with £956 now paid for gas.

Bromley (Kent).—A correspondent says that considerable dissatisfaction exists amongst the members of the Bromley Urban District Council as to the transfer of the provisional order for lighting the town with electricity. It appears that the Council entered into a provisional agreement with a company called the Bromley Electric Lighting Power Company, and undertook to hand over the powers obtained under their provisional order for a specific sum of money, but as some doubt existed in the minds of the councillors as to who were the directors of the company, the Council have communicated with the Board of Trade, and the reply has been received that the present directors of the Bromley (Kent) Electric Light and Power Company, Limited, are Messrs. Medhurst and Taylor, both of High Street, Bromley, and Mr. Gripper, an electrician, of Twickenham, who have expressed their willingness to take £5,400 worth of capital, and other capital will be offered to the residents of Bromley as soon as shares are issued.

Burton-on-Trent.—At the last Council meeting the question of the recent failure of the electric light was discussed. It was shown that it was due to the breaking down of the India-rubber insulation.

Calcutta.—An Indian exchange says that very little has been done yet in regard to commencing work on the electric supply for Calcutta, which a local firm is to carry out on behalf of a syndicate. A committee has been appointed to settle matters in regard to overhead lines, and until this question has been gone into, progress will be purposely retarded, as much depends upon the acceptance of the company's proposals for the laying of mains in the several streets.

Chelsea.—The standing orders have been found to be complied with in the case of the Chelsea Electricity Supply Bill, which came before the examiners this week.

Colwyn Bay.—The Surveyor (Mr. W. Jones) has produced plans showing the two routes for the line of cables for electric lighting of the Promenade. The cable is to be laid along Lawson Road to the Parade.

Crieff.—A letter from Mr. R. Frederick Yorke was read at the last meeting of the Town Council, in which that gentleman puts forward a scheme for utilising water power for electric lighting, which he recommends instead of the steam scheme already under the Council's consideration.

Cromer.—The *Eastern Daily Press* says that the Highways Committee has received a letter from Mr. Gibbons, (?) Town Hall, Bradford, asking if the Council had any intention of transferring their provisional order for electric lighting to a company, and stating that if such was the case he would be able to submit an offer. The Council will consider a *boná fide* proposal.

Croydon.—Prof. Kennedy has been appointed consulting engineer to the Croydon Corporation from March 25th next at a salary of £100 per annum, with commission on certain work. Mr. Minshall, the present engineer-in-charge, has been appointed electrical engineer as from March 25th next, at a salary of £250 per annum, rising on September 29th to £300 per annum.

Enfield.—The General Purposes Committee is inclined to oppose the granting of electric lighting powers to the gas company, but has asked for the company's observations first.

Glossop.—A sub-committee of the Town Council is to see the manager of the Municipal Electric Supply Company *re* the electric lighting proposals put forward by that company. The question of putting down a municipal plant is not being lost sight of.

Gourock.—The Burgh Commissioners will oppose the application made by the North British Electricity Company for a provisional order.

Greenock.—The Electricity Supply Company, which proposed to apply to the Board of Trade for a provisional order to supply electricity in Greenock, does not intend to proceed with the application at present.

Hereford.—The County Surveyor has been looking into the question of lighting the Assembly Rooms by electricity, and has prepared estimates of the cost of plant, &c., but as a provisional order is now being applied for, nothing will be done in the meantime.

Hull.—A proposal to instruct the Works Committee to consider the advisability of lighting the Workhouse premises by electricity throughout came before the Board of Guardians, but there was opposition, and the proposal was negatived by a large majority, as the Committee "already had sufficient to do."

The tradespeople are asking for a reduction in electricity charges.

Ipswich.—A London electrical firm has approached some members of the Lighting Committee with a view to securing a transference to them of the Council's provisional order.

Ipswich (Queensland).—The Australian *Building, Engineering, and Mining Journal* recently gave the following list of the tenders submitted to the municipality for the supply of electric lighting plant and machinery, &c. Notice of the invitation of tenders appeared in the Review:—

		£
Section A.—	Crompton & Co.	1,020
	Siemens Bros. & Co., Ltd.	1,075
	Babcock & Wilcox, Ltd.	1,650
Section B.—	Crompton & Co.	856
	Siemens Bros. & Co., Ltd.	971
	Babcock & Wilcox, Ltd.	1,050
Section C.—	Siemens Bros. & Co., Ltd.	8,159
	Brush Electrical Engineering Co., Ltd.	8,200
	Babcock & Wilcox, Ltd.	8,550
Section D.—	Babcock & Wilcox, Ltd.	875
	Electric Construction Co.	417
	Siemens Bros. & Co., Ltd.	518
Section E.—	Siemens Bros. & Co., Ltd.	6,894
	Noyes Bros., Agents for the Callender Co.	7,316
	Brisbane Electric Supply Co.	10,068
Section F.—	Siemens Bros. & Co., Ltd.	725
	Crompton & Co.	760
	Nalder	785

Mr. Hesketh, the Government electrical engineer, who advised regarding the contracts, made the following notes: *Section A.*—The boiler I would prefer to have accepted would be the Babcock and Wilcox water-tube, but as the price seems too high I think the compound Cornish made by Messrs. Evans, Anderson and Phelan should be accepted. *Section B.*—If the Cornish boilers are obtained the steam pipes should also be ordered from them to save trouble. *Section C.*—Messrs. Siemens Bros.' combination I consider the best. *Section D.*—It is advisable to place the order for the switchboard with the successful tenderers for Section C. if the price is not prohibitive. I therefore recommend Messrs. Siemens' tender for acceptance. *Section E.*—I have personally great faith in the B. E. S. Co. cable, manufactured by the British Insulated Wire Co., and from personal experience can testify to its excellence. I have no reason, however, to doubt the excellence of the cable manufactured by the other two tenderers, and their prices are considerably lower. *Section F.*—The transformers quoted are all good, and in the final selection it will be on details that the decision must rest.

Jersey.—The *Times* says that the St. Helen's (Jersey) Parish Assembly on Tuesday adopted, practically unanimously, a petition to the States of the island in favour of a Bill empowering the municipality to borrow £30,000 for an installation of electric light under the direction of parochial committees.

Leominster.—The matter of electric lighting is said to be among the subjects coming before the Town Council shortly.

Liverpool.—The Liverpool Corporation is raising a million-and-a-half loan. That sum includes £600,000 paid for the tramways, £50,000 for the experimental electric tramway, and £400,000 raised under the Electric Supply Act, 1896.

London.—On Thursday evening last week, Mr. Robert Hammond read a paper on "Electric Lighting" to the members of the City of London Tradesmen's Club, at the Albion Hotel, Ludgate Circus. A great many surveyors and engineers of local Vestries in the Metropolis were specially invited to take part in the discussion which followed. Mr. Hammond, in the course of an exhaustive paper, dealt particularly with the present electric lighting monopoly in the City, observing that the company now providing the electric light charged the maximum rate, viz., 8d. per unit, whilst at St. Pancras the charge was only 5½d., at St. James' 5½d., and at Kensington 5½d. He also said that the City company maintained a strict secrecy as to the number of units they supplied, in spite of the fact that by the Act of Parliament they were compelled to furnish an annual statement. From computations he had made, however, by means of the division of the revenue of the company by 8d. he found that the company had supplied during 1896 a total of 5½ million units. Now comparing that output with some of the other companies in the Metropolis, he thought the charge made by the City company was very unfair, because he found that companies with as small an output as 100,000 units only charged about 6d. The City Commissioners of Sewers were responsible for granting the present monopoly of City electric lighting, and the present arrangement was that until the company reached a 10 per cent. dividend, and cleared off the arrears of previous years, the consumers would have to continue paying 8d. per unit. The City company, he added, had quite recently issued £200,000 more ordinary shares, bringing the total of such shares to £600,000, and in consequence £60,000 a year had to be disbursed to the ordinary shareholders in dividends before the price could be reduced. In 1896 he found the profits of the year's working amounted to £67,000, out of which the ordinary shares ranked for a 7 per cent. dividend. The electric light company, he said, which supplied electric light to the Smithfield market area proposed to charge only 4d. per unit to the large consumers, and the smaller consumers 6d. In conclusion, he strongly urged the City authorities and other local bodies to put down their own electric lighting plant, and pointed out that it was possible to borrow money to attain that object at from 3 to 3½ per cent. with the repayments spread over a long term of years. A gentleman pointed out that the City street lamps were supplied at a charge of only 3d. per unit, but Mr. Hammond replied that these were arc lamps running all night, and did not require the same number of men to keep the work going. Mr. A. C. Morton, a member of the Corporation, said that the Court of Common Council had the matter before the Lighting Committee, and that he hoped before long to see an installation beneath the Guildhall, when the Corporation would compete with the present company, and supply electric light to all the large public buildings and other premises. The Corporation claimed the control of the streets within the City. An animated discussion followed, and eventually the matter was adjourned for further discussion at an early date. Mr. Hammond was cordially thanked for his paper.

The County of London and Brush Company is applying to the Board of Trade for power to change its supply of electricity from continuous to alternating currents, and recently applied to the St. George's (Southwark) Vestry for approval to that course, stating that the public would receive advantage from the change. A special committee is considering the matter.

Madrid.—A Madrid correspondent informs us that about the beginning of the present month the greater part of the district supplied by the Electricity Supply Company for Spain, Limited, was without light for 48 hours.

Margate.—The Corporation has arranged a special meeting for Tuesday, the 25th, to consider the advisability of opposing the application of the Isle of Thanet Gas Company for Parliamentary powers to supply electricity for the lighting of the town.

Motherwell.—The new shops of the Motherwell Bridge Company, Limited, at North Motherwell Farm, will have a complete system of electric driving and lighting. At the Dabnell Steel and Iron Works of Messrs. D. Colville & Sons, Limited, an electric power installation is in progress. A beginning has been made with a 100-H.P. unit, which will be used for driving the machinery, cranes, &c., of their new machine shop. This will be followed later on by two units of 500-H.P. each, which will provide current to drive all the auxiliary machinery in the mills, such as live roller gear, guillotines, plate shears, straightening machines, &c. The low-tension polyphase alternating current has been adopted, and it is expected that when the numerous small engines scattered about the works have been replaced by motors, a very large saving in fuel and cost of upkeep will result. Messrs. Selby Bigge & Co., Newcastle-on-Tyne, are the electricians for the work.

Newport.—The Corporation has decided to increase the salary of Mr. Copland, the engineer at the electricity works, and that of Mr. Taylor, the assistant engineer.

Oldham.—The estimated income and expenditure in connection with the supply of electricity for the year ending March 25th, 1898, shows an expected net profit of £1,600. The charges to consumers are to be reduced from that date.

Plymouth.—The Electric Light Committee has accepted a tender for the construction of the electricity station buildings.

Portsmouth.—At the Town Council last week the Finance Committee submitted a scale of charges and apparatus for testing electric light meters by the Corporation inspector. It was stated that all the meters would be tested before being issued to consumers. If, on a subsequent test, a meter was found to be incorrect against the consumer, the Corporation would pay the fee. If, on the other hand, the meter was correct, the consumer would have to bear the expense. The fee for removing the meter for testing was put at 5s. It was objected that the proposed fee was rather prohibitive, and it was pointed out that the Gas Company charged only a shilling for removing meters. Alderman G. Ellis, Chairman of the Electric Lighting Committee, remarked that the testing of the meters was a costly operation, and the fee suggested was based on the charges in other towns. The recommendation was referred back.

It is anticipated that the new machinery will soon be in working order. It is estimated that the engineering strike has cost the Committee fully £2,500 up to the present time, through loss of revenue, owing to being unable to carry out orders received, and to the payment of £300 to the sinking fund for money the loan of which has been sanctioned, but which it has up to now been impossible to employ. Despite this drawback, 456 new customers have been attached since Christmas, and 235 are waiting to be connected with the mains.

Reading.—The contract for supplying the handsome electroliers and other fittings, including the wiring of the Large Town Hall, Small Town Hall, Art Gallery, Museum, Public Library and Municipal Offices, comprising in all an equivalent of 2,500 8-C.P. lamps, was placed in the hands of Mr. Leo Sunderland, 39, Victoria Street, S.W., agent to the Brush Company. The current was switched on a short time ago, and the difference in the lighting arrangements have been much appreciated. This makes a good addition to the Reading Company's consumers.

Ripley.—An application from the General Power Distributing Company to provide an electricity generating station at Ripley, is to be opposed by the District Council.

Sheffield.—Last week, the recommendations of a committee—which we printed last week—*re* the proposal to purchase the undertaking of the Sheffield Electric Light and Power Company at the price offered by the company—namely, £220 of Corporation 2½ per cent. stock for every £100 of capital actually spent by the company, came before the Council. Several members spoke in favour of acquiring the undertaking at once, and the report was unanimously adopted. The final call of £1 per share has been made by the company, payment to be made by the end of the month. At this time the whole of the original capital of the company will be fully paid.

Smethwick.—The District Council will not consent to the Midland Electric Corporation for Power Distribution, Limited, making application for a provisional order to supply electric light to Smethwick, as that body is already applying for a provisional order for municipal plant.

Somerset.—Owing to the recent fire at the works of Messrs. T. H. Smith & Co., Ltd., situated on the River Parret, Somerset, Messrs. Massingham & Co., of this city, have received instructions to fit the entire building with a complete installation of the electric light. There will be two dynamos, one driven by water power and the other by steam.

Southampton.—At last week's Council meeting, the Electric Lighting Committee reported that the output for November was 24,240 units, being an increase of 8,970 units, or 58 per cent. over that of November, 1896. Owing to the general increase of output it has now become necessary to run the works continuously throughout the 24 hours. To do this the staff will have to be increased sufficiently to enable three eight hours' shifts to be worked. At present the only addition necessary is a third assistant engineer. The load on December 23rd was the heaviest on record, and required the whole of the plant to deal with it. In consideration of the extra work the engineers have performed since March last, a bonus of £10 is to be paid to Mr. Lee, and £5 each to Mr. Neame and Mr. Britton. The following tenders for the wiring and fitting for electric light at the electricity supply station were received:—Mr. H. M. Ashton, £387 18s. 6d.; Messrs. A. Fort, Lloyd & Co., £395; Messrs. Sanby and Co., £415; Mr. F. Shalders, £476. The tender of Mr. H. M. Ashton was accepted.

The Corporation want an assistant electrical engineer. See our "Official Notices."

Taunton.—The Electric Light Committee has been advertising for tenders for the supply of 1,500 tons of coal. During the month of December 99 16-C.P. lamps were installed; in November there were 52; and in October, 34. A scheme for a large extension is to come before the Council directly.

Wakefield.—Complaints are numerous in consequence of the non-completion of the electricity undertaking, the delay being due to the non-delivery of engines.

Walsall.—The Council will not agree to the proposed provisional order of the Midland Electric Corporation for Power Distribution, Limited, to supply electricity in the borough.

Wandsworth.—The lighting of the large and scattered premises known as the "Ram Brewery," was entrusted to Mr. Leo Sunderland, agent to the Brush Company. This is probably the largest installation of the kind in the district, comprising an equivalent of 750 8-C.P. lamps, and seven arc lamps. This installation will shortly be connected to the supply company's mains.

Water Power.—The famous falls of the Devon and grounds of Rumbling Bridge have, says the *Glasgow Herald*, been examined by electrical engineers with the object of utilising the water power to light the grounds and hotel by electricity. The engineers will be unable to proceed with the work till they ascertain the lowest summer level of the river. Should the scheme then be found practicable it is proposed to carry the water a short distance below the "Devil's Mill" in a two-feet pipe with a fall of 12 feet, which will give sufficient power to drive a dynamo to light the grounds, hotel, conservatory, stables, and outhouses.

Whickham.—A Committee has recommended the lighting of the Marley Hall district with electricity, 32 lamps being used. The price for the complete installation is £165, and the yearly charge of £55 4s.

Withington.—The proposal of the Manchester Corporation to supply this district with electric light has been considered by the Parliamentary Committee of the Withington Council, which recommends that an electrical expert be engaged to advise on the point. This recommendation has been sent back for reconsideration.

Wolverhampton.—It has been found, says our local correspondent, that the electricity turned out on Christmas Eve exceeded by 34 per cent. that turned out on the corresponding day of 1896. There is, of course, always a good demand at Christmas time, and it is reckoned at the head office that more customers are obtained at the Christmas quarter than during any other period of the year. It is now regarded as certain that the time cannot be far distant when the light will be extended over the entire borough. The new sub-station at Chapel Ash is rapidly approaching completion, and in a week or two's time it will be in working order. The mains will then be carried down the Tettenhall, Compton and Merridale Roads, where there are a large number of residential dwellings. An additional boiler is about to be put in at the Commercial Road works, and another new engine is shortly to be placed there.

The Town Council has resolved, by a majority of 25 to 8, to oppose the application of the Midland Electric Corporation for Power Distribution, Limited, for a provisional order empowering them to supply electricity within the borough of Wolverhampton.

Yarmouth.—During December the electric light receipts were £605 15s., and the expenditure £235 8s. 11d., leaving a surplus of £370 6s. 1d. to meet capital charges of £190 per month. There are now 255 customers with 11,938 lamps.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Burslem.—The Council is giving notice to the British Electric Traction Company that proceedings will be taken against them if Scotia Road is not completed and opened for traffic within 21 days; and notice is to be given to the North Staffordshire Tramways Company, pursuant to their agreement with the Corporation, calling upon them to commence the electric equipment of their line within three months, or in default their agreement would be cancelled.

Chesterfield.—The Highways and Tramways Committee is considering the question of continuing the tramways to Whittington Moor and other parts of the district; also the matter of mechanical traction.

Dover Harbour Works.—It it stated in a Dover paper that there is likely to be a start made in March with the National Harbour Works, and it is understood that electricity is likely to be the motive power employed, current in all probability being taken from the Dover Electricity Company.

Dover Trams.—The *Dover Standard* is responsible for the statement that with the Maxton section of the electric tramways now running, the amount of current being taken from the company is not likely to exceed the minimum arranged under the contract at the commencement of the running. The current required for the extra cars and quicker service is included in this estimate.

Dublin.—The Kingston Commissioners have discussed the proposed alteration in the electric tramway line through Upper and Lower George's Streets. A resolution, detailing an interlacing system between St. Michael's Hospital and the People's Park has been agreed to.

Dudley.—Mr. Reginald P. Wilson has been instructed to report to the Dudley Corporation as to the cost of buying the existing tramway to Hart's Hill; and also to furnish estimates as to the cost of equipping this and other proposed tram lines on an electrical system.

Ealing.—There is quite a lengthy correspondence in the *Middlesex County Times* respecting the London United Tramways Company's proposed electric tramway scheme, which the District Council has opposed so strenuously. Many of the writers are greatly surprised at the action of the Council.

Electric Traction on the Continent.—The *Financier* says that a powerful French company has addressed a simultaneous request to the Governments of France, Belgium, and Holland, for powers to establish a system of electric traction along the navigable highways of the three countries, so as to form an international network extending from the Rhine, through Holland, and as far as Marseilles through the Eastern departments of France, making use, for the purpose, of the navigable highways of the three countries. It is stated that the "Banque de Paris et des Pays Bas" is interested in the enterprise.

Electric Transmission of Power.—A meeting of the members of the South Staffordshire Institute of Iron and Steel Works' Managers was held on Saturday at the Dudley Institute, when a paper on "The Application of Electricity to the Transmission of Power" was read by Mr. H. W. Ravenshaw. The writer pointed out that managers of works and manufacturers generally were beginning to realise the fact that the old methods of transmission of power to their machinery were in many cases extremely wasteful, and that the electric motor is far cheaper in the end than the line shafting and isolated steam engines which have been generally employed. In an engineering works, mill, or colliery, immense quantities of coal are uselessly consumed in wearing out belts and bearings, and in raising steam which is to be condensed in long lines of pipes and perhaps re-evaporated in the cylinders without any useful purpose. In order to reduce these losses as far as possible electricity is being employed in many cases with great success, a central station being established in the works, and electric motors being employed to drive the machinery. With this arrangement the boilers could be concentrated, high pressure could be safely used, and the labour and coal consumption reduced to a minimum; short steam-pipes carried the steam to economical engines which drive dynamos, supplying the necessary light and power to the works. In America and on the Continent multipolar dynamos are generally used, but in England up to the present the simple two-pole machine has been usually employed. The question of pressure to be employed was an important one. In collieries 500 volts are frequently employed, and with this pressure several hundreds of horse-power could be transmitted without difficulty over a radius of at least one mile. In a works covering a comparatively small area, both lighting and power could be obtained from a 200-volt circuit with economy, incandescent lamps being now made to work up to 220 volts. A good many works and mills have been fitted for 100 volts, but there is no advantage in so low a pressure, while with 200 volts a very great saving is made in the cost of cables.

Electrical Power Distribution.—The members of the South Staffordshire Iron and Coal Masters' Association were to attend a meeting at the Queen's Hotel, Birmingham, yesterday, to hear from representatives of the Midland Electric Corporation an explanation of their scheme for supplying electrical energy for power and manufacturing purposes throughout South Staffordshire. Sir Benjamin Hingley, Bart. (chairman of the South Staffordshire Iron Trade), and Mr. C. B. Cochrane (chairman of the South Staffordshire Coal Trade), in issuing the invitations, express the feeling that the introduction of electrical energy into the district on a scale and for the purposes proposed should not only assist the trades now being carried on, but should be a powerful incentive to new trades to settle in the district, and thus increase its prosperity and rateable value. The Midland Corporation is prepared to enter into agreements to supply electrical energy for power or manufacturing purposes at 1d. per Board of Trade unit, and for lighting at the rate of 6d per unit for the first hour's use per day and 3d. per unit for each subsequent hour's use daily. The Corporation is also prepared to lay a comprehensive system of mains throughout the district, and to supply motors for hire, so that manufacturers can secure the advantages of electrical power at the minimum of capital outlay.

The Coseley District Council has resolved to give consent to the application of the Midland Electric Corporation for Power Distribution to the Board of Trade for a provisional order to supply the district.

Electrically-Driven Laundry Machinery.—Electric motors are employed at Alnwick Castle for the Duke of Northumberland for driving a large size washing machine, wringer, centrifugal dryer.

Light Railways.—The promoters of the Llanfair-Beaumaris light railway attended a meeting of the Menai Bridge District Council, and gave details of the scheme, the proposed speed and width of road. The line is estimated to cost £48,000. The Council will support the scheme.

The Essex County Council have passed a resolution strongly in favour of the construction of a light railway for Ongar, Dunmow, and Yeldham. The proposed line will be 27 miles in length, and will serve a purely agricultural district which is greatly in need of railway facilities.

Leeds.—A sub-committee of the Highways Committee is going to visit Glasgow *re* tramways.

Leith.—The Town Council has confirmed the proposal to purchase the tramways for £75,000.

Liverpool.—In connection with the purchase of the tramways by the Corporation, a proposal was before that body for the payment of £9,000 compensation to the solicitors of the tramways company for loss of net profits, and £1,200 to the auditors for ditto, through the transference. The proposition was not carried, the voting being 35 in favour of an amendment, and 11 against.

Last week there was a conference of the Lighting Committee and the Tramway Committee with regard to the utilisation of electricity as the motive power on the tramways, the lighting of the tramcars on the experimental line, and the extension of the electric mains throughout the city. A report was presented by Mr. Holmes, the electrical engineer, showing how the electric system could be applied to the tramway service, and the advantage that would probably result therefrom. The proposals included the establishment of a large new electric generating station near the Leeds and Liverpool canal, the outlay being £150,000. It was decided to refer the matter to Dr. Hopkinson.

Manchester.—It was stated last week that the Manchester Carriage and Tramways Company was inviting representatives from the various local representatives around Manchester to attend a conference on the subject of their proposed Bill for using electrical and mechanical power in connection with their tramways.

Middlesbrough.—A Middlesbrough paper in a recent issue mentions the marked progress that is being made with the preparation of the track for the electric tramways. Mr. Robert Smith, who had charge of the Dublin and Bristol construction work for the Imperial Tramways Company, is in charge here. The section between the Borough Hotel and the Ormesby Toll Bar, a distance of a quarter of a mile, was laid within eight hours, reckoning from the time of breaking up the roadway to getting in the setts.

Mines Drainage by Electrical Pumping.—Mr. J. B. Cochrane presided at the usual monthly meeting of the South Staffordshire Mines Drainage Commission on 5th inst., at Dudley, and in moving the adoption of the engineer's reports, said he understood that the Midland Electrical Power Company were seeking powers to supply electricity all through the district. They would undertake to supply, for manufacturing purposes, electricity at the rate of 1d. per Board of Trade unit, which was equal to 1 3 H.P. The question had been before several local authorities in the district, who did not quite see eye-to-eye with the company. Many were opposing the powers sought for by the company, on the ground that they would like to retain the power of supply themselves. That was reasonable enough, if the authorities were prepared to supply the electricity to manufacturers at something like the same rate that the company proposed to do it. He believed the company had approached the Dudley Corporation, who, he understood, could not supply electricity at less than 2½d. per unit, as against 1d. by the company; but they would see at once that it would be useless for the Corporation to propose the supply of electric power at 2½d. when the company could do it at 1d. per unit. He believed 18 local authorities were comprised in the area which the company proposed to supply, and it was easy to understand that whilst the company would be able to put down economical plants to supply particular areas, each of the local authorities would have to put down a separate and costly plant. He took it that the local authorities had no desire to hinder the progress of manufacturers, and if they could not do it at less than 150 per cent. more than the company, then it became a question whether the authorities should not stand aside and let the company do the work. The scheme had a most important bearing upon the work of the Commission, and the scheme for unwatering the Tipton district. They would be able to pump the water from the surface at various points by electric power, and the cost would be very small indeed compared with what it cost to pump it out of the mines. It would probably save contemplated expenditure of between £30,000 and £40,000 in the Tipton district, and they could understand what an important consideration that was at a time when they scarcely knew how to go on and face the large expense of pumping a district overloaded with water.

Motor Dust Carts.—The Hackney Vestry has deferred for six months the further consideration of the proposal to consider the advisability of adopting carts and vans driven by electrical or other automatic motors.

Motor Mail-Carts.—The *City Press* says that it is stated that the chief executive officials at St. Martin's-le-Grand are so satisfied with the experimental motor-car (steam) that runs between London and Redhill that we may shortly see the introduction of a small *electric* letter mail van.

Norwich.—The Norwich tramways are not yet begun, says the *Norfolk Standard*, and we shall not be able to chronicle work in progress for another two months at least.

Portsmouth.—The Town Council last week confirmed its recent resolution authorising the promotion of a Bill in the ensuing Session in reference to the acquisition of the local tramways.

South Staffordshire.—At the last meeting of the West Bromwich Council, a letter was read from the Board of Trade, enclosing a correspondence which had taken place with the South Staffordshire Tramways Company. The latter company had applied for a further extension of time for the use of steam on the tramways, but the Board of Trade express regret that the arrangements for the re-equipment of the lines had not taken place, and that a new method of traction had not been completed. They would grant a further extension for a period of three months, but they warned the company they must not rely upon obtaining any further extension of time.

Southport.—The Town Council has adopted the recommendation of the Tramways Committee to make application for a provisional order enabling the Corporation to lay four miles of tram lines to Blowick, with subsidiary lines forming a connection with the line to the new infirmary, and thus providing a circular route. It was proposed to adopt overhead electric wires and single deck cars, and to greatly extend the tramway system in the future.

Suggested Electric Tramway.—A correspondent of the *Surrey Advertiser* suggests a conference between experts of the Town Councils of Guildford and Godalming and the Milford Parish Council to consider whether it might not prove profitable—as it certainly would be a convenience to the public—to establish an electric tramway between the three places, with branches extending up Sandy Lane to the immediate vicinity of Charterhouse and the building land under development thereabouts, and perhaps also to the Farncombe Station from the Portsmouth Road.

Sydney.—An Australian contemporary remarks that the generators, accumulators, &c., for the Rose Bay electric tramway are now being erected at the Rushcutter Bay Power House, Sydney. The survey has been completed. Tenders for the construction of the permanent way are being invited.

The Charing Cross, Euston, and Hampstead Railway.—The Charing Cross, Euston, and Hampstead Railway Company have deposited a Bill for powers to extend their authorised line from a point under Charing Cross Road, near the Garrick Theatre, to a point under No. 23, Craven Street, Strand. This extension is to be in substitution for the authorised Charing Cross terminus, which it is proposed to abandon. The Bill also seeks an extension of time until August, 1902, within which to construct the line as authorised in 1893, subject to the new terminus now proposed. Power is also sought to enter into agreements with the South-Eastern Railway Company and the London and North-Western Railway Company as to the working, management, and maintenance of the railway when completed.

Waterloo and City Electric Railway.—This line will shortly be opened for traffic. The line itself was completed some time ago, says the *Times*, but delay which could not be avoided has occurred both by reason of the dispute in the engineering trade, and also in connection with the enormous amount of underground work which has had to be undertaken by the Central London Railway Company at the new station opposite the Mansion House.

Whitechapel and Bow Proposed Railway.—A meeting of the London, Tilbury, and Southend Railway will be held on February 3rd to lay before the shareholders the proposed Bill for the construction of works and purchase of additional lands, also to subscribe towards the undertaking of the Whitechapel and Bow Railway Company, or to guarantee interest on the capital of that company.

TELEGRAPH AND TELEPHONE NOTES.

African Trans - Continental Telegraphs. — The *Rhodesian Times* for December 17th stated that that part of the Trans-Continental Telegraph which is now being carried up northward from Umtali towards the Zambesi, and will join the line which has already been set on the farther side of the river, will, if all goes well, be finished about April next. It is expected at Blantyre that the line northward will reach Karonga about the same time—that is, Cape Town will be in direct telegraphic communication with the northern end of Lake Nyassa, 10° south of the equator. And at the same time the southern point of the telegraph line in Egypt will be about 15° north of the equator. Thus, to complete this extraordinary work, there will only remain some 25° of latitude to be crossed, and in that distance Uganda lies midway. Mr. Rhodes' wonderful dream is becoming more and more of a tangible reality.

Australian Cable Service.—Several letters have appeared in the *Financial Times* during the past few days complaining bitterly of the inefficiency of the telegraph service between this country and Australia, which subject we have ourselves dealt with on many occasions.

Delays in Australian Telegrams.—We have again to place upon record two cases of interruption and delay in the Australian land line service. As we have pointed out on former occasions, this information is gathered from press notices, and thus, doubtless, there are many occurrences of this nature which escape our notice. Were the Postmasters of South Australia and of West Australia to act up to their duties towards the Bureau International des Telegraphes, it would spare us the doubt which we sometimes feel that we have omitted to register some of the interruptions which should be reported to the Bureau for the common convenience of all interested in telegrams. The following extract from the *Melbourne Age*, of November 20th, has only just reached us:—

"The Telegraphic Service. A Far-reaching Block. Business Paralysed.

"The telegraphic system suffered very severely by the storm, and all last night the lines were in a chaotic state. Telegraphic business from the Melbourne office was completely paralysed. It was possible to communicate with Geelong and Ballarat, and with stations on the North-Eastern line, by which Sydney is reached, but Adelaide and intermediate stations, together with other trunk lines and the Tasmanian service, were completely silenced. The central authorities, indeed, state that such disastrous results have never before accrued from any storm. The public, unfortunately, will suffer serious inconvenience from the vagaries of the wind and lightning, as the operators have before them large piles of messages ready for despatch, but are absolutely prevented by the wrecked state of the lines from sending them out. Worse still, the line repairing department is, so far, unable to estimate, even approximately, the time at which the service can be resumed. Gangs of line men have been sent out in all directions, however, and the work of repair will be pushed on with all possible speed, and the operations of the repairers will, as rapidly as possible, be extended into the remote districts where it is known bad breaks have occurred."

We also gather from the press that, on Saturday week last, "in consequence of the Australian land lines working badly," no cables reached an important firm of London brokers.

Interruption of Australian Land Lines.—In the absence of information from Berne, we have to thank the Singapore press of December 13th last for the following:—"The South Australian land lines between Port Darwin and Adelaide are interrupted by heavy floods at the Katherine, 15 inches of rain having fallen in a little over 24 hours. Everything is being done to restore communication as soon as possible. The lines *via* Roebuck Bay and Western Australia are working well."

Paisley Telephones.—The National Telephone Company has asked the Council to appoint a committee to meet representatives to consider the question of certain improvements in the telephone system, such as the placing of the twin wire or metallic return system. The matter will be considered by the whole Council in committee.

Telegraphic Interruptions and Repairs:—

Cables.	Down.		Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1893	...	...
West Indies—			
St. Croix-Trinidad ...	Nov. 30th, 1896	...	...
Cape Haytien-Puerto Plata	Dec. 31st, 1897	...	...
Curaçao-La Guayra ...	Jan. 5th, 1898	...	...
Amazon Company's cable—			
Parintins-Itacatiara ...	May 5th, 1896	...	...
Obidos-Parintins ...	Dec. 7th, 1896	...	...
Para-Cameta	Jan. 13th, 1898	...	...
Bundaberg-New Caledonia ...	Nov. 4th, 1897	...	...
Ceara-Maranham	Dec. 23rd, 1897	...	...
Teneriffe-St. Louis (Senegal)	Dec. 24th, 1897	...	...
Para-Maranham	Jan. 3rd, 1898	...	Jan. 15th, 1898
Saigon-Hong Kong	Jan. 8th, 1898	...	...
Landlines.			
Trans-Continental line beyond Masol	March 12th, 1896	...	...
Carthagena - Barranquilla (Columbia)	July 4th, 1896	...	...

The Bermuda-Jamaica Cable.—The Direct West India Cable Company announces the completion of its cable from Bermuda to Turk's Island, thereby establishing telegraphic communication with the latter colony. Messages can now be accepted in Great Britain and Ireland at the rate of 3s. a word. The cable steamer is now laying the company's cable from Turk's Island to Jamaica, and it is expected to be completed well within the contract date, namely, 31st inst.

The Pacific Cable.—The *Times* of Tuesday has an article discussing the Pacific cable scheme in relation to the Colonies. It is considered that in view of the developments taking place in the Far East, the project of an all-British Pacific cable connecting the British Colonies of the North with those of the South Pacific acquires fresh importance. After dealing with the history of the proposal, the writer says:—"In the summer of last year the question again formed a subject of discussion in the conferences of Premiers held at the Colonial Office, and again no formal information was given to the public as to the result of the discussion. An informal statement was, however, made, and though unauthorised, has been since confirmed from Colonial sources in a way which leaves little doubt of its authenticity, that the position as to the construction of the cable was entirely changed by the proposal of the Eastern Extension Telegraph Company to lay an all-British line from Western Australia across the Indian Ocean to Mauritius, thence connecting with the Cape and St. Helena and Ascension. The proposal appears to have been submitted to the consideration of the Colonial Premiers as a substitute for the Pacific cable. Here, then, so far as the history of the movement can be summarised in a few words, the situation rests. As between a Pacific cable, for which they will be asked to pay, and an all-British Eastern Extension line connecting Africa with Australia, for which they will only be asked to make indirect concessions, Governments, with the fear of the Treasury before their eyes, hesitate to commit themselves to the support of the Pacific cable scheme." Dealing with the future, the writer says:—"Every sign would seem to indicate that the coming 20th century will be celebrated in the history of the world by the development of a new civilisation on the Pacific. To affirm the legitimate position of Great Britain in that civilisation must be the object of British policy, and for this purpose cheap and rapid means of communication between the local British centres is one of the first of necessary conditions. This aspect of the question is not dealt with by any proposals for cable construction that exclude the Pacific Ocean from their scope." . . . . "The estimated cost of the cable is not great, and it is difficult to comprehend that the construction can have been so long delayed." The *Daily Mail* of January 19th states, under date Montreal, January 18th, that interest in the all-British Pacific cable has been revived by events in the East, and that Sir Sandford Fleming has published an open letter to Sir Wilfrid Laurier reviewing the history of the project, and calling upon Canada to take the initiative at once.

A Cape Town despatch says that a deputation of the Afrikander Bond, headed by Mr. Hofmeyr, presented last Friday an address to Sir Alfred Milner, Governor of Cape Colony, representing the urgent necessity, in the interest of Imperial defence, of an all-British deep-sea cable. His Excellency, in reply, said he was not acquainted with the views of the Imperial Government on the subject, but he promised to forward the address to England.

The Telephone Service.—The *Daily Mail* has learned "on authority which it believes to be reliable that the Post Office has already come to a very important decision with regard to the telephone question. It hears that the Post Office inquiry into the request (for a license) that came from the city of Glasgow has resulted in an official report confirming the old attitude of refusing to grant any fresh licenses. The Post Office, it understands, takes up the position that the telephone system is on all fours with the telegraph system, that it should not be allowed to fall into local hands, for fear that systems under different regulations and possibly making different charges should be established in separate localities. The Post Office claims that, like the telegraph and penny post, the telephone system should be uniform in its charges and regulations." We are unable to obtain any confirmation of this intelligence, but since the reasons mentioned conform to those publicly advanced on behalf of the Post Office, and, moreover, agree with public policy, we should not be surprised if the information proved to be correct. But where is Sheriff Jamieson's report?

CONTRACTS OPEN AND CLOSED.

OPEN.

Ashton-under-Lyne.—February 2nd. The Baths Committee want tenders for the installation of the necessary wires and fittings for the electric lighting of the Corporation Baths. Consulting engineers, Messrs. Lacey, Clirehugh & Sillar. See our "Official Notices" last week for particulars.

Bilbao.—February 28th. The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Consul at Bilbao, reporting that the provisional board appointed in connection with the electric tramway which it is proposed to lay from Zumarraga to Zumaya, in the province of Guipuzcoa, invite plans and tenders, to be received by February 28th, for the construction and equipment of the line. Further particulars of the conditions of the tenders for the above-named tram line and branch, which together measure 30 miles, may be inspected at the Commercial Department of the Foreign Office any day between the hours of 11 and 6.

Bedford.—January 24th. The Corporation want tenders for the supply and delivery of vulcanised rubber cables. See our "Official Notices" January 7th.

Belgium.—February 11th. The Provincial Government Authorities in Brussels are inviting tenders for an installation of electric lighting in the offices of the Governor of Brabant in the Rue de Chêne, Brussels. Tenders to be sent to the Gouvernement Provincial, Brussels.

Berlin.—March 15th. The Municipal Traffic Deputation of the Town Council have opened a competition for the construction of several new electric tramways in that city. Exhaustive details concerning this project are contained in the *Elektrotechnische Zeitschrift* of the 13th inst., which mentions that proposals will be received by the Stadtische Verkehrsdeputation Rathhaus III, Berlin, by March 15th.

Blackburn.—January 22nd. The Corporation want tenders for a 500-kw. continuous current steam dynamo, and a 120-kw. steam alternator. Consulting engineer, Mr. E. M. Lacey. See our "Official Notices" January 7th.

Bradford.—February 1st. The Corporation is inviting tenders for the electrical equipment of about nine miles of street tramways. There are three contracts for the following sections:—(1) steel poles, bracket arms, &c.; (2) trolley wire, insulators and overhead equipment; (3) cars, trucks, motors and trolley poles. Particulars from the city surveyor or the city electrical engineer at the Town Hall.

Brighton.—January 31st. The Town Council want tenders for dynamos, motors, switchboards and wiring for the electric lighting of the Municipal School of Science and Technology. Specifications from the town clerk's office.

France.—January 22nd. The Municipal Authorities of Neuilly-sur-Seine are inviting tenders for the concession for the establishment and working of a central electric station in the town. Particulars from, and tenders to, La Mairie de Neuilly-sur Seine.

France.—March 31st. Tenders are being invited by the Municipal Authorities of Saint Chamond (Loire) for the concession for the lighting of the public streets of the town, either by gas or electricity. Particulars from, and tenders to be sent to, La Mairie de Saint Chamond (Loire).

Germany.—January 29th. The Hanover Direction of the Prussian State Railways is inviting tenders until the 29th inst. for the supply of 39,000 porcelain insulators, 1,000 screw supports, 300 tons of galvanised wire and about 2¾ tons of insulated wire. Particulars from, and tenders to, Die Königliche Eisenbahn Direction, Hanover.

Leicester.—January 31st. The Leicester Corporation invites designs and tender for motor vehicles for the collection of house refuse. Specifications and particulars, with drawings, to be sent to the Chairman of the Sanitary Committee, to the office of Mr. E. Geo. Mawbey, C.E., borough engineer, Town Hall, Leicester.

Newport.—January 24th. The Electricity Committee want tenders for the supply and erection of mains, transformers, switch gear, cast-iron posts and for arc lamps. Consulting engineer, Mr. Robert Hammond. See our "Official Notices" January 7th.

Newport.—January 25th. The Corporation want tenders for temporary electric lighting plant for the Wentwood Waterworks, for arc and incandescent lighting. See our "Official Notices" January 14th.

Rochdale.—February 19th. The Corporation want tenders for steam dynamos, balancer, and boosters, &c. Engineers, Messrs. Lacey, Clirehugh & Sillar. See our "Official Notices" January 14th.

Roumania.—March 15th. Tenders are being invited by the General Direction of the Roumanian Post and Telegraphs in Bucharest for the supply of 56,000 metres of galvanised iron and steel wire.

Spain.—February 1st. Tenders are being invited by the Municipal Authorities of Tarifa (Cadiz province) for the 20 years' concession for the lighting of the public streets of the town by electricity, acetylene or gas. Tenders to El Secretario del Ayuntamiento de Tarifa (Cadiz) from whom particulars may be obtained.

Spain.—February 8th. Tenders are being invited until February 8th by the Municipal Authorities of Tordesillas, a small town in the province of Valladolid, for the concession for the electric lighting of the public streets during a period of 20 years. Particulars may be obtained from, and tenders should be sent to, El Secretario del Ayuntamiento de Tordesillas (Valladolid).

Stockport.—January 27th. The Corporation is wanting tenders for various plant and machinery for electricity supply works at Millgate, Stockport, including Lancashire boilers, steam dynamos, feed water heater, storage battery, electrical instruments, electrical connections, wiring, &c., at the generating stations, underground cables. Electrical engineer, Mr. James N. Shoolbred, 47, Victoria Street, S.W. See our "Official Notices" January 14th.

Wimbledon.—February 2nd. The District Council wants tenders for the supply, delivery and erection of water tube boilers, condensing plant, overhead crane, high speed steam engine and alternator, switchboard, underground mains, conduits, &c. Consulting engineer, Mr. A. H. Preece. See our "Official Notices" January 14th for particulars.

CLOSED.

Barrow.—The minutes of the Electric Lighting Committee, which were adopted by the Council the week before last, contained recommendations to accept the following tenders, which had been reported upon by Mr. Manville, for the electricity supply undertaking:—

Buildings.—W. W. Fairbairn	£8,386
Section A.—Babcock & Wilcox	5,050
" B.—Brush Electrical Engineering Company	9,332
" C and D.—British Insulated Wire Company	(schedule prices)

These tenders have accordingly been accepted.

Derby.—The Council has accepted the tender of Messrs. S. Z. de Ferranti, Limited, for engine and dynamo at £7,132 10s. Several hundred yards of cable has been ordered for extensions at a cost of £132 14s.

France.—A contract for the construction and working of an electric tramway between Angoulême and Ruelle (Charente) has been secured by the French Thomson-Houston Company.

Leith.—By four votes to three the Town Council has given the contract for the supply and erection of steam dynamos, &c., for the electric lighting of the burgh for the sum of £8,844 to the India-Rubber, Gutta-Percha and Telegraph Works Company.

London.—From the list of tenders submitted to the Metropolitan Asylums Board for the alteration and extension of the electric fire alarm system at the South Eastern Hospital, that of the Private Wire and Telephone Installation Company at £122 10s. was selected for acceptance. The highest tender was £387 10s.!

London.—The tender of Messrs. Bergtheil & Young has been accepted for the electric wiring of the extensions of the Guildhall School of Music.

FORTHCOMING EVENTS.

1898.

Friday, January 21st, at 5 p.m.—Physical Society, at the rooms of the Chemical Society, Burlington House. Agenda:—(1) "On Electric Signalling without Conducting Wires," by Prof. O. Lodge, F.R.S.; (2) A Tesla Oscillator will be exhibited by Prof. S. P. Thompson, F.R.S.

At 8 p.m.—Institution of Junior Engineers, at the Westminster Palace Hotel. Lecture on "Laboratory Testing Machines, and the Latest Example," by Prof. A. C. Elliott, M.Inst.C.E., Hon.M.Inst.J.E., of Cardiff.

Saturday, January 22nd, at 3 p.m.—Institution of Junior Engineers—Visit to the Engineering Laboratory of the Central Technical College, South Kensington. Demonstrations by Prof. W. C. Unwin, F.R.S., Past Pres. Inst.J.E.

Latest date for receipt of Blackburn Corporation tenders.

Monday, January 24th.—Latest date for Newport and Bedford tenders.

At 8 p.m.—Northern Society of Electrical Engineers. Palatine Hotel, Hunt's Bank, Manchester. Paper by Mr. W. P. Adams on "The Cost of Heating and Cooking by Electricity."

Thursday, January 27th.—Latest date for Stockport tenders.

At 8 p.m.—The Institution of Electrical Engineers "Notes on the Electro-Chemical Treatment of Ores containing the Precious Metals." By Major-General Webber, C.B. (ret. R.E.), Past President.

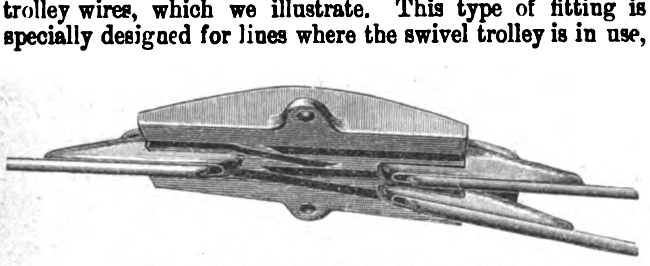
Friday, January 28th, at 8 p.m.—The Institution of Civil engineers. Students' meeting. Paper to be read on "Condensing Apparatus," by H. Williams, Stud.Inst.C.E.

NOTES.

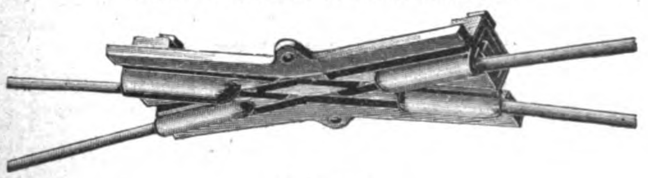
The Damage Due to the Strike.—The Board of Trade returns for December show a falling off, as compared with the same month of 1896, on steam engines from £313,069 to £188,809, and in other machinery from £1,207,930 to £909,339, or a total for the month of £422,851. On making the same calculation for the year, one-half of which was occupied by the strike, the total falling off comes to £732,165, made up of a drop on steam engines from £3,286,353 to £3,040,073, and in other machinery from £13,727,897 to £13,242,012. The total for the year is not double that of December, which month we may set down as merely showing an accidentally large reduction. Obviously the figures for the whole year are safer guides. As there have been other causes than the strike to operate unfavourably during the past year, it may be considered that the strike has, in six months, reduced the exports about £750,000. If one-fifth of this amount would count as profit, and if the wages paid amount to five times the profit, then the loss in wages is just £750,000. The employers have lost £150,000 on this basis, and the men have lost the three-quarters of a million and spent their reserve funds. In six months the falling off has been about 6 per cent. of the year's total, or at the rate of 12 per cent. of six months' output. The figures are bad enough, it is true, but they are not hopeless. Every week is increasing the productive capacity of the fresh hands as well as their number, and the prospects are that, strike or no strike, the present year will show that amalgamated engineers, as such, are not necessary to the employers. No man can be of much use to himself, his country, or his family, for an indefinite period, who orders his goings, or allows others to so order them, in direct contravention of the laws of nature, of common sense, or of common honesty.

Enclosed Arc Lamps.—Mr. W. H. Freedman concludes an article on this subject in the *American Electrician* as follows:—Besides direct-current enclosed arcs, there are now on the market several makes of alternating enclosed arcs. These have the advantage over the open that the energy employed at the arc may be a higher percentage of the total energy supplied than in the direct. They, however, work best at one particular frequency, which might be in some cases a serious objection. In general, the enclosed arc lamp as compared with the open has the following advantages:—Long life, and consequent saving of carbon, trimming expenses and annoyance from frequent renewals; pleasant light, free from hissing and spluttering, and with very little flickering; absence from flying dust and sparks, and fireproof qualities resulting from the use of two globes; being run on the incandescent circuit, there is no danger from high potentials, and no need of an automatic cut-out; simplicity of mechanism, and, consequently, less need of repairs. Ability to instal only one lamp and not necessarily two. Against the above are, however, to be balanced the disadvantages of lower efficiency, and decrease of light with the time of running.

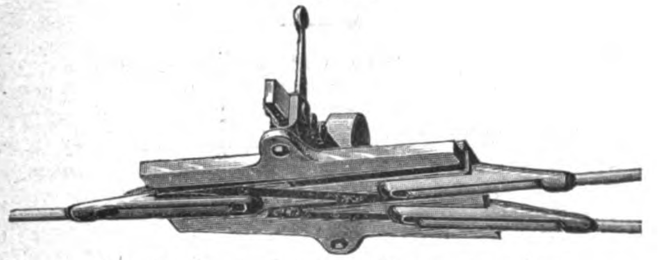
Overhead Wire Construction.—Mr. W. Wood, engineer-in-charge of the Bristol electric tramways, has devised an improved frog, crossing and movable point for overhead trolley wires, which we illustrate. This type of fitting is specially designed for lines where the swivel trolley is in use,



FROG: TWO LINES RUNNING INTO ONE.



CROSSING.



MOVABLE POINT: ONE LINE RUNNING INTO TWO.

the Bristol line being completely equipped with them. The chief feature about the device is, that after the trolley leaves the wire it is guided across the plate by a groove which fits the external diameter of the trolley wheel, and makes a positive path.

Institution of Mechanical Engineers.—The annual general meeting of this institution will be held on Thursday evening, February 10th, and Friday evening, February 11th, at 7.30 p.m., at 25, Great George Street, Westminster. The annual report of the council will be presented to the meeting on Thursday. The retiring president, E. Windsor Richards, Esq., will induct into the chair the president elect, Samuel W. Johnson, Esq. The adjourned discussion will be resumed on the Thursday evening upon the following paper read at the last meeting:—"Mechanical Features of Electric Traction," by Mr. Philip Dawson. Among the papers which will be read and discussed, is "First Report to the Gas Engine Research Committee: Description of Apparatus and Methods, and Preliminary Results," by Prof. Frederic W. Burstall, of Birmingham.

Munro & Jamieson's Pocket-Book of Electrical Rules and Tables.—We are pleased to learn that a 13th edition of this indispensable electrical engineers' pocket-book has been called for, but we hope that the authors and publishers may see their way to reduce its bulk, which has been gradually assuming undue corpulent proportions. We are sure that the authors would appreciate the advice and suggestions of any of our readers as to where they should omit old matter, and where they can, with advantage, insert new data.

Webb Testimonial Fund.—It is intended to make the presentation at a subscription dinner to be given to Mr. and Mrs. Webb by contributors to the Testimonial Fund, on Monday, February 14th, at the Whitehall Rooms of the Hotel Metropole. Tickets may be had from the hon. secretary of the fund, Mr. Henry Edmunds, 39, Victoria Street, Westminster, S.W., the price of single tickets being £1 1s.; and that of double tickets (for a lady and gentleman) being 36s.

Electrical Units.—A Bill is about to be introduced in the German Reichstag concerning electrical units of measurement.

Polyphased Armature Windings.—In another column will be found the first part of an interesting article by Mr. J. P. Stone (*American Electrician*) on the windings of polyphase armatures, which should go far toward dispelling the idea held by many that such windings are especially intricate. As will be seen, says our contemporary in an editorial note, the Y-winding consists merely of two ordinary alternator windings in the case of two-phased machines, or three such windings in the case of three-phased machines. Two-phased windings are entirely disconnected on the armature, an analogy to such a machine, therefore, being two simple alternating-current machines with their shafts rigidly connected, and corresponding wires displaced with reference to the poles, by half the distance between poles. A similar analogy to a Y-wound three-phased machine would be three simple alternators with their shafts rigidly connected, with corresponding wires displaced a third of the distance between poles, and with three collector rings—one ring of each of the three pairs of rings—connected together. The delta winding is merely the usual direct-current winding, tapped at four equidistant points for two-phased working, or at three equidistant points for three-phased working. As pointed out by Mr. Stone, the selection of either type of winding for polyphased machines is merely a matter of convenience. Where a neutral wire is to be run from a three-phased machine, the Y-winding must be used, the neutral running from a fourth collector ring being connected to the common point of the three windings. Such a neutral will supply three additional circuits of a lower voltage than that of the main circuits; that is, if the voltage between the neutral wire and the three main wires is 1,000, the voltage between the three mains will be 1,732. By placing three rings on the commutator of any direct-current machine, the rings being electrically connected to three equidistant bars, the machine will be a three-phased, delta-wound alternator, so far as generating alternating current is concerned.

Storage Battery Traction in Chicago.—The Englewood and Chicago Electric Street Railway Company has been actually in operation exclusively by storage batteries for slightly more than one year, and its cars have just completed 400,000 miles of service. This road, says the *Street Railway Journal*, was built in the most solid and substantial manner expressly for storage battery work. Late in 1896, a few cars from the Madison Avenue (New York City) line were put in service, but it was not until January 1st, 1897, that the first lot of new cars, built expressly for the road, commenced running. This number was increased as rapidly as possible, and last summer, on the heaviest days, 20 30-foot motor-cars, each with a trailer, have been required. The company owns 44 sets of batteries, and up to the present time these batteries have averaged nearly 9,500 miles of service each, the maximum being about 13,500 miles. So far, says our contemporary, there is no perceptible depreciation of the plates, and to all appearances they have yet a long lease of life. Nothing has been spent on maintenance account. The receiver, G. Herbert Condict, states that the entire operating expenses of the road in 1897 amount to but 8 cents per car mile, or 8½ cents including the expenses of the receivership. This is an extraordinarily low figure, even for a trolley line, and one which has never hitherto been approached in storage battery work. The cars run about 200 miles each per day, which is responsible for the low cost per car mile of "car service" labour. Mr. Condict, who is most fair and conservative in his statements, is unwilling as yet to say positively that storage battery traction is on this road cheaper than the overhead system would be, but says that if the batteries, which, as before stated, are apparently in as good a condition as when first installed, will last for 8,000 to 10,000 miles more, a distinct economy in comparison with the overhead system would be shown.

Obituary.—We regret to hear of the death of Mr. Wm. Patterson, of the City Wire Works, Walkergate, Newcastle-on-Tyne, whose change of address we notified last week. Mr. Patterson's death occurred on 11th inst. The business will be continued by Mrs. Patterson, under the management of Mr. Scott.

Lectures.—A course of 12 lectures is to be given at Honiton on "Magnetism and Electricity," under the auspices of the Devon County Council, by Mr. F. Brett.

Royal Institution.—Prof. J. A. Fleming is to deliver a series of five afternoon lectures on "Recent Researches in Magnetism and Diamagnetism" in March, as follows:—Thursday, March 3rd, "Ferro-magnetism;" March 10th, "Para-magnetism;" March 17th, "Diamagnetism;" March 24th, "Thermo-magnetism;" March 31st, "Magnetic Theories."

Appointment Vacant.—The Barrow-in-Furness Corporation are advertising for a resident electrical engineer at £200 per annum, to take charge of the electric light undertaking. See our "Official Notices" for particulars.

The Royal Society.—Among the papers down for reading yesterday afternoon were:—Prof. W. Ramsay, F.R.S., and Morris W. Travers, on (1) "The Homogeneity of Helium;" (2) "Fergusonite, an Endothermic Mineral." T. Preston, "On the Modifications of the Spectra of Iron and Other Substances radiating in a Strong Magnetic Field."

Marriage.—On January 11th, Mr. Tom Hesketh was married to Miss Fanny T. Dewhurst at Christ Church, Southport. Mr. Hesketh was, until very recently, assistant electrical engineer at the Hampstead Electricity Works.

Paper.—Before the Newcastle Students' Association of the Institution of Civil Engineers, a paper was read on 12th inst., at the Durham College of Science by Mr. John F. C. Snell, on "The Advantages of Direct Current Supply from Central Stations."

Such is Life!—"It may be that not to know Mr. Yorke, electrical engineer, of Glasgow, argues oneself unknown, but I must plead guilty to not having heard of the gentleman a week ago." So writes the editor of a contemporary who usually implies that what he doesn't know is not worth knowing. And yet the columns of the Electrical Review have for some years past testified to the existence of Mr. Yorke.

Electric Launches.—Mr. Justus Eck writes as follows respecting our recent note on "Electric Launch for the Czar of Russia":—"It may interest you to know that at the same time an order was placed in America for the above, another was placed in this country with Messrs. Kerby Bowen, Limited, and that this is now being built in the Isle of Wight, under the supervision of the Naval Attaché of the Russian Embassy in London. Many new ideas are being incorporated in this launch, but those responsible for the same do not intend to point out their advantages till they have been approved by practical experience. This order probably followed from the construction by the above company of successful launches for German, French and Austrian steamship and armament companies, and private (and sometimes Royal) individuals, not to speak of British customers. It will be of interest, when the time arrives, to compare the relative advantages of the launches, one all American, and the other all English manufacture."

CITY NOTES.

The Yorkshire House-to-House Electricity Company, Limited.

We have more than once congratulated the admirably managed Leeds Company upon the smartness with which it issues its annual report. Not only do we again compliment the managers upon the celerity with which they have presented the statement of affairs to the proprietors, but we must also draw attention to the extremely low cost of production which has marked the conduct of the business. We thought that Mr. Dickinson did something very noteworthy last year when he showed the cost per unit to be 1·65d., but that figure has now been decreased by ·23d., the total cost per unit during 1897 being 1·42d. and the works' cost 1·02d. The following are the chief points in the directors' report:—

"The profit for the year, after transferring £2,300 to the depreciation fund account, amounts to £10,703 1s. 11d., to which is to be added the sum of £392 12s. 2d. brought forward from the previous year, making a total of £11,095 14s. 1d., which the directors propose shall be appropriated as follows:—

To reserve fund account		£3,000 0 0
" Payment of interim dividend at the rate of 5 per cent. per annum on the amount called and paid up on the ordinary shares of the company, for the half-year ending June 30th, 1897	£2,624 8 1	
" Payment of a dividend on the amount called and paid up on the same shares, which, with the interim dividend previously paid, will equal a dividend at the rate of 6 per cent. per annum for the year ending December 31st, 1897 ...	4,142 3 7	
		6,766 11 8
" Balance to carry forward to next account		1,329 2 5
		£11,095 14 1

"The company's works and plant have been maintained in a thoroughly efficient state of repair.

"The number of lamps connected to the mains, which, on December 31st, 1896, was equivalent to 39,396 35-watt lamps, had increased by December 31st, 1897, to 49,150 such lamps.

"In accordance with the resolution passed at the last general meeting, 18,948 ordinary shares were, on February 2nd, 1897, offered at par to the then existing members of the company, and 18,626 shares were applied for and allotted. The directors carefully considered the suggestion made at the same meeting in favour of extinguishing the founders' shares in the company, but came to the conclusion that it is not yet practicable to effect such an operation.

"The company's new buildings are practically completed, and contracts have been made during the year for additional engines and alternators of a total capacity of 1,500 indicated horse-power (or 900 kilowatts). The greater portion of this plant is expected to be ready for use in a few weeks, and the remainder during the coming summer.

"A large expenditure has been incurred in the provision of improved means of distributing electrical energy in the central parts of the City. The mains have been considerably extended in the direction of Kirkstall, and an extension will shortly be made in Meadow Road.

"A reduction in the charge for electrical energy has been made, taking effect on January 1st, 1898, the maximum price having been reduced from 6d. to 5d. per unit. The charge previously made for connecting premises has been abolished, except in cases where the wires have to be carried exceptional distances, and the minimum charge of 13s. 4d. per quarter for current (authorised by the company's provisional order) is not now enforced. These modifications will represent a future total concession of several thousands of pounds per annum, but the directors decided upon them in the expectation of a compensating additional consumption.

"The Leeds Corporation have in contemplation the purchase of the company's undertaking."

The following table gives the cost per unit:—

	1897.	1896.
Total capital expended	£131,992	£105,377
Number of units sold	833,280	701,409
Number of lamps connected	49,150	39,396
Revenue from sale of current	£16,262	£14,728
Net revenue	£10,754	£7,475
Average price obtained per unit	—	—

Cost of production.	£		Per unit.	1896.
Coal	876		·25d.	·29d.
Oil, waste, water and engine room stores	184		·05d.	·07d.
Salaries and wages at generating station	2,041		·59d.	·66d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	444	Works' cost 1·02d.	·13d.	·22d.
Rent, Rates and taxes	—		—	—
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	1,406		·40d.	·41d.
Depreciation of buildings and plant account	—		—	—
Renewal fund account	—		—	—
Total	£4,951		1·42d.	1·65d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current .. .. Meter rents, &c.	17,127	0	0	—
Supply of steam	—			—
Transfer fees	—			—
Total	£17,127	0	0	

Total cost per unit (exclusive of depreciation and renewal accounts), 1·42d.; works' cost, 1·02d.

The Dividends for 1897.

Although so short a time has elapsed since the close of the year, announcements of dividends are already being made. One has for a considerable time looked upon the St. James' and Westminster in the nature of gilt-edged securities, and this view receives ample confirmation from the dividends just declared.

The following list gives the dividends announced, with the corresponding ones for the previous three years:—

London.	1897.	1896.	1895.	1894.
St. James' and Pall Mall	14½	10½	7½	6½
Westminster	12	9	7	5
Provincial.				
Yorkshire House-to-House Company...	6	6	5	4

The St. James' and Pall Mall Electric Light Company, Limited.

At an extraordinary general meeting of this company held at Carnaby Street, Golden Square, London, W., on Tuesday, the following resolutions were considered and adopted:—"That the agreement bearing date the 16th day of December, 1897, and made between the company of the first part, the parties whose names are subscribed in the first column of the schedule thereto being the registered holders of the 100 founders' shares of £1 each in the company of the second part, and Eustace James Anthony Balfour and Josiah Latimer Clark of the third part, be, and the same is hereby approved, and that the directors be and they are hereby authorised to carry the same into effect. That the capital of the company be increased to £300,000 by the creation of 20,000 new ordinary shares of £5 each, and that, notwithstanding the provisions of article 4 of the articles of association, 12,000 of such 20,000 new ordinary shares of £5 each be issued at par to the registered holders of the 100 founders' shares of £1 in the company as provided by the said agreement of the 16th day of December, 1897. That the directors be and they are hereby authorised to issue to any registered holder of a founders' share at any time hereafter not more than 120 new ordinary shares of £5 each at par upon such founders' shareholder transferring each founders' share of which he is the registered holder to Eustace James Anthony Balfour and Josiah Latimer Clark as trustees for the company, notwithstanding that the said agreement of the 16th day of December, 1897, may not have been executed by the holders of the whole of the said 100 founders' shares within the three months provided by clause 5 thereof."

The Direct United States Cable Company, Limited.

The report of the directors for the six months ended December 31st, 1897, to be presented at the forty-first ordinary general meeting of the company, to be held at Winchester House on Tuesday, January 25th, 1898, at 2 o'clock p.m., states that the usual statements of account for the half-year ended December 31st, 1897, are submitted herewith. The half-year's revenue, after deducting out-payments, amounted to £50,098 2s. 8d., as compared with £47,601 2s. 1d. for the corresponding period of 1896, showing a difference of £2,497 0s. 7d. in favour of the half-year under review. The working and other expenses for the same period, including income-tax, but exclusive of cost of renewal and repairs of cable, amounted to £19,722 13s. 10d, leaving a balance of £30,375 8s. 10d. as the net profit, making, with £3,927 13s. 4d. brought forward from the previous half-year, a total of £34,303 2s. 2d. For the corresponding period of 1896 the working expenses and other payments amounted to £19,815 13s. 6d. Interim dividends of 3s. per share for the quarter ended September 30th, 1897 (paid October 26th, 1897), and of 3s. per share for the quarter ended December 31st, 1897 (payable January 29th, 1898), together amounting to £18,213, have been declared, and after setting aside £12,000 to the reserve fund account, the balance of £4,090 2s. 2d. on the revenue account has been carried forward. The reserve fund account has been debited with £8,325 0s. 11d. for cost of cable and repairs, and with £2,000 written off the Ballinskelligs Buildings account, and after being credited with interest on investments, and sum transferred from revenue account, the balance of the reserve fund now amounts to £345,767 17s. 9d.

Blackpool and Fleetwood Tramroad Company.

An extraordinary meeting of the shareholders of this company was held last week in Association Chambers, Manchester, to authorise the promotion in Parliament of a Bill to give the company powers to construct tramways in Blackpool. Mr. George Richardson presided. It is proposed to construct a double line from Regent Terrace along the Carriage Drive, authorised by the Blackpool Improvement Act, 1893; a single line from Queen Square to the Carriage Drive, and a single line from Dickson Road to Queen Street. But it was explained to the meeting that it would not be necessary to construct these lines if the company obtained, as they hoped to do, running powers over the lines of the Blackpool Corporation. The company propose to take powers to raise £75,000 of additional capital. If it becomes necessary to issue new shares these will be offered at par to the present shareholders.

The Chairman, in moving the adoption of a resolution approving of the Bill, said the line to Fleetwood was being rapidly pushed forward, and would probably be open for traffic by May 1st.

The resolution was adopted.

The Eastern Telegraph Company.

The half-yearly meeting of this company was held at Winchester House yesterday. The Marquis of Tweedale presided, and referred to the increase in the revenue and the working expenses. The Cape traffic had fallen off, but that had been more than counterbalanced by an increase in the Indian traffic, due to the disturbances on the frontiers. After referring to the improvements made in the system from time to time, the report was adopted.

An extraordinary meeting was subsequently held for approving the conversion of the existing preference shares.

Stock Exchange Settlements.—Applications have been made to the Stock Exchange Committee (1) to appoint a special settling day in, and to grant a quotation to: Bournemouth and Poole Electricity Supply Company, Limited—6,000 4½ per cent. cumulative preference shares, and 6,000 ordinary shares; County of London and Brush Provincial and Electric Lighting Company, Limited—further issue of 10,000 ordinary shares; Direct West India Cable Company, Limited—12,000 shares; (2) to appoint a special settling day in Cape Electric Tramways, Limited—285,157 vendors' £1 shares, fully paid, Nos. 1 to 285,157; and (3) to allow the following securities to be quoted in the Official List: Barcelona Tramways Company, Limited—further issue of 5,072 ordinary shares, Nos. 14,929 to 20,000; Direct West India Cable Company, Limited—£120,000 4½ per cent. registered debentures; Halifax and Bermudas Cable Company, Limited—5,000 shares, Nos. 1 to 5,000, and £103,500 4½ per cent. first mortgage debentures. Also to appoint a special settling day in, and to grant a quotation to:—West Coast of America Telegraph Company, Limited—30,008 shares of £2 10s. each, and £150,000 4 per cent. debentures, in lieu of the shares and debentures of the old company of the same name now quoted; and to allow the following securities to be quoted in the Official List:—Commercial Cable Company—Further issue of £264,711 sterling 4 per cent. 500-year debenture stock.

City and South London Railway Company.—The accounts for the half-year ended December 31st show a balance, after providing for the debenture interest and the full dividend on the 5 per cent. preference shares, sufficient to allow the payment of a dividend on the consolidated ordinary stock at the rate of 1¾ per cent. per annum, carrying forward a balance of £1,511 to the new account. The dividend for the corresponding period last year was at the rate of 1¾ per cent. per annum, the balance carried forward being £1,314.

City of London Electric Lighting Company.—All outstanding forms of application (with the banker's receipt for the payment upon application which is attached thereto), and all certificates for fifths of a share of the issue of 10,000 ordinary shares, November, 1897 (Nos. 90,001 to 100,000), must be lodged with the company on or before 31st inst., otherwise the same will be liable to to cancellation or forfeiture at the discretion of the board.

The Eastern Extension, Australasia and China Telegraph Company, Limited.—This company notifies that the interest on the 4 per cent. mortgage debenture stock for the half-year ended 31st inst. will be paid by warrant on February 1st next. The stock register will be closed from the 27th to the 31st inst., both days inclusive.

Westminster Electric Supply Corporation.—During the past week this company has offered 3½ per cent. debentures to the extent of £200,000 for subscription. They were issued at par, redeemable in March, 1920, at par. We learn from the financial press that the issue was subscribed four times over.

The St. James' and Pall Mall Electric Light Company, Limited.—The Directors recommend a dividend for half-year ending December 31st of 11s. per share on the ordinary shares, making, with the interim dividend, 14½ per cent. for the year 1897.

Electric Construction Company.—The transfer books for the ordinary shares will be closed from 18th to 31st inst. inclusive, for the payment of the second half of the dividend of 6 per cent. per annum declared on July 22nd last.

The Globe Telegraph and Trust Company.—The directors announce an interim dividend of 1s. 9d. per share on the ordinary shares.

Oldham, Ashton and Hyde Electric Tramway.—The letters of allotment have been posted.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending January 16th, 1898, were £1,085; week ending January 17th, 1897, £1,085; total receipts for half-year, 1898, £3,259; corresponding period, 1897, £3,278; decrease, £14.

The Liverpool Overhead Railway Company. The receipts for the week ending January 16th, 1898, amounted to £1,361; corresponding week last year, £1,278; increase, £83.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending January 14th, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,240.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, Jan. 12th.	Closing Quotation, Jan. 19th.	Business done during week ended Jan. 19th, 1898. Highest.	Lowest.
137,400l	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	...	...	100 —104	100 104	...	...
25,800	Amazon Telegraph, Limited, shares...	10	...	...	...	6 — 7	6 — 7	...	...
125,000	Do. do. 5% Debs. Red.	100	...	...	...	... — ...	93 — 96	...	...
923,960l	Anglo-American Teleg., Ltd.	Stock	£2 9s.	£2 13s.	...	61 — 63	61 — 63	61¾	...
3,038,020l	Do. do. 6 % Pref.	Stock	£4 18s.	£5 6s.	...	111 - 112	111 - 112	112	111¼
3,038,020l	Do. do. Defd.	Stock	...	...	...	13½ — 14	13½ — 14	13 11/16	13½
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	...	...	16¼ — 16¾	16¼ — 16¾	16¾	16⅝
75,000l	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	...	...	112 —116	112 —116	...	...
44,000	Chili Teleph., Ltd., Nos. 1 to 44,000	5	4 %	4 %	...	3 — 3½	3 — 3½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	...	182 —187	185 —190	190	...
653,586l	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	105 —107	105 —107	107	105⅞
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	2 %	...	1/16 — 3/16	1/16 — 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	...	8 — 9	8 — 9	9	...
6,000	Do. 10 % Pref.	10	10 %	10 %	...	18 — 19	18 — 19	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	...	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	...	10 — 11	10 — 11	...	...
30,000l	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	...	102 —105%	103 —106%	...	...
60,710	Direct United States Cable, Ltd.	20	2½%	2½%	...	10½ — 11	10¼ — 10¾xd	10¾	10⅝
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	...	17½ — 17¾	17¾ - 18¼xd	18 1/16	17⅝
70,000	Do. 6 % Cum. Pref.	10	6	6%	...	18 — 19	18½ — 19½xd	18¾	18½
89,900l	Do. 5 % Debs., repay. August, 1899	100	5 %	5%	...	102 —105	102 —105	...	...
1,302,615l	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4%	...	130 —133	131 —134	133½	131½
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7%	...	18½ — 19	18¾ — 19¼xd	19⅛	18½
25,200l	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,826	100	5 %	5%	...	99 —103	99 —103	101	...
100,500l	Do. do. Bearer, 1,050—3,975 and 4,827—6,400	100	5 %	5%	...	100 —103	100 —103	...	...
320,000l	Do. 4 % Deb. Stock	Stock	4 %	4%	...	132 —135	132 —135	134	...
51,100l	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5%	...	99 —103	99 —103	...	...
69,200l	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5%	...	100 —103	100 —103	...	...
300,000l	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4%	...	103 —106	104 —107	...	...
200,000l	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4%	...	108 —111%	108 —111 %	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	...	11¾ - 12¼	11¾ — 12¼	12⅛	11⅞
180,042	Do. do. 6 % Pref.	10	6 %	6%	...	17¾ - 18¼	17¾ — 18¼	18⅛	17⅞
150,000	Great Northern Teleg. Company of Copenhagen	10	10 %	10%	...	25½ - 26½	27 — 28	26⅞	...
160,000l	Do. do. do. 5 % Debs.	100	5 %	5%	...	101 —104	101 —104	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10%	...	52 — 55	52 — 55	53⅞	...
100,000l	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6%	...	107 —110	108 —111	109½	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	...	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5½%	5½%	...	6½ — 6¾	6⅝ — 6⅞	6⅞	6 11/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	15 — 17	15 — 17	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	14 — 16	14 — 16	15 11/16	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	...	6 — 6½	6 — 6½	6⅜	...
130,766	Do. do. Nos. 119,235 to 250,000, £5 paid	5	...	...	...	5¾ — 6¼	6 — 6½	...	...
329,471l	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	...	102 —107	102 —107 xd	105½	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	9/16 — 11/16	⅝ - ¾	11/16	...
100,000l	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	...	105 - 108	105 —108	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	7½ - 8½	7½ - 8½	8⅜	8
3,381	Submarine Cables Trust	Cert.	...	...	...	136 - 141	138 143	143	142½
58,000	United River Plate Teleph., Ltd.	5	4 %	...	...	4 — 4½	4 — 4½	4 5/16	...
146,733l	Do. do. 5 % Debs.	Stock	5 %	...	...	101 —106	101 —106	103¾	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	nil	...	4 — 5	4 — 5	...	...
213,400l	Do. do. do. 5 % Debs.	100	5 %	5 %	...	103 —106	103 - 106	...	...
64,268	Western and Brazilian Teleg., Ltd.	15	3 %	2 %	...	9¾ - 10¼	9¾ - 10¼	9¾	...
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	...	7½ — 7¾	7½ — 8	7 11/16	7⅝
33,129	Do. do. do. Def. Ord.	7½	1 %	...	...	2¾ - 3¼	2¾ — 3¼	...	...
382,230	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	104 —107	104 —107	105	...
88,321	West India and Panama Teleg., Ltd.	10	⅞%	1 %	...	⅜ - ⅝	⅜ - ⅝	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	7¼ - 7¾	7 — 7½	7½	7¼
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	5 — 7	5 — 7	...	...
80,000l	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	...	105 —108	105 —108	...	...
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7%	...	105 - 110	105 —110	...	...
160,100l	Do. do. 6 % Ster. Bonds.	100	6 %	6%	...	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	1895.	1896.	1897.	Closing Quotation, Jan. 12th.	Closing Quotation, Jan. 19th.	Highest.	Lowest.
30,000	Charing Cross and Strand Electy. Supply	5	5 %	6 %	...	12½ — 13½	12½ — 13½	13½	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6¼ - 6¾	6¼ — 6¾	6 7/16	...
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	...	10½ — 11	10½ — 11	10⅞	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	4½%	4½%	...	112 —114	112 —114	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	7 %	...	26 — 27	27½ - 28½	28	26⅞
10,000	Do. do. Prov. Certs.	5	...	...	...	25½ — 26½	27 — 28	25½	...
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	...	17 — 18	17 — 18	17⅝	17½
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	...	129 —134	129 —134	...	...
30,000	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—30,000	10	*nil*	*nil*	...	13¾ - 14¼	13¾ — 14¼	14¼	14
20,000	Do. do. do. 6% Pref., 40,001—60,000 ...	10	6 %	6 %	...	15½ — 16	15½ — 16	15 15/16	15⅞
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5	...	...	...	9 — 10	9 — 10	9½	...
10,000	Do. do. 7 % Cum. Pref. ...	5	...	...	...	11 — 11½	11 — 11½	11¼	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	4 %	5 %	...	18½ — 19½	18 — 19	18 15/16	18⅜
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem. ...	10	...	...	...	18 — 19	18 — 19	18⅜	...
220,000	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	117 — 121	117 —121	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	2 %	4 %	...	17½ - 18½	17½ — 18½	...	...
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,000	5	7½%	10½%	14½ %	17 — 18	17½ — 18½	18	17½
20,000	Do. do. 7 % Pref., 20,001 to 40,000	5	7 %	7 %	...	10 — 11	10 — 11	10¾	10⅝
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	...	101 —104	101 —104	...	...
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2⅝ — 2⅞	2⅞ — 3⅛	3 1/16	2 13/16
79,900	Westminster Electric Supply Corp., Ord., 101 to 80,000 ...	5	7 %	9 %	12 %	16 — 17	16 — 17	16⅞	16 7/16

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, Jan. 12th.	Closing Quotation, Jan. 19th.	Business done during week ended Jan. 19th, 1898. Highest	Lowest
30,000	British Electric Traction	10	...	...	...	17½ — 18	17½ — 18	17⅞	17½
90,000	Brush Elect. Enging. Co., Ord., 1 to 90,000...	2	...	...	...	1⅞ — 2⅛	2 - 2¼	2⅛	2 1/16
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	...	...	2⅛ — 2⅜	2¼ — 2½	2⅜	2¼
125,000*l*	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	...	...	...	109 — 113	109 - 113	112	...
50,000	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	100 — 103	102 — 105	102½	...
19,196	Central London Railway, Ord. Shares	10	...	...	...	9¾ — 10¼	9¾ — 10¼	10⅛	9⅞
143,106	Do. do. do. £6 paid	10	...	...	...	5¾ — 6	5½ — 6	5 13/16	5⅝
58,830	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1½ — 1⅝	1½ — 1⅝	...	...
61,777	Do. do. Def. do. £5 pd. ...	...	...	...	...	4 — 4½	4 — 4½	4⅜	...
630,000*l*	City and South London Railway	Stock	1 3/16 %	1 9/16 %	1⅞ §	69 — 71	69 — 71	70	69½
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	nil	...	...	2 — 2½	2 — 2½	...	...
99,261	{ Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 99,261 }	5	5 %	5½%	...	2½ — 3	2½ — 3	...	...
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5½%	...	4½ — 5½	4½ - 5½	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	5 %	6 %	...	2⅝ - 2⅞	2⅝ - 2⅞	2 13/16	2 11/16
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 ...	2	7 %	7 %	...	3⅛ - 3⅜	3⅛ 3⅜	3 5/16	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	...	...	...	½ - ¾	½ ¾	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	...	...	...	½ — ¾	½ ¾	...	...
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	10½%	...	...	9 — 11	9 — 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	8 %	10 %	...	21½ 21½	21 - 22	...	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	...	18½ - 19½	18½ - 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	...	110 — 115	110 115	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	...	23½ — 24½	23½ 24½	23⅞	23⅜
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	..	...	...	103 — 107	103 — 107	...	..
37,500	†Liverpool Overhead Railway, Ord.	10	2⅞%	2⅞%	...	11 7/16 - 11 9/16	11⅜ - 11½	...	...
18,000	† Do. do. Pref., £10 paid	10	5 %	5 %	...	16 — 16½	16 — 16½	..	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	15 %	...	36 — 39	38 — 41	41	...
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	...	101 — 104	102 — 105	102½	...
54,000*l*	Waterloo and City Railway, Nos. 1 to 54,000	10	...		...	12½ — 13	12½ — 13	12⅞	12 11/16

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0 %; 1891—7 %; 1890—8 %.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

* Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 11.

Electric Construction Corporation, 6 % Debentures, 105—106.

House-to-House Company, 4½% Debentures of £100, 108—110.

Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 15—15½; 1st Preference Cumulative 6 %, £5 (fully paid), 8½—8⅝. Dividend, 1896, on Ordinary Shares 7 %.

London Electric Supply Corporation, £5 Ordinary, 3—3½.

* T. Parker, Ltd., £10 (fully paid), 11⅝—12⅛.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8¼—8⅝. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount 3 per cent. (October 14th, 1897).

THE APPLICATION OF VECTOR ALGEBRA TO ALTERNATING CURRENTS.

By W. G. RHODES, M.Sc., Royal Technical Institute, Salford.

(*Concluded from page 56.*)

STATIONARY TRANSFORMER.

23. We will now apply the method to the study of a stationary transformer in which the reactances and mutual inductions may be considered constant.

Let the resistance of the primary circuit be r_1, its reactance s_1, and the primary current i_1, and let the corresponding quantities for the secondary circuit (internal and external), be r_2, s_2, and i_2, the mutual induction between the two circuits M; and the potential difference applied between the primary terminals, e.

Then, following the argument of Section 21, the vector equation of E.M.Fs. in the primary circuit is

$$r_1 i_1 + k s_1 i_1 + k p \text{M} i_2 = e. \qquad (28)$$

The E.M.F. in the secondary circuit due to mutual induction is $- k p \text{M} i_1$. This has to furnish a component, $r_2 i_2$, in phase with the secondary current to drive the current against the ohmic resistance of the circuit, and also a component, $k s_2 i_2$, to balance the E.M.F., $- k s_2 i_2$, due to the secondary reactance. We thus have the vector E.M.F. equation

$$r_2 i_2 + k s_2 i_2 = - k p \text{M} i_1,$$

or

$$r_2 i_2 + k s_2 i_2 + k p \text{M} i_1 = 0. \qquad (29)$$

Equations (28) and (29) are then the vector E.M.F. equations of the primary and secondary circuit respectively. Eliminating first i_2 and then i_1, we get

$$\{(r_1 r_2 - s_1 s_2 + p^2 \text{M}^2) + k (r_1 s_2 + r_2 s_1)\} i_1 = (r_2 + k s_2) e$$

and $$\{(r_1 r_2 - s_1 s_2 + p^2 \text{M}^2) + k (r_1 s_2 + r_2 s_1)\} i_2 = - k p \text{M} e$$

which may be written in the forms

$$[\{r_1 (r_2^2 + s_2^2) + p^2 r_2 \text{M}^2\} + k \{s_1 (r_2^2 + s_2^2) - p^2 s_2 \text{M}^2\}] i_1 = (r_2^2 + s_2^2) e \qquad (30)$$

and $$\{- (r_1 s_2 + r_2 s_1) + k (r_1 r_2 - s_1 s_2 + p^2 \text{M}^2)\} i_2 = p \text{M} e \qquad (31)$$

Hence the *magnitudes* of the primary and secondary currents are given by

$$\left.\begin{aligned} i_1 &= \frac{e}{\sqrt{\left\{ r_1^2 + s_1^2 + 2 p^2 \text{M}^2 \dfrac{(r_1 r_2 - s_1 s_2)}{r_2^2 + s_2^2} + \dfrac{p^4 \text{M}^4}{r_2^2 + s_2^2} \right\}}} \\ i_2 &= \frac{p \text{M} e}{\sqrt{\{(r_1^2 + s_1^2)(r_2^2 + s_2^2) + 2 p^2 \text{M}^2 (r_1 r_2 - s_1 s_2) + p^4 \text{M}^4\}}} \end{aligned}\right\} \qquad (32)$$

If R and S are the equivalent resistance and reactance of the primary circuit, we get at once from equation (30)

$$\left.\begin{aligned} \text{R} &= r_1 + \frac{p^2 r_2 \text{M}^2}{r_2^2 + s_2^2} \\ \text{and} \quad \text{S} &= s_1 - \frac{p^2 s_2 \text{M}^2}{r_2^2 + s_2^2} \end{aligned}\right\} \qquad (33)$$

From equation (30) we also see that the primary current lags behind the applied potential difference by an angle θ, where

$$\tan \theta = \frac{s_1 (r_2^2 + s_2^2) - p^2 s_2 \text{M}^2}{r_1 (r_2^2 + s_2^2) + p^2 r_2 \text{M}^2},$$

whence the current and applied potential difference are in phase if

$$s_1 s_2^2 - p^2 \text{M}^2 s_2 + s_1 r_2^2 = 0, \qquad (34)$$

that is, for a given primary reactance there are two values of the secondary reactance for which resonance may occur in the primary circuit, provided the roots of equation (34) are real, that is, if

$$p^2 \text{M}^2 > 2 s_1 r_2.$$

From equation (31) we see that the secondary current lags behind the primary potential difference by an angle $\pi - \phi$, where

$$\tan \phi = \frac{r_1 r_2 - s_1 s_2 + p^2 \text{M}^2}{r_1 s_2 + r_2 s_1}.$$

It is evident from this that the secondary current is in exact opposition to the primary applied potential difference if

$$r_1 r_2 - s_1 s_2 + p^2 \text{M}^2 = 0, \qquad (35)$$

and this condition is satisfied for one value only of s_2.

Moreover, conditions (34) and (35) cannot be satisfied simultaneously, since then we should also have

$$r_1 s_2 + r_2 s_1 = 0,$$

and the secondary current would be infinite, as is seen by reference to equation (31).

If condition (34) is satisfied we see from equation (30) that the primary current is given by

$$i_1 = \frac{e}{r_1 + \frac{s_1}{s_2} \cdot r_2} \qquad (36)$$

which shows that even if the primary current is in phase with the impressed potential difference, its value depends upon the resistance of the secondary circuit, and the ratio of the reactances of the two circuits, as well as upon the primary resistance.

Again, from equations (32) we have

$$\frac{i_1}{i_2} = \frac{\sqrt{r_2^2 + s_2^2}}{p\,M}.$$

If now the secondary resistance is negligible compared with its reactance, and if its reactance is due simply to its self-induction L_2, this becomes

$$\frac{i_1}{i_2} = \frac{L_2}{M}.$$

If, further, there is no leakage, so that $M^2 = L_1 L_2$, L_1 being the primary self-induction,

$$\frac{i_1}{i_2} = \sqrt{\frac{L_2}{L_1}}$$

$$= \frac{N_2}{N_1}$$

where N_1 and N_2 are the number of turns on the primary and secondary coils respectively.

24. As a last example we will consider the action of an induction motor.

The Induction Motor.*

A multiphase induction motor may be considered as a transformer with its secondary circuit free to rotate. The primary coils are wound round a stationary laminated iron framework, and are fed by two or more alternating currents differing in phase from each other, so as to produce a more or less uniform magnetic field rotating with a more or less uniform angular velocity. We shall here suppose that the magnetic field is uniform and that its angular velocity is uniform also.

The secondary circuit usually consists of a number of short-circuited conductors imbedded near the periphery of cylinder built up of thin circular discs of iron.

The stationary part of the motor is called the *stator*, and the rotating part the *rotor*. The currents in the stator produce a rotating magnetic field which induces currents in the rotor conductors, the effect being a tendency on the part of the rotor to follow the rotating field.

25. Suppose that each circuit in the stator consists of N_1 turns of wire, and each rotor circuit of N_2 turns, and let the resistance and reactance of each stator circuit be r_1 and s_1 respectively, and of each rotor circuit when at rest r_2 and s_2, and let the E.M.F. induced per turn in the stator coils be e.

If ω_1 and ω_2 are the angular velocities of the rotating field and rotor respectively, and the frequency of the current i_1 in a stator coil be n, then the frequency of the currents i_2 in the rotor coils will be

$$\frac{\omega_1 - \omega_2}{\omega_1} \cdot n$$

or, putting σ for $\frac{\omega_1 - \omega_2}{\omega_1}$,

the frequency of the rotor currents is $\sigma\, n$.

σ is frequently called the "slip."

(We will suppose that E.M.Fs. and currents have their root mean square values.)

It follows that the E.M.F. induced per turn in the rotor coils is $\sigma\, e$. The E.M.F. induced in each circuit of the rotor coils is therefore given by

$$E_2 = \sigma\, N_2\, e \qquad (37)$$

and the vector E.M.F. equation is

$$r_2\, i_2 + k\, \sigma\, s_2\, i_2 = \sigma\, N_2\, e$$

the reactance when in motion being $\sigma\, s_2$. Thus

$$i_2 = \frac{\sigma\, N_2\, e}{r_2 + k\, \sigma\, s_2}$$

$$= \frac{\sigma\, N_2\, e\,(r_2 - k\, \sigma\, s_2)}{r_2^2 + \sigma^2\, s_2^2} \qquad (38)$$

The power spent per circuit in heating the rotor is then the scalar product of (37) and (38), that is

$$\text{power wasted} = \frac{\sigma^2\, N_2^2\, e^2\, r_2}{r_2^2 + \sigma^2\, s_2^2} \qquad (39)$$

26. Again, the E.M.F. induced in each stator circuit due to the rotating field is given by

$$E_1 = N_1\, e. \qquad (40)$$

Also, the current i_1 in the stator consists of two parts, the function of one part, i_1', being to excite the stator and produce the rotating field, and that of the other part i_1'' to transmit energy to the rotor.

But $$i_1'' = -\frac{N_2}{N_1}\, i_2$$

$$= -\frac{\sigma\, N_2^2\, e\,(r_2 - k\, \sigma\, s_2)}{N_1\,(r_2^2 + \sigma^2\, s_2^2)} \;\ldots \text{(by equation (38))} \qquad (41)$$

The power transmitted per circuit to the rotor is, therefore, the scalar product of the vectors

$$-N_1\, e \text{ and } -\frac{\sigma\, N_2^2\, e\,(r_2 - k\, \sigma\, s_2)}{N_1\,(r_2^2 + \sigma^2\, s_2^2)},$$

that is,

$$\text{Power transmitted to rotor} = \frac{\sigma\, N_2^2\, e^2\, r_2}{r_2^2 + \sigma^2\, s_2^2}. \qquad (42)$$

The output, P, of the motor is then obtained by subtracting (39 from (42), that is

$$P = \frac{\sigma\, N_2^2\, e^2\, r_2}{r_2^2 + \sigma^2\, s_2^2} - \frac{\sigma^2\, N_2^2\, e^2 r_2}{r_2^2 + \sigma^2\, s_2^2}$$

$$= \frac{N_2^2\, e^2\, r_2\, \sigma\,(1 - \sigma)}{r_2^2 + \sigma^2\, s_2^2} \qquad (43)$$

27. To find the torque T exerted per circuit on the rotor, we must divide the output P by the angular velocity ω_2, but

$$\sigma = \frac{\omega_1 - \omega_2}{\omega_1},$$

therefore $$\omega_2 = \omega_1\,(1 - \sigma)$$

that is $$T = \frac{N_2^2\, e^2\, r^2\, \sigma}{\omega_1\,(r_2^2 + \sigma^2\, s_2^2)}. \qquad (44)$$

This expression gives the torque in terms of the slip, the resistance and reactance of the rotor coils, the E.M.F. developed per turn by the rotating field at full frequency, the number of turns per section on the rotor, and the angular velocity of the rotating field.

The relation between torque and slip is shown graphically in fig. 11.

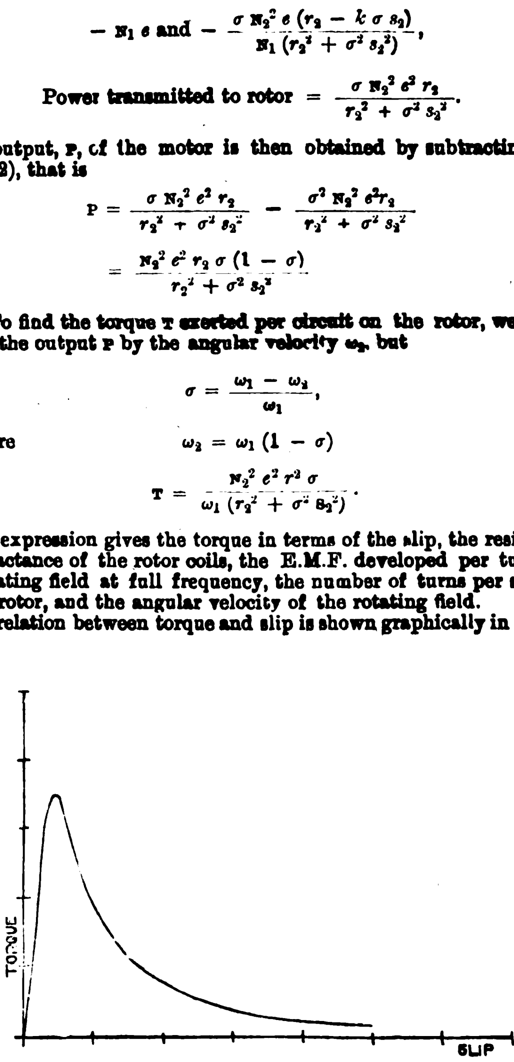


Fig. 11.

Equation (44) shows the starting torque is (putting $\sigma = 1$)

$$T_0 = \frac{N_2^2\, e^2\, r_2}{\omega_1\,(r_2^2 + s_2^2)},$$

which is greater the less the reactance of the rotor bars, and the less the angular velocity of the rotating field.

To give a large torque the E.M.F. induced per turn by the rotating field should be large, that is, the air-gap should be as small as possible and leakage should as far as possible be avoided.

The Monophase Induction Motor.

28. In the foregoing theory it has been assumed that the rotor bars are cut by a magnetic field rotating at a uniform velocity ω_1. So long that this condition is satisfied the number of independent currents in the stator does not affect the theoretical treatment of the problem. When, however, the stator is fed by one alternating current only, the conditions of the problem are altered. The resultant alternating field now preserves a constant direction relative to the stator. We can, however, regard this resultant field as compounded of two uniform magnetic fields rotating with equal angular velocities but in opposite directions round the stator.

29. Suppose, now, that the rotor is started in either direction by any means whatever and let the "slips" relative to the two rotating fields be σ_1 and σ_2 respectively, so that $\sigma_1 + \sigma_2 = 2$, and $\sigma_1\, \sigma_2 < 1$ (except at start when it equals unity).

If the rotor is started in the direction such that $\sigma_1 < 1$, it will, by (44) be subject to a torque

$$T_1 = \frac{N_2^2\, e^2\, r_2\, \sigma_1}{\omega_1\,(r_2^2 + \sigma_1^2\, s_2^2)}$$

tending to diminish σ_1, and a torque

$$T_2 = \frac{N_2^2\, e^2\, r_2\, \sigma_2}{\omega_1\,(r_2^2 + \sigma_2^2\, s_2^2)}$$

* See also "Theory of the General Alternating Current Transformer," by C. P. Steinmetz, *Transactions* American Institute Electrical Engineers, 12, pp. 351—365, 1897, and "Alternating Current Motors," by W. G. Rhodes, M.Sc., Electrical Review, Vol. 37, pp. 599-600, 1895, and Vol. 38, pp. 139—142, 1896.

tending to increase σ_1 and diminish σ_2. The resultant torque in the direction of σ_1 diminishing is

$$
\begin{aligned}
T_1 - T_2 &= \frac{N_2^2 e^2 r^2}{\omega_1} \left\{ \frac{\sigma_1}{r_2^2 + \sigma_1^2 s_2^2} - \frac{\sigma_2}{r_2^2 + \sigma_2^2 s_2^2} \right\} \\
&= \frac{N_2^2 e^2 r_2}{\omega_1} \; \frac{(\sigma_2 - \sigma_1)\,(\sigma_1 \sigma_2 s_2^2 - r_2^2)}{(r_2^2 + \sigma_1^2 s_2^2)\,(r_2^2 + \sigma_2^2 s_2^2)}. \qquad (45)
\end{aligned}
$$

30. Equations (44) and (45) bring out clearly the difference between the actions of multiphase and monophase induction motors. A multiphase motor will run up to synchronism with the rotating field before the torque vanishes, and its value is a maximum for variations of σ when $r_2^2 - \sigma^2 s_2^2 = 0$. In a monophase motor, however, the torque is zero when $\sigma_2 = \sigma_1$ (at start), and again when

$$\sigma_1 \sigma_2 s_2^2 - r_2^2 = 0,$$

that is, when

$$\sigma_1 \sigma_2 = \left(\frac{r_2}{s_2}\right)^2,$$

or

$$\sqrt{\sigma_1 \sigma_2} = \frac{r_2}{s_2} \qquad (46)$$

which shows that every monophase induction motor has, for a given frequency of the current, a speed peculiar to itself beyond which it cannot go, and this speed is determined by the ratio of the resistance to the reactance of the rotor windings.

Equation (45) also shows that unless s_2 is greater than r_2, the motor will not run at all, because the product $\sigma_1 \sigma_2$ being necessarily less than unity in whichever direction the motor is started, there would be a torque in the opposite direction.

31. Whereas, then, the multiphase motor can possibly approach to synchronous running with the rotating magnetic field, if the load were made sufficiently small, a monophase induction can never go beyond the limit set (see (46)) by its own resistance and reactance, and will thus, under the most favourable conditions, have a speed less than that corresponding to synchronism with the supply current.

32. With regard to the representation of root mean square (R M S) values by vectors, and interpreting results deduced from vector equations as if the quantities represented R M S values, we can only say that it is often convenient to take R M S instead of maximum values, more especially since for most purposes we can take any periodic E.M.F. or current curve and proceed to make calculations as if the actual curve was replaced by a simple harmonic curve having the same periodic time and the same R M S value, and if we give to a vector a magnitude to represent the R M S value, and a suitable phase positions, we shall accurately interpret any results involving only *scalar products*.

33. The simplicity of vector calculations in alternating current problems and the ease with which the method may be taught to students whose mathematical knowledge is of an elementary nature renders the teaching of a difficult subject much less laborious; and we think that the sooner young electricians know that much may be learnt of the theory of alternating currents without a previous arduous mathematical training, the sooner will a greater interest be aroused in what is perhaps the most fascinating branch of physical science.

34. In conclusion I may add that the foregoing theory, most of which is not elsewhere obtainable, may be understood by any reader possessing only a knowledge of a little trigonometry and of algebra up to quadratic equations, on taking for granted Propositions 1, 2, and 3 of Section 9. These, together with Sections 6 and 7, are the keynotes of the whole method which I have applied to a few of the more prominent problems of alternating currents. When these are thoroughly understood, it should be an easy matter to adapt the method to most problems which may arise.

Corrigendum.

I regret that there is an algebraical error in Section 22 (second article). As the slip affects the final result I have completely rewritten that section. My thanks are due to Mr. Alexander Russell, M.A., for very kindly drawing my attention to the error in a private letter.

22. In this case the vector equations to be solved are

$$
\left.\begin{aligned}
(r_1 + k s_1)\, i_1 + k p M_{12}\, i_2 &= e \\
k p M_{21}\, i_1 + (r_2 + k s_2)\, i_2 &= e \\
\text{and} \qquad i &= i_1 + i_2
\end{aligned}\right\} \qquad (23)
$$

whence, on putting $M_{12} = M_{21} = M$

$$
\left.\begin{aligned}
\{r_1 r_2 - s_1 s_2 + p^2 M^2 + k (r_1 s_2 + r_2 s_1)\}\, i_1 &= \{r_2 + k (s_2 - p M)\}\, e \\
\{r_1 r_2 - s_1 s_2 + p^2 M^2 + k (r_1 s_2 + r_2 s_1)\}\, i_2 &= \{r_1 + k (s_1 - p M)\}\, e
\end{aligned}\right\}
$$

Putting for shortness

$$
\left.\begin{aligned}
r_1 r_2 - s_1 s_2 + p^2 M^2 &= P \\
\text{and} \qquad r_1 s_2 + r_2 s_1 &= Q
\end{aligned}\right\}
$$

these equations become

$$
\left.\begin{aligned}
(P + k Q)\, i_1 &= \{r_2 + k (s_2 - p M)\}\, e \\
(P + k Q)\, i_2 &= \{r_1 + k (s_1 - p M)\}\, e
\end{aligned}\right\} \qquad (23a)
$$

which by multiplying both sides of the equations by $P - k Q$, and simplifying, may be written

$$
\left.\begin{aligned}
(P^2 + Q^2)\, i_1 &= [P r_2 + Q (s_2 - p M) + k \{P (s_2 - p M) - r_2 Q\}]\, e \\
(P^2 + Q^2)\, i_2 &= [P r_1 + Q (s_1 - p M) + k \{P (s_1 - p M) - r_1 Q\}]\, e
\end{aligned}\right\} (24)
$$

These are the vector current equations giving the components of i_1 and i_2 along and at right angles to e. By addition we have

$$
\left.\begin{aligned}
&(P^2 + Q^2)\, i = \\
&\quad [P (r_1 + r_2) + Q (s_1 + s_2 - 2 p M) + k \{P (s_1 + s_2 - 2 p M) - Q (r_1 + r_2)\}]\, e
\end{aligned}\right\} (25)
$$

which gives the components of the main current along and at right angles to e; thus the component in phase with e is

$$\frac{P (r_1 + r_2) + Q (s_1 + s_2 - 2 p M)}{P^2 + Q^2} \cdot e,$$

and the component at right angles to e, or the wattless component, as it is called, is

$$\frac{P (s_1 + s_2 - 2 p M) - Q (r_1 + r_2)}{P^2 + Q^2} \cdot e.$$

Multiplying and dividing the right-hand side of equation (25) by

$$P (r_1 + r_2) + Q (s_1 + s_2 - 2 p M) - k \{P (s_1 + s_2 - 2 p M) - Q (r_1 + r_2)\},$$

we get, after some reductions,

$$i = \frac{\{(r_1 + r_2)^2 + (s_1 + s_2 - 2 p M)^2\}\, e}{P (r_1 + r_2) + Q (s_1 + s_2 - 2 p M) - k \{P (s_1 + s_2 - 2 p M) - Q (r_1 + r_2)\}},$$

which shows that the equivalent resistance, R, and reactance, S, of the parallel circuit are given by

$$
\left.\begin{aligned}
R &= \frac{P (r_1 + r_2) + Q (s_1 + s_2 - 2 p M)}{(r_1 + r_2)^2 + (s_1 + s_2 - 2 p M)^2} \\
- S &= \frac{P (s_1 + s_2 - 2 p M) - Q (r_1 + r_2)}{(r_1 + r_2)^2 + (s_1 + s_2 - 2 p M)^2}
\end{aligned}\right\} \qquad (26)
$$

and the equivalent impedance, I, is given by

$$
\begin{aligned}
I^2 &= R^2 + S^2 \\
&= \frac{P^2 + Q^2}{(r_1 + r_2)^2 + (s_1 + s_2 - 2 p M)^2},
\end{aligned}
$$

or, putting in the values of P and Q,

$$
\left.\begin{aligned}
R &= \frac{(r_1 + r_2)(r_1 r_2 - s_1 s_2 + p^2 M^2) + (s_1 + s_2 - 2 p M)(r_1 s_2 + r_2 s_1)}{(r_1 + r_2)^2 + (s_1 + s_2 - 2 p M)^2} \\
- S &= \frac{(s_1 + s_2 - 2 p M)(r_1 r_2 - s_1 s_2 + p^2 M^2) - (r_1 + r_2)(r_1 s_2 + r_2 s_1)}{(r_1 + r_2)^2 + (s_1 + s_2 - 2 p M)^2} \\
I^2 &= \frac{(r_1 r_2 - s_1 s_2 + p^2 M^2)^2 + (r_1 s_2 + r_2 s_1)^2}{(r_1 + r_2)^2 + (s_1 + s_2 - 2 p M)^2}.
\end{aligned}\right\} (27)
$$

AMBROIN.

[COMMUNICATED.]

Among the various insulating materials which, besides ebonite, vulcasbest, porcelain, and slate, have from time to time made their appearance, ambroin is well worth consideration by electrical engineers, and during the short period of its existence the many advantages it presents to the electrical industry, have caused it to be highly appreciated by all who, from practical experience, are in a position to judge.

Ambroin is composed of fossil copal and silicates, and the silicates are saturated and mixed with the copal by a patent process in such a manner that, after being subjected to a very great pressure, an exceedingly strong, firm, uniform, and non-hygroscopic material is produced. By varying the proportions of the component parts a number of qualities, to meet all possible requirements that can be demanded of an insulator, are manufactured, and, for example, the fireproof quality contains only a sufficient quantity of copal to ensure the adhesion of the mass and to destroy the water-absorbing capacity of the silicates.

A short summary of the qualities of ambroin may be of interest.

After being subjected to pressure ambroin does not undergo any variation in volume, and, in consequence, the most complicated pieces can be very accurately moulded. This is of special importance where the insulation consists of several parts, as all the parts are interchangeable, and portions which are particularly subjected to wear can be easily replaced. Screws can be moulded in ambroin and do not require any further cutting to ensure accuracy.

Ambroin, even in the open air, does not absorb moisture, in which it differs from most other materials, and this not only greatly increases its value as an insulator, but there is no danger of the destruction of the insulation owing to the water taken up freezing in the winter. To illustrate the relative amount of water absorbed by various materials we give the following comparison. Pieces of equal size and with a smooth surface were taken, and after being immersed in water at 75° C. for $1\frac{1}{2}$ hours the increase in weight was:—

1. Ambroin	0 32 per cent.
2. "Aetna" material (the surface became rough)	3 17 „
3. Stabilit	1·41 „
4. Vulcasbest	4·80 „
5. Vulcanised fibre	24 5 „

Dielectric strength according to tests of the Reichsanstalt, Berlin:—

(1) A dry sheet 0·34 mm. thick was *not* pierced with 5,000 volts.

(2) A sheet 5 mm. thick, after lying in a room containing 40 per cent. moisture, was *not* pierced with 36,000 volts.

The *insulation resistance* of dishes 3 mm. thick with 200 volts:—

(1) Without preparation was 200,000 megohms.

(2) The dish was half filled with sulphuric acid, 26° Bé, covered up and subjected to a temperature of 49° C. for 10 days. After a superficial drying with blotting paper the resistance was the day following 150,000 megohms, and two days later 200,000 megohms.

In view of the great importance of mechanical strength in an insulating material, especially when used for traction work, a comparison between ambroin and other substances should prove instructive. For the purpose of the compression tests 1-in. cubes of ambroin and ebonite were taken, which presented a surface of 1 sq. in. to the pressure.

At normal temperature the destruction of the ambroin cube took place under a load of 2,688 lbs., and of the ebonite cube under a load of 3,196 lbs.

At 60° C. the ambroin cube withstood the pressure up to 1,958 lbs., while the destruction of the ebonite cube begins under a very small load.

To test the *tensile strength*, rods of equal dimensions were taken, and at normal temperature the breaking strain was:—

For ebonite...	1,088 lbs. per sq. in.
" aetna material	1,350 " "
" ambroin	2,082 " "

At 60° C. ebonite stretched extensively, while the tensile strength of ambroin is even greater than at ordinary temperature.

The ordinary quality of ambroin does not begin to burn until subjected to a temperature of 400° C., while the special quality, made for switchboards, &c., withstands the hottest zone of a bunsen flame (1,700° C.) for some considerable time, and this quality can, therefore, be used in all cases where, owing to short circuits, sparking causes a momentary great heat. Of other materials, ebonite and celluloid soften in water at a temperature of 70° C., celluloid burns readily at 110° C., ebonite at 180° C. and stabilit cracks when subjected to heat.

Ambroin, quality S, withstands the action of sulphuric acid, 45° Bé., up to a temperature of 80° C. and of concentrated hydrochloric acid, and this quality is well adapted for battery boxes, while a special quality which is not attacked by alkalio or chlorine is made for electro-chemical purposes.

Ambroin does not contain sulphur or any other oxidising substances.

The uses to which ambroin may be put include the insulating parts of dynamos, electromotors, and transformers, as Brush insulators, commutator rings, transformer bobbins, &c., also accumulator boxes, while plates for resistances and switchboards, either with contact studs complete or with holes moulded in to screw down the contact pieces, deserve special attention. Ambroin overhead insulators for tramways have been used on many of the principal lines on the Continent with satisfactory results, and it is particularly adapted for motor cars, in fuse boxes, spark arresters, switchboards, switches and controller insulation. For the last named a special quality is made, which combines high insulation with resistance against the action of sparking, and which is evenly and firmly pressed on to the controller axle.

REPAIRING A "BURNT-OUT" COMMUTATOR.*

By NORMAN H. CROWELL.

If the dynamo-tender understands his business and has suitable instruments at hand, it may be but a matter of a few minutes' time to discover the cause of a "breakdown" and set about its repair. If, however, he happens to be a good steam engineer, but a novice at the practice of the electrical art, and tends dynamo by "throwin' her in gear" and trusting to luck, he may as well sit calmly down and wait for reinforcements.

Under the supervision of a competent electrician, a serious breakdown is of rare occurrence. There can be little trouble with the machine with a firm foundation, steady power, tight screws, evenly ground brushes, and the constant application of a good big "rag" to the parts where dirt, grease and copper dust collect.

In the case in hand the dynamo had gone on for months grinding out its existence with no attention from the tender. He never knew whether the brushes bobbed, the commutator cut or sparked, or where to oil the journals. This state of things could not continue long without something giving way, and the lights suddenly winked out one night leaving Mr. Engineer "up a stump."

By the aid of a dim and flickery lantern we hastily inspected the dynamo, field-magnet, wall attachments, ground wire and even the friction clutch. As far as could be seen everything was tight and in order. Now we must roll up our sleeves and hunt for the "trouble." A small boy eagerly grasps the opportunity to turn the "magneter" handle while we poke around feeling for shocks, and we find a good many.

Everything is found all right until we test the exciter, and here we find a grave condition of things. By placing one wire against a segment of the commutator and the other firmly against the end of the armature shaft, we get a merry tinkle from the bells. By testing the segments one by one we discover that about every third one is in connection with the shaft. We have located the difficulty, and now proceed with the treatment.

We first remove the armature from its chamber, and by testing it again we prove our theory to be the right one. Then we make out a little list of articles needed and send the small boy away with it. The list reads as follows: Twenty pieces of heavy mica, 4 × 5 ins.; can of shellac and brush; strip of heavy duck cloth, 6 ins. wide; needle and saddler's thread.

While he is in quest of these things, we place the armature in the lathe to facilitate matters, and unscrew the burr that holds the cap over the ends of the commutator segments. Next, we remove the "cap," and the cause of the short-circuit is visible to the eye. In several spots the thick mica layers are charred through, and when we peel them off we find the copper has a "worm-eaten" appearance.

Take a flat file and cut through the band of wires about the armature head. If the cover is badly worn or torn, file both bands and take the cover off entirely, saving the eyes for use on the new cover. This exposes to view the 20 pairs of wires leading from the armature to the lugs of the segments. Now comes the delicate task of spreading the segments. It is delicate for the reason that they are worn to the thinness of an ordinary pasteboard and require careful handling. However, by pulling gently with the pincers they are lifted from their bed and the charred insulation is scraped and blown away.

At this point, we test the connections between the armature wires and the lugs and find them good. Now carefully inspect the insulation of the base-cap, and if you find it unimpaired, proceed to the laborious task of cutting the mica into strips.

These strips we make ½ inch wide, 4 inches long, and cut one end off at an angle of 45°. Care must be taken to keep the mica from flaking, otherwise you will be greatly hindered in the work to follow. After enough strips are cut, we lay them in a place convenient to our reach and turn our attention to the dismantled commutator. Make sure that no small pieces of insulation adhere to the segments, and then carefully return them to their original position. Slip a heavy rubber band over their base to keep them in their place.

Now we insert the shaft in a vice, with the commutator end uppermost, giving us the most convenient position for handling the ticklish job we now undertake. The next step is to put a strip of the mica between each segment and its fellow, making sure that the pointed end fits the V-shaped recess in the base-cap closely. Take a strip and swab it with shellac, then gently pry two segments apart and slip in the strip. The job increases in difficulty as it nears completion.

A small wooden mallet may be used to tap the strips down into place, and this is the place to exercise patience as long as possible.

Now, with the task half done, the mica strips stick out ¼ in. from the normal surface of the commutator, and should project at least an inch beyond the ends of the segments. The ends that thus project are now carefully clipped off close to the segments with a pair of sharp shears, care being taken to make good clean cuts. When this is done, drop the mica ring behind the strips to hold them from the shaft. Now take an extra thick and fine sheet of mica, and cut out a circular piece with a hole in the centre. This is to take the place of the old insulation on the "cap," and must fit accurately, and be thick and solid.

Fit this ring to the cap and put the cap on the shaft in position. Now start on the burr. Unless you have access to a special vice for holding the cap firm, it will be very liable to turn, thereby twisting the segments out of position and perhaps destroying the insulation. This must be avoided, but the burr must be set on so tightly that there will be no probability of its loosening, although the direction of the armature's rotation may tend to unscrew it, which is unfortunately the case with many machines.

* *American Electrician.*

With the cap and burr in place, we proceed to remove the superfluous mica that confronts us. This is done best with a very sharp knife point. When the most of it has been cut and pared away with the knife, take the file and finish it.

Now, if you have succeeded in getting the commutator round or approximately so, you may be assured that your job has been well done, but if it presents an oval shape or a very uneven surface, you will probably have the pleasure of going over the whole process again. If it is oval the brushes will bob and dance until the bulging part wears thin and caves in. If uneven, the chances are that it will not permit lathing, and you may have to loosen the burr and spend an hour adjusting it. The commutator should be so nearly circular that a small amount of light filing will complete it.

Having removed the rubber band, you are ready to put on the drum or canvas coating on the armature head. It is a good idea to have some one who is handy with tools attend to the making of a duplicate of the old cover, which is a simple matter, while you are engaged on the other work. Wrap the cover tightly around the head and sew with the saddler's thread. Put on a liberal coat of shellac. Then cut some long strips of medium thin mica to support the band wires. Next wrap some No. 16 (B. & S.) wire around the edge of the drum over the strips of mica at a strong tension. Make a band about ½-in. wide and solder in several places. Care must be taken that no part of the cover or solder bulges out so that it will touch the chamber when the armature is placed in position.

Now everything is completed, and you are ready to slip the armature back into its chamber, adjust the brushes and start up. It will take a minute for the magnet to pick up, but if you have been thorough in your work you will have the satisfaction of seeing the pointer begin to dance, and when you turn the handle, realise that you have saved your company time as well as expense.

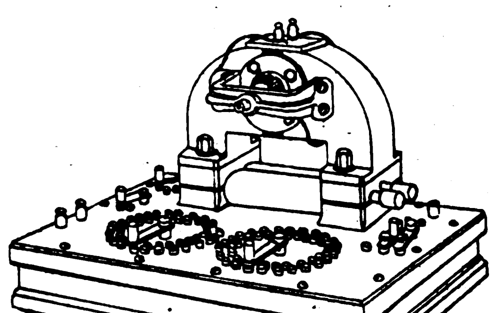
A MAGNETIC TESTING INSTRUMENT.

Messrs. R. B. Treat and S. W. Esterline, of Purdue University, Lafayette, Ind., have recently published a description of a piece of apparatus for testing samples of iron, which presents some features of interest, though no new principle of construction is involved. The general arrangement of the apparatus is shown in the figure. Two bars under comparison are clamped side by side, in holes turned to fit them, in heavy blocks of very soft iron. Round the bars are ebonite bobbins or spools, wound with copper wire, and a closely fitted slot-wound dynamo armature is run at a high known speed, presumably by a motor, in a gap between the blocks. The dynamo brushes are connected to a Weston voltmeter, so that only a very small current is taken from the armature, and the readings of the voltmeter are directly proportional to the flux through the armature.

The instrument can be used in two ways. In one the magnetising currents in the bobbins on the two bars may be adjusted, so that the fluxes in the two bars are equal, and opposite in direction. When this is the case, there will be no flux through the revolving armature, and the voltmeter will show no difference of potential between the brushes. If one bar, whose magnetic properties are previously ascertained, be used as a standard of reference, and the magnetising force of the current round it carried through any range, then by continually adjusting the magnetising force acting on the other bar, so as to give no deflection on the voltmeter, a continuous comparison between the properties of the two bars is obtained.

Another way of using the instrument is to remove one bar, and use the revolving armature and voltmeter to measure the flux through the iron circuit, as the magnetising force on the bar is continuously varied. By these means the hysteresis cycle of the specimen, or its B.H. curve, can be determined.

The dimensions of the test bars are 10 inches long, 4 π cm. between the yokes, and ·575 inch in diameter. The bobbins on the test bars are wound with 100 turns of wire, capable of carrying 10 amperes, giving a possible magnetising power of 1,000 ampere-turns. The two coils are connected in series, and switches are arranged by which the number of active turns on the two bobbins can be varied. In any case the ratio between the number of ampere-turns on the two bars is equal to the number of active turns. The number of turns on the bobbin round the bar which is intended to be used as a standard of reference, may be either 50, 75, or 100, while the number on the other bar may be anything from 1 to 100. The two switches seen in front of the magnetic parts change the number of turns on one magnetising coil, and are arranged to insert an equivalent resistance as each turn is cut out, so as to keep the resistance of the circuit unaltered. The armature has 7,000 turns, laid in 40 slots, and is driven at 4,000 revolutions per minute. With a flux density of 17,000 lines per square cm. through one bar, an E.M.F. of 90 volts is said to be generated, but this figure



seems to be inconsistent with the other data. The existence of one line of magnetic flux across the armature is said to be readily detected. The reluctance of the air-gaps at the dynamo armature is small, owing to the close fitting, and the areas of the clamped joints are 32 times the section of the bar.

An instrument of this kind, in which the magnetic flux through a bar can be continuously varied and measured on a direct reading instrument, offers great convenience in comparison with the method of obtaining the flux as the sum of a number of small increments measured separately by the throws of a ballistic galvanometer. The design is however, open to obvious objections. For instance, the method of changing the magnetic force in the bar by cutting out turns may be objected to on the ground that the distribution of force is varied as well as its total intensity, a defect that would not occur if the current were reduced or increased. Again, the behaviour of a bar kept in a state of tremor by the vibration of an armature would be different from its behaviour when unshaken. But for the use of engineers such objections are readily overbalanced by considerations of convenience, and we have no doubt from its description that the apparatus might be exceedingly valuable. A good deal of information about the arrangements for clamping the test bars, and other points of detail, is given in an article in the *Electrical World* of New York, December 11th, 1897, to which we may refer our readers.

THE TELEGRAPH TROUBLES.

The Clerks' Point of View.

By CHAS. H. GARLAND.

The case of the telegraph clerks has suffered in the past, because of the difficulties besetting a clear statement of their position. Documents have been prepared which have been summarised by the newspapers of the country, and garbled in the summary. Members of Parliament, unacquainted with the technicalities of Government employment, have attempted, with the most laudable intentions, to explain the complaints to the House of Commons. The result has been a misunderstanding. Public functionaries and trade-union officials have always failed to grasp the peculiar *milieu* of a civil servant and his limitations; and the class papers are read only by the class affected. Again, considerable public attention is attracted only during periods of great excitement, and newspapers, eager for exclusive news of a sensational character, have over-emphasised or mis-stated minor points, to the utter exclusion of the more important issues. The association of last year's movement, with a strike against the performance of overtime, reasonable or unreasonable, is an instance of how far misconception and misrepresentation can go. The main point in dispute was the violation of certain rights in the matter of promotion. I therefore welcome the opportunity afforded me by the editors of the ELECTRICAL REVIEW to summarise our point of view on the principal claims of the postal telegraph clerks.

There are certain general principles underlying the whole of our movement which are, from time to time, attacked by the representatives of the Department, and the organs that range themselves on their side. As agreement with these principles is the necessary presupposition of any sympathy with our claims, it would perhaps be well to deal with them before attacking these details. A criticism of our opponents will make our position clear.

It is seriously contended that, provided the salary and prospects remain the same as they were some 16 years ago, the staff should be content there being no ground for complaint. It will be my aim to prove that in the case of a large section of postal employés the prospects have actually deteriorated during the past 16 years, but meanwhile I will draw attention to this principle of departmental economy, and offer a few reasons against it. It is neatly stated in a letter from Sir S. Walpole to a Mr. Newton, dated August 31st, 1897: "The prospect of obtaining £190 a year to which reference was made in the Civil Service Commissioners' Circular issued between 1880 and 1891 . . . . still remains, and as the proportion of superior appointments, including senior telegraphists, in the number, to the total number of the staff is almost exactly the same as it was at the date of Mr. Fawcett's revision (1881) whatever prospect a young man had at that time of obtaining promotion to the higher classes he enjoys now." This argument may be called the justification of standing still, and is entirely opposed to any desire for progress. The other general objections to our movement have been stated in various quarters, notably by Mr. Lewin Hill (assistant secretary G.P.C.) in his evidence before the Tweedmouth Committee on March 23rd, 1896. The same views have been crudely summarised by the *Times* so recently as December 29th, 1897, and are tersely expressed in all their native ugliness in the following sentences from a leader of that date:—"It may be suggested to them (the telegraph clerks) that they still possess the right to resign positions which do not suit them. The Government has no difficulty whatever in finding plenty of candidates for vacancies, and so long as that is the case it has no occasion to raise its terms. It is not difficult to become a telegraph clerk of average utility, and there are any number of people quite ready to accept the present conditions of service." These arguments may be described as the right to resign, which, in the case of old clerks, is also the right to starve, and the right of the State to "sweat."

Let us look, first, at the justification for standing still. The Government should be, "in the first flight of employers," a Cabinet Minister said in the House of Commons. Mr. Arnold Morley, when Postmaster-General, declared that the State should be "the model employer." If the Government is to set the example to other employers, should it stand still in the midst of a general progression? Yet this is what it has done, if it has left the pay and prospects of its employés identically the same as in 1881. Take a rapid glance at two recently published reports of the labour department of the Board of Trade. The report of Mr. Burnett, the chief labour correspondent, upon the strikes and lock-outs of 1896, shows that for several years there has been a notable upward tendency of wages. The Fourth Annual Report of the Board of Trade (1896-7) shows conclusively that while the hours of work are on the decrease, there is a distinct increase in the wages paid. A few figures from the latter document will clearly illustrate this. Taking the class described as "Employés of public authorities" as illustrating the general tendency, and approximating somewhat in terms of service to the civil servant, we find that the "average amount of decrease in weekly hours of labour (per head of those affected") is stated as follows:—

1893.	1894.	1895.	1896.
4·49	4·02	5·32	2·65

During the same period, the "net effect of changes on weekly wages [(+) = increase (−) = decrease]" is given for the same class in the following figures:—

Amount per head of those affected:

1893.	1894.	1895.	1896.
+ 1·6¾	+ 1·5¾	+ 1·7½	+ 1·2¼

We will suppose that the pay and prospect offered after the revision of 1881 were based upon some consideration of the market value of the work at that period, and we will bear in mind that the market value of the work is affected by the standard of living of the class performing the work. This standard of living may be raised, and it is a commonplace of economics that the luxuries of one generation become the necessaries of another. Again, the cost of maintaining an equal standard of living may be increased by a rise in price of the necessaries of life. The latter eventuality has undoubtedly happened in London. The cost of living has increased. To take only one important factor. The average rise of London rent (on unaltered buildings) since 1870 has been £304,634 per annum, or 1·08 per cent. on the average valuation. The homes of Londoners have been driven farther and farther from the centre by the increase in the commercial importance of the City; the hours have been lengthened by the railway journey, and the cost of living has been increased by the daily railway fare. To take only this one instance of the increase in cost, without discussing the large increase in the cost of meat and other things, we see that even if the standard of living had remained the same as in 1881, the relative value of the pay and prospects offered to telegraph clerks has decreased. Meanwhile, however, it has been the constant endeavour of public organisations to raise the standard of living of all classes by the multiplication of educational and other facilities. Undoubtedly these efforts have been crowned with some measure of success. Leaving aside the question of whether the pay and prospects of telegraph clerks have retrograded, it is obvious that for a Government to plume itself on being a model employer because it has stood still during 16 years of progress is a sheer absurdity. If telegraph clerks ask that better pay and prospects should now be given than were offered in 1881 they are merely pressing the Government to move with the times and take its proper place among "the first flight of employers."

The "right to resign" is offered to those who, under pressure of changing environment, feel that the conditions of service are not what they should be. By the time a boy has become a good telegraph clerk, despite the *Times*, he has spent a sufficient period in the service to be too old for commencing in another profession. His whole training has been directed to fitting him for the keen competitive examination which he has to pass, and has consequently unfitted him for any other employment. At 16 years he enters the Post Office full of hope, but with all the irresponsibility of youth. He is little troubled with prospects. He fondly thinks they are assured. Youth is essentially unreflective, and it is not till he has passed some four or five years in postal service, and has left the parental nest, that he begins to realise his cruel disillusionment. Then he is offered the right to resign; and then he feels he cannot accept it. On the principle that half a loaf is better than none, he hangs on, and by means of overtime and careful management, perhaps succeeds in getting through the years that divide him from a salary he can live on. With only the prospect of throwing himself on an overcrowded labour market, having spent the best years of his life in acquiring a trade of which the Post Office has a monopoly, he feels he cannot use the "right to resign," which is so freely offered to him. So there are relatively few resignations. But he has another right. He has the right possessed by all citizens to look to the Government not to exploit his weakness, and to call upon the State to become, in reality, the "model employer." Where any prospect of placing his special knowledge is opened up, the Government employé is quick to take advantage of it. The *Cables Recorder*, a Valparaiso paper, of May, 1895, said, speaking of the staff of the Commercial Cable Company:—"The company's success can be attributed not a little to the splendid working staff who are chiefly from the British Postal Telegraph Service." This may be said of all the cable companies.

Really one can hardly accept the supposition that because relatively few telegraph clerks resign, a veritable Utopia must exist in the Postal Telegraph Service.

The other contention is that, so long as clerks can be obtained at the present salaries, there is no need to raise the terms. By a parity of reasoning, it might be contended that because women working upon the making of match boxes for over 100 hours per week could be obtained for a wage of 4s. weekly, there was no need to raise the terms. Or because London seamstresses can be induced to starve on a wage of 12s. for a week of 70 hours, they are well paid. Because 150 persons apply for a post as foreign correspondent at 30s. a week, does it prove that 30s. is an adequate remuneration? This is commonly known as the sweater's argument. It was while such unenlightened principles guided the commercial world, that the "Song of the Shirt" was written. It is against such principles that all recent labour legislation has been directed, and against the application of such principles to State employment, it is the duty of all Englishmen to fight.

I thought it well before entering on the more detailed exposition of our claims, to deal with these general principles. Telegraph clerks feel that the Government should indeed be among the first flight of employers, and one of the duties of intelligent Government should be to keep its own servants abreast of the times. That they have not retrograded in 16 years, whilst all the rest of the world has progressed, is not a cause for satisfaction, self-congratulation, or pride. That they have not progressed is rather a cause for shame. To fall back on the effete principles of an inhuman political economy to justify parsimony, is unworthy of a model employer. The duty of the State is rather to show an example of humane dealing to even its most insignificant employé, and thus constitute itself a model which other employers can copy, to the benefit of justice, humanity and progress.

(*To be continued.*)

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1898.

[*Compiled expressly for this journal by* W. P. THOMPSON & Co., *Electrical Patent Agents*, 322, *High Holborn, London, W.C., to whom all inquiries should be addressed.*]

16. "Improvements in the manufacture of diaphragms for electrolysis." J. W. TOWERS. Dated January 1st.

26. "An improved construction of and method and means of laying underground electrical cables or conductors." T. F. J. TRUSS. Dated January 1st.

45. "Electric switch apparatus for railways to enable train to receive currents from signal station when in contact with its electric current conductor (especially useful during fog)." W. T. BRAIN. Dated January 1st.

58. "Improvements in rail joints for electric railways." M. BARSCHALL. Dated January 1st.

67. "An improvement in holders for electric glow lamps." H. C. GOVER, C. F. PROCTOR and W. G. PIPKIN. Dated January 1st. (*Complete.*)

80. "Improvement in electrical advertising devices." G. A. LESIEUR. Dated January 1st.

121. "Improvements in electric meters." E. BATAULT. Dated January 3rd.

122. "Improvements for separating stable or other salts and generating electricity." D. F. SINCLAIR. Dated January 3rd.

124. "Supporting electric accumulators for electric traction purposes and the like." K. BOWEN. Dated January 3rd.

125. "Speed regulating switch for electric traction." K. BOWEN. Dated January 3rd. (*Complete.*)

143. "Improvements in electric arc lamps." W. J. DAVY and G. T. DAVIES. Dated January 3rd.

148. "An improved electric terminal." L. RIDOUT. Dated January 3rd.

156. "Improvements in the method of fixing and suspending bare electric conductors." A. B. BLACKBURN and N. H. WHITE. Dated January 3rd.

166. "Improvements in dynamo-electric machines." C. B. CRAWSHAW and C. W. HILL. Dated January 4th.

189. "An improved wire cable coupling device for car or trolley cables and the like." A. KAISER. Dated January 4th. (*Complete.*)

192. "Support for electric lamps or other fixtures." S. S. BROMHEAD. (O. C. White, United States.) Dated January 4th. (*Complete.*)

235. "Improvements in or relating to dynamo-electric machines." R. BELFIELD. (Westinghouse Electric and Manufacturing Company, United States.) Dated January 4th.

242. "Improvements in, applicable to, or connected with targets, mantles, and the like." F. RICHARD and T. LEUTZ. Dated January 4th. (*Complete.*)

305. "Device for preventing the displacement of the roller receiving the current from the cables of electric railways with overhead conductors." P. MEYERSFIELD. Dated January 5th. (*Complete.*)

331. "Improvements in preventing sparking when making and breaking electric circuits." A. MULLER and H. TUDOR. Dated January 5th.

358. "A new process for the preparation of electric paste accumulators." E. KOSEL and F. FRENTZEL. Dated January 6th.

373. "Improvements in insulated and protected conductors for the transmission of electrical currents." G. WILKINSON. Dated January 6th.

398. "An improved electrically-propelled bicycle." S. PREM. Dated January 6th.

435. "Improvements in and connected with primary batteries." S. W. MAQUAY. Dated January 6th.

462. "Improvements in, or connected with, electric mains." G. H. NISBETT. Dated January 7th.

468. "Improvements relating to enclosed motors or dynamos." P. ROSLING and H. W. APPLEBBY. Dated January 7th.

494. "Automatic rheostat for use in starting electromotors." A. EMRICH. Dated January 7th. (*Complete.*)

525. "Improvements in electric signalling." S. P. THOMPSON. Dated January 7th.

533. "Improvements in electric arc lamps." A. J. HILLS. Dated January 8th.

571. "Improved means for making electrical connections upon railway trains." W. BRIERLEY and R. FOSTER. Dated January 8th.

584. "Improvements in underground conduits for electrical conductors." E. STANLEY. Dated January 8th.

586. "Improvements relating to the mounting of dynamo-electric machines." P. R. JACKSON & Co., LTD. and J. S. LEWIS. Dated January 8th.

591. "Improvements in telephone transmitters." A. GRAHAM. Dated January 8th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. THOMPSON & Co., 322, High Holborn, W.C., *price, post free*, 9d. (*in stamps*).]

1896.

18,319. "A new or improved electric hand lamp for general or special purposes." A. J. WESTMANCOTT. Dated August 19th, 1896. Relates to a portable incandescent electric lamp more particularly for use as a cycle lamp or a policeman's bullseye. The shell is fitted with partitions which leaves a space at the back for an accumulator, and a front space for a lamp which is suspended by its leads. The terminals of the accumulator rest in socket blocks mounted on an ebonite slide. From one of the blocks a connection leads to the switch and thence through the lamp to the other block. The switch is also mounted on an ebonite slide.

18,364. "An improved electric motor or dynamo-electric machine." J. T. KNOWLES. (J. H. de Thierry, Italy). Dated August 19th, 1896. An electric motor for use in the propulsion of tramways, vehicles, &c., and capable of being employed also as a generator is composed of two independent armatures having their axes of rotation parallel and a single field-magnet the winding of which is arranged symmetrically with the armatures and in planes parallel to their axes. The magnetic circuit is completed by a ring and a single or double pole-piece.

18,485. "Improvements in acid-proof electrical non-conducting articles and composition therefor." W. MORISON. Dated August 20th, 1896. A plastic substance, which is both an acid-proof and electric insulating composition suitable for making cases for galvanic batteries and for other purposes, consists of asphalt or of a mixture of asphalt and pitch, which is melted, and a little gutta-percha may be added thereto and while still hot asbestos is thoroughly mixed with it. The mass is spread on a hot surface and worked, beat, and pounded, and during this process a little sulphur may be worked into it. The article required is made by moulding this composition.

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CONTENTS:

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SHOP MANAGEMENT.

THE termination of the strike has not, at the time of writing, ended the dispute, and we cannot think that the men's executive have been well advised in allowing a capitulation to become a rout, and in making a last stand upon the question of interference with shop management, which they have always disavowed, while throwing overboard the hours' question as of no importance. We need not, however, pause to discuss what was, after all, a mere stalking horse. No one who knows anything of facts has any doubts as to the issue. The socialist idea of bringing all work under control of the nation at large may or may not be good, but whatever its merits, the consummation of the idea is only to be reached by hard work and discipline, by honesty of purpose and of deed. People who condemn socialism when they understand that it implies the obligation of every man to work to his best ability do so because, not being themselves too fond of work, they do not relish a state in which wealth is not a passport to idleness. To them socialism implies tyranny. But on most of us, who depend on our own exertions, the obligation to work would sit very lightly, and were socialism ever to become a working fact we should still find that our manufactories were under the management of the Colonel Dyers as the most fitting men to manage and to secure the largest output in the fewest hours. Anything more fallacious than the belief that short hours are to be secured by restriction of work cannot be imagined. In striving to wrest management from employers, Mr. Barnes has been endeavouring to upset that natural order of things of which an ideal socialism is but the extended application. The workmen of the country have a right to as much of the product of labour as they can fairly secure. To secure this right, they must see to it that production is a maximum. If labour obtains five-sixths of the excess of value beyond materials' cost, it is obvious that, doubling the output, would double labours' share, and labour should, if wise, give to management every aid in securing production even to the extent of demanding efficient management and American methods, which seem to be within reach much sooner than Mr. Burns intended, when he shouted so loudly for them. The immediate present danger, however, is, that the employers are face to face with a new set of conditions. They have trained up a lot of men to do their work, and are about to engage such of the old union men as they can find room for. These old men may look on the new body as enemies to be hounded out by fair means or foul, and there may be many difficulties. We have more than once in the past six months urged the importance of the employers standing loyally by their new men. After previous strikes the new men have been badly treated, and have been individually choked off by the unionists. We have heard of an occasion where, after a strike, on the re-entry of the men, a union man has deliberately ousted a non-union man from the machine to which he considered he had the right. Our contemporary, *Engineering*, now urges the importance of the protection of the men whose loyalty has carried the employers through the storm. There must be no casting adrift of these men—a dishonourable act, not, says our contemporary, without precedent. In the old days, to discharge a trades unionist who practised intimidation, would have produced a strike. Intimidation may again be attempted, and it must not be allowed. It must be cut down and stamped out, and ringleaders sought out and discharged. But so also must there be discharged any man weak enough or foolish enough to let himself be made a tool in such practices. Howls about the principles of trades unionism must be strictly disregarded. It must be accepted that if trades unionism requires the abrogation of fair dealing and justice, and first principles, we can none of us recognise trades unionism as anything but a foul and pestilential growth. No more must we hold a candle to the devil in blinking at such evils, even at the risk of a strike. But let us again turn to the other side of the question on which we are also supported by our above-named contemporary, and that is the ability of the management. The first office of management is to manage. Now management in knuckling down to the demands formulated in Stamford Street—formulated simply for aggravation, and on the principle that "the office work being slack, let us see what firm can be annoyed," has abdicated portions of its functions, and was left six months ago with only the name. Management has been too exclusively non-engineering in quality, and the men have found this out, and have on their side employed other men also not engineers, or out of touch with their trade, to make foolish demands. If there is no engineer in a firm, the sooner one is admitted the better it will be for that firm. Mere managers without knowledge are of little good. One such man recently was brought to our notice, who, having asked an engineer to get him out estimates for a certain undertaking, sent it back with the request that the estimate should be halved. Management of this type has the added misfortune that it must open its mouth and show the poverty behind the words. The averseness to the means of wealth, which characterises so many sons of the rich, often happily leads to their entire separation from business, but where the untaught untrained sons remain in a business they do incalculable harm, even when really decent fellows. Men who take the top positions in a huge factory without even being trained in their own works, and with no basis of scientific knowledge, are far too common.

Germany has not grown this class yet. America has grown some of them, but young rich Americans are more averse to work than Englishmen when they do tend to idleness, and they quit work altogether. It is the man who is not such a fool as to live in absolute leisure, yet who has felt it unnecessary to learn as though he hoped to earn £300 a year, that is the bane of our English trade, that falls a prey to the glib-tongued commercial, or that lets slip the valuable invention for lack of knowledge of principles. Shop management can never earn respect unless itself competent in the technicalities of what it professes and claims to manage, or has the good sense to secure competent interested management, and gives the same a free hand. The present is not the time for the *dilettante* in business. By shop management we do not propose to confine the term to the management of the men and the proper rating of machines and piecework prices, but we would include a far wider range. Every well-established shop that has the money to pay for it ought at once to clear out the accumulation of years of odds and ends which collect under benches and tools, and should learn that a scrap-heap is for scrap, and should be periodically sold. All tools ought to be overhauled, and old muscle-absorbing articles destroyed if not cheaply reformable. The power department of many works ought to be carefully considered as to the improvement by the adoption in whole or part of electric driving or gas power in place of steam. We have in mind as we write a new shop of small power where the power is over 100 feet distant from the principal power absorber, where, indeed, it makes very little difference whether power is utilised or the shafting run unloaded. We have another shop in mind where some power must be costing nearly £3 per horse-power week instead of as many shillings. These may or may not be extreme instances. We believe they are common; they come under our notice simply. Want of crane power is another shop evil. We know where the removal of a heavy casting on a truck requires a whole crowd of skilled and unskilled men for a temporary, and, perhaps, only occasional tug. The same would be effected by one or two men with a slowly-turning bollard and rope.

We wish to see shop management alive to all such facts. We want capital to allow management to abolish such extravagancies. Yet we have known a works manager severely handled for spending a few thousands on improvements which repaid themselves in a year. True, an apology followed, but not until weekly returns showed that the money spent was coming back. This was an instance of good management hampered by lack of knowledge on the part of principals, and it is happening every day; and gentlemen of education and ability are dispensed with in frequent cases because they do not bow and scrape to principals of less ability than themselves. But are not all these facts known to every experienced man in some form or other. Nothing of this sort would happen if there were more knowledge at the top, and the education of the working men is by no means the only education wanted. There must be no interference with management; but management ought to be good and intelligent. Is it always so?

Electrical Anomaly and Chemical Constitution.—Certain liquids are found to possess an anomalous absorption for rapid electrical vibrations, and an anomalous dispersion of their electrical indices of refraction (ratio of the wavelength of the vibration in air to that in the compound under investigation). This anomalous absorption appears to be intimately connected with chemical constitution, for the hydrocarbons, the ethers, the ketones, and aldehydes behave normally, but alcohols and acids, and generally compounds containing the hydroxyl group, possess an anomalous absorption. The differences are so marked that in many cases this property would probably be of service in settling vexed questions of constitution. An examination of ethylic aceto-acetate, for example, show that, as this compound possesses a normal behaviour, it cannot be regarded as containing the hydroxyl group. Ethylic asceto-oxalate, on the other hand, appears from the results obtained to contain hydroxyl. An exception to the above rule appears in the case of water, the behaviour of which is perfectly normal. Where an anomalous behaviour is noticed for the liquid, this appears to be maintained also by the compound in the solid state. The above is an abstract of a paper by Paul Drude, *vide* the *Annalen der Physik und Chemie*, 1897 (II.) No. 60, pages 500—509.

OZONE MAKERS.

By E. ANDREOLI.

In a very humoristic article on "Electrical Engineering," published in *Mechanical Engineering* for December last, Mr. James Swinburne disserts on the subject of sterilisation of water by ozone, and he wonders "how it is not put into practice more?"

I cannot resist quoting a few lines of his sarcastic dissertation: "One great trouble in the case of ozone work, is the extraordinary vagueness of the ideas of the worker. An inventor working at ozone seldom seems to know what pressure, what current, or what frequency he wants."

"Neither has he the least idea how much ozone he can make or how much of it goes to annoy the particular little animal it is his mission to annoy."

"Until people are exact in their measurements, there is but little chance of making much progress."

Mr. Swinburne is somewhat severe when he speaks of "people who are not exact in their measurements," but after all he is quite right, and I can only approve of the sentence he passes on the *sans gêne* of certain chemists or analysts in making their determinations of ozone.

Mr. Swinburne no doubt alludes to a process for generating ozone which a friend of his had, and has still, perhaps, under his control as consulting chemist: *Amicus Plato, sed magis amica veritas*. The process which I speak of was said by its directors to give some most extraordinary results, and to beat the record of the world.

Mr. Swinburne must evidently have been scandalised by the following public statement which I have in print before me, and on the faith of which the capital of the concern (Limited) was subscribed: "It is believed that over *25,000* cubic feet of ozone can be produced by the apparatus invented by . . . . which is actuated by an . . . . induction coil or converter, capable of working up to 250,000 volts. Such cubic contents equals *1,250,000* grammes, or *3,362* lbs. . . . . The cost of producing *25,000* cubic feet of ozone per hour and of operating the machinery will, it is thought, not exceed *2s. 10d. per hour!*"

25,000 cubic feet of ozone per hour at a cost of 2s. 10d. What shall we call this? The directors will say that their process is a revolution in the art of making ozone; there are some people who will say that it is a perverted statement; no! it is not a fraudulent representation I am sure. It is most certainly a *bonâ fide* declaration made by a very honest man or several honest men (including the well-known chemist, who ought not, however, to have been a party to the promise of 3,362 lbs. of ozone for 2s. 10d.) who were unaware of the many causes which can completely spoil the results of a determination of ozone. Still, the chemist ought to have noticed that the ozoniser worked too well, and was giving much more than the theoretical yield!

But to return to the sterilisation of water by ozone, things are not done in one day; it takes time to devise commercial ozonisers and to improve them, then to construct new ones, sometimes quite different from the first, to try one after the other several new methods for working it, which often have to be abandoned until an efficient, strong, simple and inexpensive apparatus is constructed which gives a satisfactory output, can be worked on any scale for weeks and months, almost without stoppage, does not need skilful superintendence, and does not get out of order or necessitate repairs.

Had Mr. Swinburne realised the magnitude of an installation for sterilising water, he would have been more indulgent and would have better appreciated the efforts of "the people," as he calls them rather contemptuously, "who work at ozone."

Mr. Swinburne's theory is, that the ozone question is, like many others, a matter of patents, and that it is "because the broad principle is open to everybody that it is not done in earnest." Patents have nothing to do with the development of the application of ozone to the purification of drinking water. Conscientious workers do not hurry to attempt to start installations until they know for certain that their generators are capable of doing the work and supplying in a continuous manner, the quantity of ozone required for the purification of thousands of gallons of water per hour.

Mr. Swinburne must not think that all the inventors working at ozone are ignorant of the conditions required to ensure success. Among the names of the men who have recently devised some new forms of ozonisers we find those of D'Arsonval, Patin, some doctors of the Institut Pasteur, and of Tesla. We have not yet heard anything about the value of their apparatus as commercial generators, but surely such men know what pressure is required, and how to make determinations of ozone. None of them, however, profess to produce 25,000 cubic feet of ozone at the nominal price of 2s. 10d. I insist on this preposterous statement because there is no truth in it. We do not say that the figures have been inflated on purpose for certain specific reasons, but we require a corrected statement of the real output of this too much talked of ozoniser. *Parturiunt montes* . . . how much pure ozone is there in those 25,000 cubic feet of ozone which cost 2s. 10d.?

Instead of lecturing indiscriminately the people who work at ozone, Mr. Swinburne ought to have severely scolded the analyst who allows such wrong statements to fly under his colours.

Mr. Swinburne is the inventor of a condenser and of a transformer well-known all over the scientific world; better than anybody else does he know what an ozoniser, *i.e.*, a condenser must be like. The best man to produce a large quantity of ozone is one of scientific accomplishment like Mr. Swinburne, who is thoroughly master of the theory as well as of the construction and working of condensers and of transformers; he is evidently the right man to design the best apparatus for generating ozone, in which the production of heat will be avoided in the most efficient manner. If ozone is still in its infancy, let scientists like Mr. Swinburne who know what the conditions for favourable working should be, take the matter up, and the problem will soon be solved. Why did he not try his hand at it; surely he would have succeeded, but I confidently predict that he never will be able to produce 25,000 cubic feet of ozone for 2s. 10d.?

Mr. Swinburne does not perhaps realise that it is more difficult to make a good commercial ozoniser than to make a good transformer. What is a transformer after all, if not, as Mr. Swinburne says, an apparatus, *the broad principle of which is open to everybody?* Still it is done in earnest, and, luckily for the ozone industry, efficient transformers are not scarce. Ten years ago there were only small laboratory ozonisers, such as the Siemens, Berthelot, Thénard, Houzeau tubes; when Mr. Swinburne constructed his first high-tension transformer, there was not in all the world a single commercial ozoniser capable of producing cheap ozone. We have now some good, strong, efficient ozonisers, and also some excellent transformers. We can start ozone installations of 50 or 100 kilowatts and undertake to apply ozone to any staple industry or to the sterilisation of water. This, after all, is not too bad, and "ozone makers" may say that they have done something.

Is it an easy thing to ascertain the pressure required to produce the maximum yield of ozone? One must not believe that algebraic equations will enable anyone to do it. They are peculiar, the properties of this substance isomeric with oxygen, which is the sole element of ozone and which is regenerated from it. Ozone is formed under the influence of electricity which so often supplies the complement of energy required to generate substances formed with generation of heat. Ozone is formed with absorption of heat which it stores under the influence of electricity, and we are in presence of a body which is more condensed than its element and which absorbs heat instead of generating it, as is the case with condensation.

If the formation of ozone was due, not to a rise in temperature, but to the passage of electricity through oxygen, there would be a ratio between the proportion of the ozone formed and the quantity of electricity consumed, but there is nothing of the kind, as the formation of ozone is intimately dependent on the production, in oxygen, of electrical discharges which render it luminous, and at the same time cause a considerable rise in temperature, and the electric conditions of the formation of ozone are so little known, that it is still a question whether the silent discharge acts as an electrical phenomenon or as a heater of the oxygen which it traverses.

Then we have to consider the changes of the electric tension during the interval of the sparks and of the alternations.

Are the chemical reactions caused by these alternations and by the resulting collisions and molecular vibrations, or are they simply due to a potential difference, to an orientation of the gaseous molecules without any intervention of voltaic current, of rise of current caused by the sparks or of the frequent variations of current?

We may consider the *rôle* of the silent discharge in the isomeric transformation of oxygen to consist merely in placing temporarily this gas in such a condition that it is susceptible of fixing heat.

These are the data on which the ozone makers must determine the pressure required for the working of their ozonisers. They have besides to take into account the *rôle* of the dielectric and of several other factors, and it is no exaggeration to say that they have to contend with some intricate difficulties, and that if they only succeed partially, those "people" deserve something better than to be sneered at, who produce, on a commercial scale, ozone, that body of which Frémy said that oxygen is the greatest discovery of the last century, and among the conquests of modern chemistry there is not one more important than that of ozone.

ISOLATED PLANT v. CENTRAL STATIONS.

The question of isolated plant *v.* central stations is one which is very seldom discussed or much spoken of in the electrical press. It is one, however, which exercises the central station engineer, especially in manufacturing towns, more than he cares to admit.

This is true, more especially in cases where arc lighting is employed. A slight variation in the voltage is not so noticeable as in an incandescent installation; consequently in large works, the machinery of which is operated by a modern engine, well governed, a dynamo or dynamos can be run off a shaft, like any other machine.

It is useless to disguise from ourselves this fact, for when we remember that a variable drive in, for instance, a spinning or weaving factory, would be very detrimental to the delicate threads and fibres manipulated, we can readily realise that a dynamo would be afforded a sufficiently steady drive to ensure a practically constant voltage.

By this means the primary cost is reduced, and the subsequent item of attendance also reduced, for if no separate engine be employed no wages would have to be paid for this work. The dynamo is no longer an experimental toy, but a machine which can be depended upon to do its work well with the minimum of attendance.

When the cost price of the Board of Trade unit generated is compared with the price charged by most electricity supply concerns, it is not surprising to find that many large consumers of electricity prefer to generate their own current, and to put up with, perhaps, a little inconvenience at rare intervals in the shape of brief irregularities in the supply, although these could easily be provided for by having a connection from the electricity supply mains or by having a battery of accumulators for reserve and supply when the main engine was not running. The demand for current in factories, large houses of business, and the like, takes place, as a rule, at the same time as most other consumers, consequently a reduction in the price cannot be claimed by coming under the head of "long hour customers." An alternative plan of installing an accumulator and charging it during the daylight hours, or hours of minimum load, and using it to supply the current when the light is required is open to grave criticism. The current thus supplied would enable the consumer to buy his current very cheap, and the effect on the load curve at the central station would be very beneficial, but it is very doubtful if, when the efficiency of the present day accumulators and the heavy depreciation of the same are taken into account, any real saving would take place.

We have no desire to preach isolated plants, but we cannot close our eyes to the fact that electricity is too dear at present, and we must not be surprised if probable large consumers prefer to undertake their own supply, just as many large concerns manufacture their own gas.

When electricity is sold at a popular price, especially in provincial manufacturing towns, then may we expect to see the private consumer drawing his supply from the mains which pass his door, and gladly putting on the shoulders of those whose business it is to supply electricity the responsibility which he has taken upon himself merely because he could supply himself with electricity at cost price.

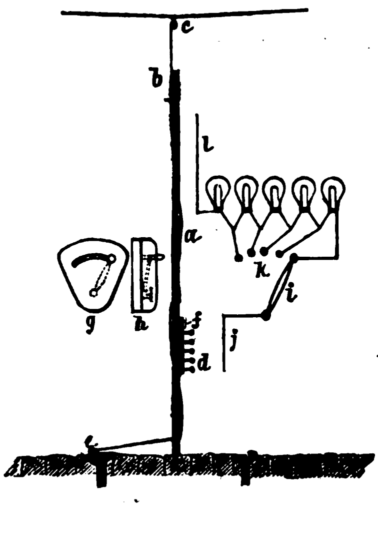
In comparing the cost between the two systems, it must be borne in mind that the cost of the wiring and lamps is the same, in fact, no notice need be taken of any expense incurred from the supply company's terminals or the terminals of the dynamo. The interest and depreciation is the same in both cases. The interest on extra capital spent only applies to the dynamo, batteries, switch gear, and engine, if one is employed. There are hundreds of private installations spread about the country which are giving perfect satisfaction, and it is a very serious question for the dispensers of electricity to consider the elimination of these installations by inducing consumers to buy their current, and this can only be done by a reduction in the price charged for electricity, bearing in mind the fact that the more current sold the cheaper it can be produced and distributed.

HOME-MADE TESTING RIGGING.

"Superintendent" writes to the *American Electrician* as follows:—

For testing the drop along a line of road, nothing goes ahead of a good voltmeter, but it is not always expedient to send out such an instrument, and for constant use in a "hurry-up waggon, the life of the best voltmeter is short. A good home-made rigging for this purpose is illustrated by the engravings herewith. It consists of the pole, *a*, which is preferably long enough to reach from the ground to the trolley wire. A jointed pole may be prepared for this purpose, and quite a short pole can be used on a pinch. The bare contact wire, *b*, is bent into the form of a hook, so as to catch over the trolley wire, *c*, and hold the pole and rigging in position.

A bank of five lamps, shown at *d*, is connected in series with a wire running up the pole to the contact wire, *b*. Another wire is carried down the pole, through a rubber tube, and connected with another contact wire which is put on the rail, *e*, thus completing the circuit through the lamps from trolley to rail. The brightness of the lamps tells how the



voltage is. This is, however, a rather discouraging test, and may be made much more valuable by adding a kind of a rheostat whereby some of the lamps may be cut out until the remainder glow up to full candle-power, thereby giving a better clue to the voltage at that particular piece of track.

This arrangement is shown in the detail drawings. The rheostat shell, shown at *g* and *h*, may be the case of a played out voltmeter, with the glass removed, but a wooden case, or one made of fibre is better as there is less danger of the instrument getting grounded, thereby giving the operator a test instead of the line. Five contacts are arranged as shown in the upper part of the detail, *g*, and a spring arm is made fast so as to sweep over these contacts. The side view, *h*, shows how the arm is made part of a spiral coiled around the stout screw, and how the spring arm is moved by an insulating handle which projects through the top of instrument case.

The method of connecting up lamps is shown at the other side of the drawing, where *l* is the wire coming from the trolley and running to the first lamp. All the lamps are wired in series in the usual manner, the last lamp being connected to the last contact of the rheostat box. Branches are taken off between the lamps, and run to the other contact points as shown in the engraving at *k*. The wire, *j*, is carried to the rail contact, and as the lever, *i*, is moved around, it successively cuts out the lamps by short-circuiting them.

In use, the pole is set up and the contacts made, and if the lamps do not go up to full brightness, the rheostat lever is moved a point and the lamps carefully watched. If the four remaining in the circuit go up too bright, the lever is released before the lamps have a chance to damage themselves much, but if the four do not go up to full power, another move of the lever cuts out a second lamp. This can be continued until only one lamp is left in the circuit, if necessary, but there will be a pretty big drop or a bad short circuit somewhere on the line when all the lamps but one can be cut out.

The object of having the spring lever to the rheostat is to prevent the burning out of the lamps, which would surely happen if an ordinary form of rheostat were used. The current could not be cut off quick enough when the limit of lamp cutting out had been reached, and away they would go. But with the spring rig, as soon as a man lets go the handle, all five of the lamps come right into the circuit again and no damage will be done from leaving the lever turned.

A very desirable modification of this rig is to put in 50-volt lamps instead of 110. Then the number of steps could be increased and the testing made so much more elaborate. The 110-volt lamps would burn brightly at 550, 440, 330, 220, and 110 volts respectively, but with a bank of 11 50-volt lamps tests could be made at 550, 500, 450, 400, 350, 300, 250, 200, 150, 100, and 50 volts potential between rail and trolley wire. With three or four 50-volt, and the others 110-volt lamps, a very good combination could be made with close readings of the higher voltages.

MACHINERY AS A FACTOR IN CHEAP PRODUCTION.

During the progress of the recent strike it became every day more plain that the heart of the whole matter was the use of machinery, curious as it may seem to-day when the whole world is using automatic machinery which was practically invented in England. There is, indeed, no engineers' tool of a labour-saving type but had its origin in England. The slide lathe, the planer, the steam hammer, to name three prominent machines only, all were born and perfected in England, which was the birth-place of the steam engine and the locomotive. Yet it is Englishmen who have struck against machinery just at the time when that machinery has helped to make so keen a competitor of the foreigner.

The rights of labour supposed falsely to be interfered with by machinery are seen to be rights of a very narrow class, the members of the A.S.E., irrespective of their skill. The outsider, and especially the poor labourer, has no rights. Mr. Maxim, in the *Engineering Magazine*, shows how cheap production has only been possible by the use of machinery, and he states:—

"An unskilled mechanic is as much a citizen of the country in which he lives as anyone else, and is entitled to the same degree of protection and consideration as is accorded to the skilled mechanic." The skilled mechanic has no right whatsoever to create any artificial system which will restrict the liberty or the facilities of the employer to employ this important class of the community. Every man is apt to look on a question from the point of view of his own immediate interest. Seeing how very large is the labourer class, let us try to look upon the machine question with the eyes of an intelligent and fairly educated labourer. We see a body of skilled workmen bound in a narrow guild, and claiming for themselves, to our exclusion, the right to perform certain work. We see the invention of certain machines, capable of greatly cheapening the production of this work. To fix ideas, we will suppose the particular work to be the manufacture of sewing machines, and their price is £8. About one house in every ten possesses a sewing machine in the district in which we live, and these houses are the homes of the favoured skilled men.

We see that if the production of sewing machines can be cheapened so far as to enable them to be sold for £2, there would be probably eight times as many in use, for they would now enter the homes of our own class. But the favoured few forbid the cheapening to be done. They say it will throw some of them out of work. Yet by the use of machinery, which we are competent enough to work, we labourers would add considerably to our wages, and would become purchasers of the very goods we make, and in doing so, we would actually cause the employment of more of the favoured class than were employed in making the machines to sell at £8. Is it likely that we look upon the skilled men with friendship? They grudge us an extra few shillings wages, though, by earning them, we help to make more employment for them. We see all these things plainly, because so many of us are students, readers, amateur naturalists, botanists, or geologists, and have better trained minds than your pot-house trades unionist, who, as a rule, is so puffed up with pride of position, that he does not think it necessary to do anything outside his trade.

Such, to many intelligent labourers, is the appearance of the machine question and trades unionism. It is a bar to his own better living to which he has a right. Mr. Maxim considers it would cost about £60 to make a Winchester rifle by hand, and only very skilled men could do it. They would only be saleable, as a luxury, to the rich, and about 20 mechanics would probably fill the market.

By automatic machinery their cost is about 24s., and they are sold retail at £3, in place of at £100 at least. Unskilled men and boys make them. There is not a large proportion of skilled men. Where are the skilled men? Chiefly making the high-class machines, gauges, tools, &c., without which the unskilled could not work. The result is, in place of a small trade employing 20 skilled men there is a huge trade employing thousands of unskilled men and hundreds of skilled men on accessories, and Winchesters are everywhere.

It is the same in watchmaking. Watchmaking machinery was invented in England. We have seen the drawings of the first. But they were only taken up in America, and English watchmaking almost died until Rotherhams, of Coventry, went one better than even the Americans, and in watchmaking England is, we believe, getting back her own.

Before the era of machinery, the working classes simply lived and had a roof over them. They were not purchasers of anything beyond mere necessaries; they were producers only, and at so slow a rate, that any sale at all for their productions was only possible by reason of the labour being very poorly remunerated. But by reducing the labour cost per item, production has been so cheapened that the producing class have become purchasers, and wages have perforce increased. The appetite for luxury grows, and the learning to consume has widened markets. False socialism—thrifty in other things besides soap and water—tends to narrow markets. True socialism, which is opposed to thrift, makes everyone a consumer to the extent of his income. The inculcation of thrift is really a mistake. If every man spent the whole of his income as he received it, there could be no slack times in trade; there would be a constant and steady flow of business. We have every sympathy for that socialism which would compel every man to work and support the infirm, the aged, and the sick, for such a policy would destroy the necessity for thrift, which, whether it be the putting by of the daily penny or the hoarding of the millionaire, is bad for trade. We do not feel the full evils of thrift, because hoarded money is very largely entrusted to banks which use it in trade. Thrift carried to extremes at short notice becomes panic. To hear the term Socialism applied to the ignorant follies of latter-day trades unionism is very vexing to the soul of the real socialist, to whom socialism is not synonymous with either communism, anarchy, or laziness. True socialism would be very irksome to the naturally lazy man.

Mr. Maxim says, with some truth, that the manufacturer—he would have better said some manufacturers—is apt to look on his works as a necessary evil, in which he takes very little interest, and from which he hopes to be released and to retire. He does not identify himself with his workers, who look on themselves as slaves to their trade, and so on. A good deal of this has a basis of truth, even if spoken with that disagreeable spirit of spreadeagleism which marks Mr. Maxim as an American. We do, however, agree with him that a destruction of old tools would be a great benefit. Long after the modern three-grooved tap had been invented, there was an old four-flat $\frac{7}{8}$-inch tap in a shop we wot of that would not be lost, and cost pounds in wages that would have bought new ones; but it was of magnificent material, and stood wonderfully, and so was kept at work. This sort of thing goes on on a large scale, but is, of course, wearing out, and we fancy there are a goodly number of English shops where freedom reigns, and modern methods prevail, but of which the proprietors say little.

Mr. Maxim's experience at his own works has been very vexatious in the matter of union interference with automatic machinery, such as running a lathe all day without a cut, and he strongly advocates the counter move of the Employers' Federation.

It appears that several of the labour leaders have come from Mr. Maxim's own works, and he naturally has something to say of their methods. He contrasts the understanding between masters and men in the workshops of America and Germany with the lack of it in England, where no understanding can be arrived at on the question of cheap production. It were useless to build fine shops and equip with the best tools, unless labour will assist to make those tools do their duty. This could, he thinks, easily be managed, but for the professional agitator, who aims to teach the men that an employer is of necessity a criminal. The first strike at Crayford—Mr. Maxim's works—was due to their refusal to promise that no piece work should ever be done there. They obtained a lot of Frenchmen, who, finding they could only work 54 hours a week, set up little works at home to fill in their time and made electric bells, &c., just as the Woolwich men, on eight hours, are making bicycles and interfering with the local makers. Mr. Maxim would abolish protection in America as no longer, if ever, necessary, but he evidently shares our opinion in looking on Americans politically as fools influenced by political agitators, in the way Englishmen are fools to the labour agitator.

TECHNICAL LITIGATION AND THE QUESTION OF GOOD WORK IN HOUSE WIRING.

By V. ZINGLER, A.I.E.E.

A recent case in the Law Courts brought both of the subjects involved in the above heading into prominence—into unfavourable prominence, it may be said—and into utter confusion and indefiniteness. Into unfavourable prominence, because it only served to demonstrate again the oft-repeated assertion that the Law Courts is not a place for referring these cases to, or the law (as it now stands) a fit and proper instrument for deciding such cases on their merits; it also brought before the public what must be considered a curious state of things in the house-wiring question, calculated to alarm them as to the safety of their houses, and to surprise them in the differences of opinion of the experts (surely in this case we cannot say, "*in the multitude of counsellors there is safety*);" into confusion, because to anyone present it was apparent that the state of both the exponents of the law—who did not understand what they were talking about, and of the twelve good men and true, who did not understand what they were listening to—was "confusion worse confounded;" into indefiniteness, because it showed that technical litigation is an uncertainty and a lottery, and the question of good work in house wiring is as far from being standardised as ever.

We may deal with both the subjects of the title separately, in order not to still further confound the two issues.

To take technical litigation first. The case was of the sort that is constantly coming up in other trades—work alleged to have been negligently done; part payment stopped from the account, and process to recover same. The verdict was no doubt arrived at, after due deliberation of the many points involved, so far as they presented themselves to the jury, after filtering through counsel and judge. It is with the conduct of these technical cases that we have to deal, and the aspect of this case, both from the point of view of conduct, and of the ultimate feeling of the technical spectator, that the whole thing was a farce, is deplorable. We assume no partizanship; one side may have been as right as the other; both may have been equally wrong. But the fact remains that such a case as at present tried is a farce, and undoubtedly the result is often a miscarriage of justice. For what do we find? A body of twelve men picked indiscriminately from the classes and the masses, the odds immense against any one of them understanding anything about electricity, or whatever science the particular case before them may involve. Twelve men, whose only qualification is that they pay rates, and can, perhaps, be credited with sufficient common sense to discern whether a witness is honest or not; and even here they may fail, if the examination is on a technical subject. Then the counsel, who are no doubt admirable men in their way, but who understand little or nothing about science. These gentlemen have to be stuffed up by their respective witnesses, and endeavour in a few hours to grasp and hold forth on matters which it takes an average man years to acquire. And finally the judge, arrayed in babe-like innocence, who makes jokes at which everybody is expected to laugh, and then sums up on what he has learned from counsel and terrified witnesses, who, by methods of counsel with which it is proposed to deal, have unwittingly been made to perjure themselves again and again. And on this the jury find a verdict—not before they have, perhaps, shown their good sense as honest men by saying that they cannot agree, and so endeavouring to avoid pronouncing a definite opinion on subjects with which they are not competent to deal. But this will not do for the judge; he not only does not wish to run up the costs of the case by discharging the jury, and he has no doubt had enough of the case himself. And so the jury are bullied a little, and as they are only human, and often hungry, and have wives and families to whom they wish to return, they eventually agree on a verdict, but compromise with their consciences by leaving the contending parties to come to some arrangement as to terms.

Now we may ask: Is this fair? Is this the proper way the law should be administered? Most decidedly it is not; but then do not the parties in the case know this? If both sides are technical men they know it as well as any reader of this journal; they know exactly what they may expect to get in the way of judge, counsel, and jury. Then why do they go to law at all? Why do they not get an arbitrator to decide the case between them? Why do they not both decide on a man who could be depended on to hear both sides in all they have got to say, who, moreover, could understand what they are saying, and who would be competent to decide the case on its technical merits and not on side issues? There comes the rub. If it were possible to appoint such a court, whose decisions in technical cases would meet with the approval of outside technical men, how many such cases would come before it? It is probable that the office would be a sinecure, and many cases which—if the judge could only see their "true inwardness"—would be dismissed under the Vexatious Actions Act—would never see the light of day at all. No; it is the glorious uncertainty of the law as it now stands, and the sporting (?) instinct of the English nation, which drives these cases into the Law Courts.

If A thinks that B has infringed his patent, is it not better to challenge him to a sort of game of chance in which A or B will ultimately win all the stakes, and to engage a band of professionals on each side, than to argue the matter out before an impartial expert? Most decidedly it is more exciting, and in the generality of cases it is the man who is in the wrong, who knows he is in the wrong—who brings the action. It is a game of bluff, all or nothing. The challenged party may know he is right; he may know he is wrong; at any rate, he thinks, the odds will be even either way; he is on his defence; if he compromises he will lose caste, and perhaps only gain half of what he may gain by fighting. So there is a rush to engage the best players; not necessarily those who know the game best, but those who can play it in the most audacious style, who can "beat" their opponents by all manner of clever tricks, who can make them actually play on the wrong side by mistake. That is what fetches the public, in the shape of the jury; that is what decides the case. Or take another example: A makes a contract with B that B should perform certain work. When the work is said to be finished, A is of a different opinion and presses for what he considers the interpretation of the contract, and perhaps thereby accidentally makes some legal technical mistake. B then brings an action against A for fulfilment of his part of the contract, namely, payment which may have been withheld. Why does B not suggest appointing a technical arbitrator? Because he knows he would not win his case. But as the matter now stands, he is aware that A has made some mistake which will most likely be the cause of his paying the costs; therefore B's position if he loses the action will be no worse than if he did not bring it at all. On the other hand, if he wins the action he is in the same position as if he had fulfilled his contract properly. The case is fought out on the same lines as indicated before; counsel get hold of side issues, twist them about, turn them inside out, and in the end the real question before the Court, which the Court never understood, is quite lost sight of.

Then as to the methods of counsel. The gentleman in charge of the case is no expert; what he has learned, he has learned quickly and superficially; he does not grasp the technicalities of the case as he should, and when he has finished examining a witness—perhaps a voluble witness—he has perhaps done his side more harm than good—that is, if the other counsel is sharp enough to take advantage of it. He asks the witnesses technical questions which they have suggested to him in private, but has no idea what they mean, and therefore no power of following them up. He then goes out of court for an hour or two, perhaps to take another case of quite a different nature, and then his junior proceeds. If this gentleman has not been present at a consultation with witnesses beforehand he knows even less of the matter. And then the senior counsel returns, and addresses the jury for his client. If his junior has made some points during his absence, he does not follow them up, and the jury lose sight of them.

In cross-examination the farce becomes even worse, for the one and sole object of counsel is to make witnesses confused. This may be quite legitimate if the counsel has a thorough grasp of what he is talking about. But in technical cases the witness knows more about the matter, and may often give an answer which may "floor" counsel, who then says, "Well, I do not understand anything about that." In order to avoid such *contretemps* the method adopted is very frequently as follows: Counsel asks witness a technical question of an utterly meaningless and childish sort—in fact, having no connection with the case. Witness looks perplexed; he asks for the question to be repeated. With a meaning look at the jury, counsel repeats it; the witness looks more confused; the jury gradually wake up to the fact that this is a discreditable witness; the witness says he does not see what this question has to do with the case, and of course the jury think this is an attempt at evasion. Counsel says that he (witness) is not the judge of that, and so in despair witness appeals to the judge. The judge, waking up with a start, suggests that witness should have patience with counsel and reply to the question. The question is again put; witness hesitates. Now is the time for counsel; throwing down his brief, he roars, "Answer yes or no, sir!" Witness, now utterly helpless, says "Yes" in a reluctant way, and counsel, smiling at the jury, says: "Gentlemen of the jury, this witness is an expert." The jury look very wise and make rapid mental notes. And so the case goes on, much to the disgust of technical men in court who may just have looked in to hear what is going on. One expert swears that there is no harm in doing a thing, which it is shown afterwards that he has privately condemned, and which no expert worthy the name would permit. Another tells jury gaily that fire insurance rules are only got up for fun, and that nobody works to them, or some such nonsense. Counsel tries to show, by garbling technical requirements, that these rules contradict themselves and are therefore valueless. What, says he, is the use of permitting twisted flexible wire to be used if the other wires may not be bunched? It is an anomaly. When the question is raised of passing flexible wire through holes with sharp edges in a metallic back plate, and the consequent danger from short-circuiting, counsel, in cross-examination, wisely holds up a wooden patress and wants to know if wires are not passed through this and if it is not inflammable. Witness agrees, and counsel looks still wiser at the jury, who again draw their own conclusions. Truly remarkable! And witness's counsel never attempts to put the matter right; the reason is very simple—he does not see it.

On side points are cases fought and won. Is it not, indeed, time that something should be done to appoint either a special judge with a knowledge of elementary science, or a technical adviser to the existing judges? Should a case of this sort be heard before a jury? and, lastly, is it decent, is it honest to their clients, for barristers to accept briefs and fees, for cases of this sort, unless they have previously attended a course of elementary science? If any scientific man is not sure of his answer, let him go to the Courts when a technical case is on, and he will speedily come to a conclusion, and will probably agree with Bumble that (as it affects technical cases) "the law is a hass."

(*To be continued.*)

DR. LODGE ON WIRELESS TELEGRAPHY

Last Friday, Dr. Lodge described at the Physical Society some experiments that he has recently been making on telegraphy without connecting wires. He objects to the term "wireless" telegraphy which has been commonly applied to this kind of signalling, since there is considerable amount of wire about some of his apparatus, but we may stick to it for the present till the scientists have agreed among themselves as to a better name.

Dr. Lodge's efforts have been more especially directed to the design of a transmitter and receiver which can be sharply

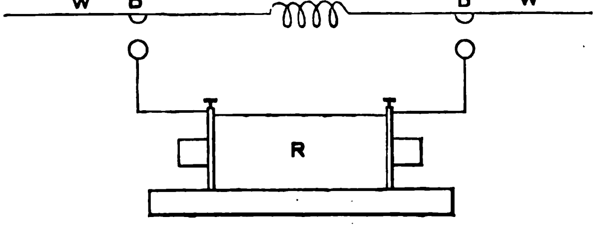


Fig. 1.

syntonised, to enable messages to be sent to a definite point. As is well known, the Marconi apparatus is defective in this respect, for the reason that the waves which it generates are very quickly damped. Theory indicates that the damping can be reduced by increasing the capacity and the self-induction and reducing the resistance of the conductors in which the oscillations take place.

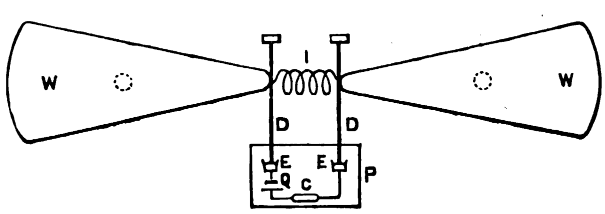


Fig. 2.

A large number of arrangements were described to attain this end. In figs. 1 and 2 we give a diagrammatic illustration of one of the best of these instruments, which is capable of being used both as a transmitter and a receiver.

Fig. 1 may be taken as a plan, and fig. 2 as an elevation. Two wings, W W, of thick copper plate about 6 or 8 feet in length, and triangular in shape, are connected by a coil, I, consisting of a few turns of thick copper wire.

When the instrument is used as a transmitter, sparks are discharged from an induction coil, R, across air-gaps to knobs, B B, at the centre of the wings. This causes a current to surge across the coil, I, from one wing to the other, and send out powerful and persistent Hertzian waves in every direction.

In fig. 2, the apparatus is shown connected up as a receiver. Two sliding rods, D D, pass down through apertures in a metal box, P, and dip into mercury cups, E E, at the terminals of the circuit containing the battery, Q, and coherer, C. The sliding rods, D D, are drawn up, and the metal box completely closed, when it is desired to use the apparatus as a transmitter.

A number of methods of connecting up the coherer and the telegraph instrument were brought forward by Dr. Lodge, which we hope to describe more fully later on.

Dr. Lodge gave no results as to distance telegraphed by his apparatus, but he appears to be at present conducting a series of experiments, the results of which, we hope, will soon be published.

CORRESPONDENCE.

Dynamo Design.

In reading through Mr. Zingler's two articles on "Dynamo Design," I have been struck by several points which, in the interests of the would-be designer, require further light thrown on them. These points I will take up in the order in which they occur in the papers. We are told that the symbol *c* represents the number of convolutions or bars. Now it is quite evident that it does not represent both these, for in a drum armature, with which he is dealing, there must be at least two bars to a convolution. As a matter of fact, the use of it in the equation

$$N = \frac{E \times 60 \times 10^8}{n\,c},$$

tells us that it is the number of bars. A little later on, however, we are told that it should not be less than 40. This corresponds to 20 commutator parts, which is surely too low a number for the satisfactory collection of 400 amperes at 80 volts.

Having assumed a value for *c*, in a seemingly very arbitrary manner, a value for N, the total flux through the armature is deduced from the ordinary formula, and then 10 per cent. is added for armature and demagnetisation losses. How do the latter affect the value of N? I have always understood that the formula

$$N = \frac{E \times 10^8 \times 60}{n\,c},$$

where E is the actual E.M.F. generated, *i.e.*, the terminal P.D. + the loss of volts due to the resistance of the armature, was absolute and required no correction.

There is an apparent discrepancy between the first and second articles. In the first, the size of the armature core is taken as 15½ inches diameter × 16 inches long, whereas in the second the length of the pole face is elaborately worked out, and given as 18½ inches.

This, it is needless to say, will scarcely make a satisfactory combination; in fact, it is very desirable to keep the length of the pole face rather less than that of the armature core, in order that the end plates may be kept as much out of the field as possible.

The first paragraph under the head of "Ampere-turns" is very loosely worded. The products of the magnetic reluctances, and total flux, N, do not give the ampere-turns required, but only the M.M.F.; and, moreover, to be strictly accurate, it is the sum of the products of the total fluxes in each portion of the magnetic circuit, and the corresponding reluctances that give the M.M.F., since N is by no means constant throughout the magnetic circuit.

Again, under the same heading, in calculating B in the air-gap, the author neglects the fringes in arriving at the polar area, and so gets a value for B of 5,750; whereas on the preceding page, by allowing for fringing, he has a value of 5,000 for B, with the same value for N. Why this difference of treatment?

Another point I must take objection to, is that in calculating the field winding, no account is taken of the increase of resistance of the field when the machine gets hot. Consequently the ampere-turns will be too low (quite 15 per cent., with the radiating surface allowed) after the machine has been running for some time.

It is in calculating the ampere-turns required that we must add a sufficient number to compensate for the demagnetising effect of the armature.

It is doubtless a slip of the pen when we are told that the watts per square inch should not be higher than 1·5. I take it that what was meant was, that the square inches per watt should not be less than 1·5.

In conclusion, I would point out that the one point, more than any other, which determines the size of a machine, is not touched upon, or, at most, very indirectly. I refer to the heating of the armature. True, we are told to take a current density of 1,500 amperes per square inch, but no account is taken of eddies and hysteresis, the former of which, even at moderate speeds, contribute a very important part in the heating.

Amicus.

I will endeavour to reply to "Amicus" as briefly as possible. "c = No. of convolutions or bars," was meant to imply—as referred to a wire wound or bar wound armature *generally*. The terms are perhaps vague—conductors would be better. The same applies to the next remark, which referred to armatures generally, and not this particular one.

As regards adding 10 per cent. for armature and demagnetisation losses, certainly N would require no correction if there were no losses to allow for.

Any discrepancy between the first and second articles can be accounted for by the fact that the calculation in the first were merely approximate to get a rough idea of the size of armature, with an arbitrary and different number of bars to that afterwards assumed. Certainly in such a calculation something must be assumed.

As regards his remarks on fluxes in different parts of the circuit, I think "Amicus" cuts things rather fine. I can only refer him to Prof. Silvanus Thompson's book.

Turning to the value of B in air-gap, I thought I had made it clear that 5,000 was the assumed induction if there were no fringing. To allow for this in calculating the *effective* polar area B is increased by the usual method to 5,750. This allows for the additional ampere-turns to make good for the lines lost in fringing.

The radiating surface allowed, is certainly not small. The resistance taken was for 60° F. This, together with the fact that a good deal of allowance was made for slack, and only three sides of the bobbin included for the area, will give "Amicus," I think, some volts in hand when running cold at the normal speed.

The remark about watts per square inch, was certainly a slip of the pen.

In conclusion, I can only repeat again what I stated in my article, that the magnetic calculations had only been touched on. Perhaps it would have been better to have substituted the word "winding" for that of "design," in the title.

V. Zingler.

January 24th, 1898.

Shielded Conductors.

In his article under the above heading, which appears in the last two issues of your paper, Mr. Price tells us some true things about buried armature conductors, and illustrates his remarks with one or two well drawn diagrams. But on the subject of eddy currents he seems to have missed the point.

He introduces the question of eddy current heating, and points out that buried conductors give less trouble from this cause than surface conductors, which is, of course, quite true, and a matter of common knowledge. We hope, however, that he is leading us by gentle steps towards a simple and lucid explanation of this phenomenon; instead of which we are compelled to conclude that the line of force—or tube of force—theory which Mr. Price is, apparently, trying to justify, fails us here. But why?

Long before the discussion of magnetic problems and paradoxes became the rage, it was well known that eddy current losses in buried armature conductors were practically negligible; the explanation given being that, whereas in a smooth core armature, the conductors enter and leave the magnetic field gradually, taking an appreciable *time* to do so, in the case of a slotted armature, the lines *snap across* the conductors so quickly that the eddy-current losses are necessarily very considerably reduced.

This explanation may not be remarkable for its accuracy of expression; but surely we are right in assuming that, *for a given E.M.F. generated*, the eddy-current loss in a conductor, depends upon the *time* which it takes in passing into or out of the uniform magnetic field under the poles.

If, in the case of a slotted armature, the magnetic lines which form the "fringe" at the pole tips, may be considered as "snapping across" the whole width of the conductor in an inconceivably short space of time, it stands to reason that, since all portions of the conductor enter or leave the magnetic field almost at the same instant, the work done by eddy currents (quantity of electricity set in motion × mean E.M.F.) will be hardly worth considering.

Mr. Price then deals at some length with Prof. Du Bois' statements anent ring magnets, and with the aid of some more beautifully-drawn diagrams, he tells us many things which it may be useful to know. It is unfortunate that, after all is said and done, we are still in a state of semi-obscurity as to what it is that Prof. Du Bois really *has* observed. One cannot suppress the feeling that it would have been nice to have known this at the beginning.

Then there is Mr. Price's *paradox*. We are told to consider the space between two infinite plane magnetic shells, of which the opposing faces are of the same polarity. These magnetic shells are built up of an infinite number of small bar magnets, placed side by side. It is pointed out that, with such an arrangement, there is no magnetic field, and the question is: Have the bars ceased to be magnets?

That the resultant magnetic induction between the shells would be *nil*, is quite evident; but whether or not the bars have ceased to be magnets must depend, to a great extent, upon the accepted definition of the word magnet.

It is wonderful how a simple analogy will sometimes sweep the cobwebs from a mind which has been dwelling too long upon some apparently involved or obscure point, and the following electrical analogy, though no doubt highly unscientific, may help to guide us towards a solution of Mr. Price's difficulty.

The terminals of two dynamos, which are generating exactly the same E.M.F., are joined together, positive to positive and negative to negative. There is no flow of current, and the question is, have the dynamos ceased to be generators of electricity?

Alfred Still.

"Dynamo-Electric Machinery."

I must apologise for an unfortunate but obvious mistake in the letter you were good enough to publish in last week's issue. The first term in the second example should of course be 2·5, and not ·25.

W. Casson.

New Type of Locomotive.

I, and doubtless many more of your readers, having access to no other engineering journals save the ELECTRICAL REVIEW, would feel greatly obliged by an expression of authoritative opinion regarding the marked statement in the enclosed, taken from the *Glasgow Herald* of 14th inst.—the leading daily, as you may, perhaps, be aware, in the West of Scotland, and usually a tolerably safe guide in matters mechanical. An intelligent locomotive man here, with a lot of practical experience, assures me that N.B. Railway engines, with cranks on the usual "quarter-throw" principle, and wheel-segment balances, give, when running at or close on 60 miles per hour, no indication whatever of "sledge-hammering," as alleged by the *Herald* writer; and one might, indeed, be such excused for feeling surprised if they did. Obviously the solid segments in the wheels of such engines will represent the 180° cranks of Mr. Manson's new type, though being, perhaps as regards centre of gravity, further removed from the axle centre, the stripes which they set up within the axle may prove more injurious to the latter. That they can effect to any great extent, however, the wheel-rims, seems highly improbable. By the way, is it not a misnomer to speak of such engines as "high-speed," their wheel revolutions,* at 60 miles per hour, being only about 251 per minute?

E. M'Lean.

[In the arrangement proposed by Mr. Manson, the balance weights in the wheels may be entirely omitted, and the two oppositely moving pistons will balance one another in a sense, but unfortunately the two pistons are not in the same plane—vertical—and they will cause more or less tendency to vibrate the whole machine in a horizontal direction. This produces what is known as *nosing*, the front of the locomotive swaying from side to side.

The so-called hammer blow, due to unbalanced vertical action, has been awarded far more attention than in England. The reason is three-fold. In the first place the reciprocating parts of American engines have been very clumsy, and therefore excessively heavy; secondly, the wheels have been very small, and thirdly, the rigid economy in American bridge-work, combined with numerous long spans, has enabled the unbalanced action to be markedly shown. It has been suggested to employ three or four cylinders in a locomotive, two outside the frames, and the remainder inside. The two outside cranks would both point one way, while the inside crank or cranks would point the opposite way. The total inside reciprocating weights would exactly balance the outside, and a perfect all-round balance would be practically secured.

The only objection to such a system would be that the engine would not start when on its dead points. This could be overcome by allowing the two sets of cranks to vary from perfect oppositeness a few degrees only, being content to allow a very slight departure from perfect balance; or by the use of a small engine to turn the large one off the dead point as usual in large stationary engines. This idea is perfectly feasible, but probably not one locomotive engineer in a hundred is not too hide bound to perceive its utility. The locomotive engineer thinks a locomotive cannot run unless its cranks are at angles of 90°. He knows all about fly-wheels, but fly-wheels revolve round a centre, and he does not realise that a 60-ton locomotive moving at 60 miles' velocity in a straight line is as good a fly as a 60-ton wheel rim at 5,280 feet per minute circular velocity. There is really nothing special in Mr. Manson's engine. It's simply a partial step in the right direction, but has the mark of the conservative beast in the shape of cranks at 90°. Especially for long runs is this angle unnecessary. To this fetish locomotive men sacrifice speed, balance, bridges, rails, quiet, durability, rather than employ a little barring engine. To speak of blows like a sledge hammer being given to the rails is wrong. The effect of balance weights is simply to alternate lighter and heavier wheel pressure on the rail. The rail does not distinguish between a wheel of 10 tons pressure whether such pressure be simply normal or made up of 5 tons weight and 5 tons centrifugality. It has been known that the wheels of some locomotives with heavy counterbalances must, at high speeds, lift off the rails. An American college has a sample locomotive which has shown this experimentally by means of running it on friction wheels with lead wire between these and the engine wheels, the wire being flattened proportionately to the pressure. Large wheels with English design of moving parts appear not to cause trouble, the tendency to hammer blow being inversely as the wheel diameter squared, a 7-ft. wheel being thus barely half as bad as a 5-ft. wheel for equal forward travelling. With electricity there need be no imperfect balance; hence the wide range of wheel diameter possible.—EDS. ELEC. REV.]

Electrical Advertising.

Could you kindly inform me in your next issue if I should infringe anyone's patent by fixing glow lamps in front of

* For 7 feet wheels, as they are understood to be.

D

letters on a sign board, and switching the same by contacts, worked by any ordinary clock movement.

A. E. Rouch.

[We imagine one is at perfect liberty to do this, but perhaps some of our readers can give more precise information.—Eds. Elec. Rev.]

Electrical Hypothesis for the Solar and Planetary Systems, &c.

Only recently the Electrical Review was celebrating, with just pride, its attainment of years of discretion; or shall I say, of venerable antiquity? Should it not then be prepared to put away childish things, lest detractors should be tempted to speak of a second childhood having come upon its hoary hairs? Of course, those who can appreciate the intense humour of "Delta's" *Electrical Hypothesis for the Solar and Planetary Systems, &c.*, would not for a moment suspect the editor of the Review of mistaking the true value of such a contribution; but how about the large number of your readers, whose knowledge of physics is not much greater than "Delta's" own? May not they think that four and half columns of the leading electrical journal is enough to give an article the hall-mark of, if not authority, at least of some pretensions to sense. To criticise such a production adequately would be waste of your space; a writer who thinks that physicists of to-day regard the sun as being "in a state of magnificent conflagration," gradually "burning itself up," is hardly in a position to point out difficulties in their views.

It is a small matter that "Delta" regards the present estimate of the sun's distance to exceed 95,000,000 miles, but it shows his study of astronomy does not extend to very recent works; for the analysis of the results of the observations of the transit of Venus of *1874* brought the estimate down to its present figure of between 92 and 93 millions. But his ignorance of the absorption of radiant heat by the atmosphere, and his quaint idea that, according to existing theory, beams of light should "be seen traversing the dark interplanetary space, exactly as we see the beams of an arc light projected from the lantern of a lighthouse at sea," stamps "Delta" as a paradox-monger of the lowest order; even the paradoxer, however, should not draw so freely on his imagination as to say, we *know* "that if it were possible to produce an absolute vacuum between two separated terminals of opposite polarity, that an electric current would flow from one to the other, &c."

But, seriously, Sir, it is surely the duty of a paper of the Electrical Review's standing not to publish articles of this kind without a warning note that if not *written* for a joke, they are at least only printed for the amusement of your readers. It is difficult enough to drive sound science into the mind of the average individual, to the great cost of the nation in its commercial progress and struggle with competitors, but the technical press should at least be careful that it does not obscure the "dry light" of science.

Arnold G. Hansard.

Ipswich, Queensland.

On page 80 of your issue of January 21st, we notice that under the heading of Ipswich (Queensland) our name is included as having given tenders for Sections C and D.

Permit us to say that this is an error, as we do not quote for electrical apparatus, and Sections A and B were the only ones for which we tendered.

By making the above correction in your next issue, you will oblige.

Babcock & Wilcox, Ltd.
H. W. Kolle.

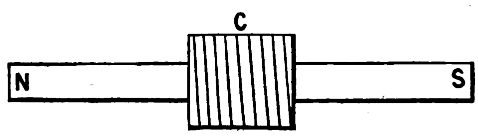
147, Queen Victoria Street, London.
January 24th, 1898.

[The table of tenders submitted, was given as stated last week, on the authority of the *Australian Building, Engineering, and Mining Journal*, which gave Messrs. Babcock & Wilcox's name in all the four items, together with the amounts quoted. We refer our correspondents to that journal.—Eds. Elec. Rev.]

A Problem.

The following problem might prove interesting to some of your readers:—

A helical coil (*c*) consisting of a single layer of insulated wire surrounds a bar magnet (N.S.)



How can the coil be taken away from the magnet without having an E.M.F. generated in it?

Archd. H. Finlay.

Electrical Engineering in the Colonies.

May I ask you to let me have a little information in one of your next numbers as to the prospects of a thorough practical electrical engineer in any of the Colonies, especially New Zealand, and oblige.

E. Smith.

[Perhaps some of our readers, with special experience in this direction, will be able to give some information.—Eds. Elec. Rev.]

"HONOUR TO WHOM HONOUR IS DUE."

There have been a good many misstatements made on the subject of wireless telegraphy, and most of our readers are aware that much annoyance has been felt in some quarters at the publicity which Marconi and his methods have obtained. We must confess to a feeling of surprise, however, that a science note in the *Pall Mall Gazette* should state that "It has been very vexatious for Dr. Lodge to have a young foreigner cutting from under his feet, the ground he had made so peculiarly his own, and to see his rival taken up by the British Post Office authorities." Why should Dr. Lodge be vexed at the cutting-out operations of Marconi? Did Dr. Lodge ever submit anything himself to the Post Office? From a scientific point of view Dr. Lodge ought to rejoice that his theories have received such striking confirmation, but we take it that the origin of the offence arises from the fact that the British Post Office investigated the system and apparatus brought forward by Mr. Marconi, who came here with proper credentials and introductions, and whose methods, after all, have, apparently, not commended themselves to the postal authorities. It seems to be forgotten too that Mr. Preece for 14 years past has been experimenting in this direction, and in 1895 secured practical success.

Nothing was said, nor, indeed, was much done, till it was discovered that the Post Office was making further experiments, and that there was a remote contingency of a new system of wireless telegraphy coming into actual use. Then, indeed, we find professors of the highest repute rushing into print, and using every opportunity to belittle the efforts of a young man who was merely attempting to demonstrate the commercial utility of a system that had been previously relegated to the lumber-room of a laboratory. We cannot help thinking such an attitude suggests little of the scientific spirit that pervaded such men as Faraday and Davy. There is an element of commercialism that we should scarcely expect to meet outside the City. Davy demonstrated the power of an electric current to effect chemical decomposition; moreover, by the agency of the electric current he succeeded in extracting potassium from potash, and thereby laid the foundations of an industry that has had untold influence upon the wealth of the country. But what was Davy's guerdon or reward? Faraday took Davy's electro-chemical work a step forward. More than all he discovered the first principles of the dynamo; but would Faraday have heaped abuse upon the men who, grasping the importance of his discovery, sought to utilise it in a practical way? We think not. Rather would he have rejoiced that the fruits of his mind had met with such striking appreciation.

Commercial electricity has done much we know to kill that kind of spirit, but still we should have thought that the dignity that even nowadays attaches to science, would have prevented the unseemly incidents that have marked the introduction of wireless telegraphy into this country.

THE ENGINEERS' STRIKE.

This we had hoped would have completely terminated before the opportunity of again using the above heading. But it seemed good to the strike leaders to withdraw the nominal basis of the quarrel, and to pretend to the continuance of the dispute on another basis, on the assumption of some fancied interference with the principles of trades unionism, a species of magniloquence now so common. A large display of verbiage is perhaps required to cover a few very awkward facts. A moderate estimate of expenditure and wages loss upon the strike is that the men's side have mulcted themselves to the extent of £3,000,000 sterling, which is a pretty big sum to pay for the privilege of butting one's head against a stone wall for six months, especially if it be thought that the destruction of the wall would drown one in the ditch beyond. But all this wall-butting has been done to please a section of the men's executive, and there is a disposition abroad to accept the intentions of this section as perfectly good, as founded on a belief that the results aimed at were such as could be commended. We confess never to have had this belief ourselves. We have not rated the intelligence of the men's executive at the level of their procedure, and have simply explained this procedure as dictated by personal motives alone, by a wicked desire to be unpleasant, irrespective of the consequences to either the enemy or to the deluded victims, the men themselves. When the *Engineer* considers it important that the wishes of Mr. Barnes and Mr. Sellicks should be known, we fail to see why. Could they have had their way, they would have had it even if they had wrecked the country in doing so. It is simply that they have a desire to get on in the world, and we recognise this desire as perfectly lawful to a point. Doubtless the idea was, once again, to squeeze employers, and rise a peg on the glory of having won a fight and paved the way for another. The suggested full management of the shops, and the action of the A.S.E. when they had got it, hardly comes into the scope of argument. The immediate question is what of the future. It is idle to blink the fact that the men are routed completely, and we know many of them are very sore. Can trades unionism be rehabilitated on respectable and sound lines? Is it absolutely necessary that the men's leaders should be men capable of stump oratory? We do not find that the managers of life insurance companies are speech makers, or even expected to be, yet in the case of the A.S.E. we find the huge funds of the biggest trades union placed unreservedly in the hands of a man whose title to run the business, seems to have been simply an ability to harangue the crowd.

When the 48 hours' demand was withdrawn, the employers offered to open their shops last Monday to the union men in their collective capacity, but this did not meet the men's approval, and the lock out notices pending were put in force. As a result of negotiation, however, the employers granted a week's extension of the time for returning to work, and by Sunday it was generally understood that next Monday will see a return to work. Fresh firms were posting lock-out notices up to the end of last week. The cause of the delay in returning to work seems to have been due to internal dissensions of unionism. The members in the country naturally feel they have been sold by the executive in London. They have fought for seven weary months the battle of the London men at the order of a London executive, on a point which is now dismissed as hardly worth consideration, and the men are now debarred from going back to work on a new issue altogether. All this, of course, raises into prominence the real issues, those of management and machine working.

As to the A.S.E., the general opinion is that this society is financially ruined, and a new society of 10,000 members is to be started on the Clyde. Probably the near future will see trades unionism more healthily managed, with self-contained local societies in place of one huge centralised body, of which the centre knows not the outlying districts except as contributors to the centre only. Local interests and general interests must be lost sight of when a trades union becomes a huge fighting machine. We should like to see not only trades unionism split up into local bodies, but also the Employers' Federation similarly reduced. It borders on the impracticable to deal with local interests by a centralised body. Far better work can be done by local societies with some touch of the humanities in them. Masters and men know each other; there is not the chance of working the amount of mischief that the present system allows the blatant self-seeking agitator.

In the old days of 25 years ago we recollect how the representative of the union in the workshop got along on friendly terms with both men and masters, and it would be so again were the irresponsible district general secretary unable to foment local quarrels on such questions as the opening of eggs at the large or small end. To run a huge affair like the A.S.E. successfully demands brains and intelligence and common sense. From the very beginning of the present strike, or from when its true basis was perceived, which was not long after it started, everyone seems to have arrived at the conclusion that the men would lose, yet the fight went on to the complete extinction of funds and into a great depth of debt. Why could not the men's executive see that they could not win and retire before the strike was a month old? John Burns said he would have it over in a fortnight. Why, if he could not win in a fortnight, did he not consent to be beaten? We think it well that the men's leaders have been afforded a glorious opportunity of demonstrating their intelligence and capacity to lead. With their fall comes the destruction of the false surroundings that have gathered upon trades unionism and choked its vitality, but the fall of trades unionism as practised by no means implies its extinction as an honourable institution when properly managed.

The morning papers of last Monday were able to announce that the strike was over, and that next Monday will see a general return to work. This will round up the duration to 30 weeks. To each clause of the employers' conditions there is now appended a note. We see very little in these notes, but it pleases Mr. Barnes to consider they modify the harshness of the clauses, and the men are ordered back to work. While, therefore, we are of opinion that the men have lost, as they deserved to do, we consider also that they will discover, before they can again afford to strike, that there are possibilities of high wages in British engineering that they have been for years striving to bury under a load of stupid restriction. That this may be found out by the men is much to be hoped, and this it is makes it so desirable for employers to keep to the front. True, they have had very little encouragement from their men these dozen years or more. Engineering has been a heart-breaking business with the half-hearted service and the rampant tyranny of trades unions; but we hope this is all over, and that work will now go on harmoniously, and we hope also all the men at present out will speedily be re-engaged, and find good wages. We reprint below the final clauses and notes of agreement. Resumption of work still awaits the return of the men's ballot which was to take place yesterday, but Mr. George Barnes, interviewed by a Press representative, stated that the men would have to accept the terms of settlement whether they liked them or not. Work would definitely be resumed on Monday next, 31st inst.

Thus, in this curt manner, does the men's general secretary treat the feelings of the 81,000 men who, whatever else may be said, have fought a plucky fight. Here are the final clauses:—

"General Principle of Freedom to Employers in the Management of their Works.

"The federated employers, while disavowing any intention of interfering with the proper functions of trade unions, will admit no interference with the management of their business, and reserve to themselves the right to introduce into any federated workshop, at the option of the employer concerned, any condition of labour under which any members of the trade unions here represented were working at the commencement of the dispute in any of the workshops of the federated employers; but, in the event of any trade union desiring to raise any question arising therefrom, a meeting can be arranged by application to the Secretary of the Employers' Local Association to discuss the matter. Nothing in the foregoing shall be construed as applying to the normal hours of work, or to general rises and falls of wages, or to rates of remuneration."

Note.—No new condition of labour is introduced or covered by this clause. It simply provides for equality of treatment between the unions and the Federation by reserving for all the members of all the trade unions, as well as for all the federated employers, the same liberty which many trade unionists and many employers have always had. Special provision is made in the clause and in subsequent "provisions for avoiding disputes" to secure to workmen, or their representatives, the right of bringing forward for discussion any grievance or supposed grievance.

"1.—Freedom of Employment.

"Every workman shall be free to belong to a trade union, or not, as he may think fit. Every employer shall be free to employ any man, whether he belong or not to a trade union. Every workman who elects to work in a federation workshop shall work peaceably and harmoniously with all fellow employés, whether he or they belong to a trade union or not. He shall also be free to leave such employment, but no collective action shall be taken until the matter has been dealt with under the provisions for avoiding disputes. The Federation do not advise their members to object to union workmen, or give preference to non-union workmen."

Note.—The right of a man to join a trade union if he pleases involves the right of a man to abstain from joining a trade union if he pleases. This claim merely protects both rights. The Federation sincerely hope that a better understanding will prevent any question of preference arising in the future, and advise the members not to object to union workmen.

"2.—Piecework.

"The right to work piecework at present exercised by many of the federated employers shall be extended to all members of the Federation and to all their union workmen. The prices to be paid for piecework shall be fixed by mutual arrangement between the employer and the workman or workmen who perform the work. The Federation will not countenance any piecework conditions which will not allow a workman of average efficiency to earn at least a wage at which he is rated. The Federation recommend that all wages and balances shall be paid through the office."

Note.—These are just the conditions that have been for long in force in various shops. Individual workmen are much benefited by piecework. A mutual arrangement as to piecework rates between employer and workman in no way interferes with the functions of the unions in arranging with their own members the rates and conditions under which they shall work.

"3.—Overtime.

"Terms of Recommendation Agreed to be made to Employers.

"When overtime is necessary, the federated employers recommend the following as a basis and guide:—That no man shall be required to work more than 40 hours' overtime in any four weeks after full shop hours have been worked, allowance being made for time lost through sickness or absence with leave. In the following cases overtime is not to be restricted, viz.:—Breakdowns in plant; general repairs, including ships; repairs or replace work, whether for the employer or his customers; and trial trips. It is mutually agreed that, in cases of urgency and emergency, restrictions shall not apply. This basis is to apply only to men of the trade unions who are represented at this Conference. All other existing restrictions as regards overtime are to be removed. It is understood that, if mutually satisfactory to the Local Association of Employers and the workmen concerned, existing practices regarding overtime may be continued."

Note.—These overtime conditions are precisely the conditions now in operation in various places, though in many federated workshops no limitation whatever exists at the present time. In many cases this will be the first attempt to regulate or prevent excess of overtime.

"4.—Rating of Workmen.

"Employers shall be free to employ workmen at rates of wages mutually satisfactory. They do not object to the unions or any other body of workmen in their collective capacity arranging amongst themselves rates of wages at which they will accept work, but, while admitting this position, they decline to enforce a rule of any society or an agreement between any society and its members. The unions will not interfere in any way with the wages of workmen outside their own unions. General alterations in the rate of wages in any district or districts will be negotiated between the Employers' Local Association and the local representatives of the trade unions or other bodies of workmen concerned."

Note.—Collective bargaining between the unions and the Employers' Associations is here made the subject of distinct agreement. The other clauses simply mean that as regards the wages to be paid there shall be (1) freedom to the employer; (2) freedom to the union workmen both individually and in their collective capacity —that is to say, collective bargaining in its true sense is fully preserved; and (3) freedom to non-unionists. These conditions are precisely those in operation at present on the North-east coast, the Clyde, and elsewhere, where for years past alterations of wages have been amicably arranged at joint meetings of employers and representatives of the trade unions.

"5.—Apprentices.

"There shall be no limitation of the number of apprentices."

Note.—This merely puts on record the existing practice, and is to prevent a repetition of misunderstandings which have arisen in some cases.

"6.—Selection, Training, and Employment of Operatives.

"Employers are responsible for the work turned out by their machine tools, and shall have full discretion to appoint the men they consider suitable to work them, and determine the conditions under which such machine tools shall be worked. The employers consider it their duty to encourage ability wherever they find it, and shall have the right to select, train, and employ those whom they consider best adapted to the various operations carried on in their workshops, and will pay them according to their ability as workmen."

Note.—There is no desire on the part of the Federation to create a specially favoured class of workmen.

"Provisions for Avoiding Disputes.

"With a view to avoid disputes in future, deputations of workmen will be received by their employers, by appointment, for mutual discussion of questions in the settlement of which both parties are directly concerned. In case of disagreement, the local associations of employers will negotiate with the local officials of the trade unions. In the event of any trade union desiring to raise any question with an employers' association, a meeting can be arranged by application to the secretary of the employers' local association to discuss the question. Failing settlement by the local association and the trade union of any question brought before them, the matter shall be forthwith referred to the executive board of the Federation and the central authority of the trade union; and pending the question being dealt with, there shall be no stoppage of work, either of a partial or a general character, but work shall proceed under the current conditions."

Note.—A grievance may be brought forward for discussion either by the workman individually concerned, or by him and his fellow workmen, or by the representatives of the union.

General Explanation.—In no instance do the federated employers propose conditions which are not at present being worked under by large numbers of the members of the Allied Trade Unions. The federated employers do not want to introduce any new or untried conditions of work, and they have no intention of reducing the rates of wages of skilled men. These conditions, with relative notes, are to be read and construed together.

The following is also to be read in to the terms, being part of letter handed to the delegates at the Hotel Metropole on January 21st:—

"The note appended to the recent explanations issued by the employers, disclaiming any intention of reducing the rates of wages of skilled men, applies to time wages and to piecework earnings. In the latter case there is no intention of interfering with the usual practice of making extra payment for extra effort."

The latest news to hand is that such ballots as have come in are in favour of a return to work on the above conditions.

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending Jan. 18th, 1897.	£	s.	Week Ending Jan. 18th, 1898.	£	s.
Antwerp	13	0	Aden	48	0
Auckland	112	0	Alexandria	40	0
Barcelona	15	0	Amsterdam	200	0
Barranquilla. Teleg. mat.	350	0	Antwerp	195	0
Bremen	50	0	Auckland	150	0
Buenos Ayres	54	0	Bangkok	150	0
Brisbane	13	0	Bombay	21	0
Calcutta	391	0	Bremmerhaven	34	0
Cape Town	35	0	Buenos Ayres	75	0
Colombo	129	0	Bushire. Teleg. mat.	120	0
Durban	727	0	Calcutta	102	0
East London	167	0	Cape Town	125	0
Hamburg. Teleg. mat.	225	0	Colombo	44	0
Hobart	27	0	Flushing	160	0
Hong Kong. Telep. mat.	90	0	Genoa. Old Teleg. wire	60	0
Madras	12	0	Gibraltar	15	0
Melbourne	135	0	Hamburg	35	0
" Teleg. mat.	74	0	Madras	29	0
Perth	173	0	Malaga	494	0
Port Elizabeth	360	0	Melbourne	87	0
Reval	30	0	Monte Video	69	0
Santander	250	0	Natal	429	0
Shanghai	465	0	Odessa	63	0
Singapore. Teleg. mat.	82	0	Ostend	78	0
Smyrna	67	0	Port Chalmers	34	0
Syra	42	0	Port Elizabeth	45	0
Sydney	415	0	Singapore	24	0
Wellington	231	0	Sydney	60	0
			Yokohama	107	0
Total	£4,736	0	Total	£3,103	0

Foreign Goods Transhipped.

	£	s.
Melbourne. Teleg. mat.	200	0

Electrical Wares Exported.

Week Ending Jan. 25th, 1897.	£	s.	Week Ending Jan. 25th, 1898.	£	s.
Alexandria	372	0	Adelaide	178	0
Albany	397	0	Alexandria. Teleg. wire	23	0
Amsterdam	125	0	Amsterdam	60	0
Antwerp	151	0	Bangkok	24	0
Bangkok. Teleg. cable	120	0	Bombay	6	0
Bombay	50	0	" Teleg. mat.	47	0
Buenos Ayres	488	0	Boulogne	37	0
" Teleg. mat.	73	0	Calcutta	44	0
Calcutta	454	0	Cape Town	241	0
Callao. Elect. Lighting Cable	768	0	Colombo	9	0
Cape Town	368	0	Copenhagen	24	0
Colombo	50	0	Durban	58	0
Durban (and 187 tons Teleg. mat.)	142	0	East London	10	0
East London	147	0	Flushing	10	0
Flushing	38	0	Genoa	297	0
Hiogo	508	0	Gothenburg	560	0
La Treport	10	0	Hobart	15	0
Madras	14	0	Malta	48	0
Melbourne	92	0	Melbourne	72	0
Perth	165	0	Ostend	10	0
Port Elizabeth	25	0	Port Elizabeth	236	0
Reval	72	0	Rangoon	22	0
" Teleg. mat.	80	0	Rosario	114	0
Rosario	108	0	Shanghai	163	0
Santos. Teleg. mat.	592	0	Singapore	32	0
Sydney	573	0	Sydney	1,017	0
Valparaiso. Teleg. mat.	145	0	Vigo. Teleg. cable	10,920	0
Yokohama	535	0			
Total	£6,661	0	Total	£14,267	0

Foreign Goods Transhipped.

	£	s.		£	s.
Port Elizabeth. Teleph. mat.	143	0	Cape Town. Electrical machinery	264	0

Alternating Enclosed Arc Lamps.—The General Electric Company are, we understand, now in a position to supply a good enclosed arc lamp for alternating current circuits, taking 6 amperes.

Annual Dinners.—The annual dinner of Messrs. Rosling & Appleby, electrical engineers, of Bradford, took place at the County Restaurant on Friday evening, 21st inst., when about 100 sat down. A musical programme was afterwards executed.

The staff and long-service employés of the Electric Construction Company, Limited, sat down to the fourth annual dinner given by Sir Daniel Cooper, Bart., the chairman of the company, on 8th inst. There were 220 persons present.

Bankruptcy Proceedings.—At the London Bankruptcy Court last week William Alan Fraser, electrical engineer, Cecil Court, Charing Cross Road, applied for an order of discharge. According to the official receiver's report, the bankrupt failed last February with liabilities £904, and no realisable assets. He commenced business in partnership at 18, Cecil Court, in May, 1895, with a capital of £250, borrowed from his father. The trading resulting in a loss, the partner retired in the following August. The bankrupt opened a branch business at Guildford in November, 1895, but that proved unprofitable, and was discontinued in July, 1896. During the following month he abandoned the London business, which had been carried on at a loss throughout, sold off the stock, &c., for £60, and used the proceeds partly in paying debts and partly for personal expenses and subsistence. The offences reported were (1) insufficiency of assets to pay 10s. in the £ to the unsecured creditors, (2) imperfect books, and (3) trading with knowledge of insolvency. His Honour upheld the report, and imposed a suspension of two years.

The case of Messrs. Paterson & Cooper, electrical engineers, of the European Works, Pownal Road, Dalston, Princes Chambers, Victoria Street, Westminster, and Regent Street, Glasgow, came before Mr. Registrar Brougham last week at the London Bankruptcy Court. The failure occurred in August, 1896, the accounts showing total liabilities £19,514, and assets valued at sufficient to yield a surplus of over £7,000, after discharging all liabilities. An application for the discharge of the bankrupts has been lodged, and was in the list for hearing on the 21st inst. Mr. Muir Mackenzie, on behalf of the debtors, applied for a further adjournment, in order that the assets might be realised before the application was heard, as the decision of the Registrar would be affected by the result. By consent of the official receiver and all other parties interested, his Honour ordered the hearing to stand over until March 25th.

Business Announcement.—Mr. J. W. Westmoreland, F.I.C., who has been for the last five years an assistant analyst with Mr. Edward Riley, has opened a laboratory and assay office at 3, Love Lane, Eastcheap, E.C., and is prepared to undertake the sampling, assay, and analysis of ores, minerals, metals, and metallurgical products generally.

Catalogues.—The General Electric Company have issued the 12th edition of their electric bell catalogue, also the seventh edition of their telephone list. These two sections of the company's catalogue contain prices and particulars of all requisites for electric bells and telephones, and these editions are specially brought out to emphasise the fact that, as these are the two directions in which the hardware dealer or ironmonger usually starts when adding electrical work to his business, the company have kept the idea before them of making them as simple as possible, in order that a customer may find them sufficient to enable him to start in these lines. A full description is given of their new works at Manchester, where the supplies mentioned are made. In the electric bell catalogue many new developments are introduced. The bell and indicator pages have been very much enlarged, and many new patterns added. Batteries, bell pushes, wire, and all the various accessories are detailed. As in previous editions, a few notes are included on the application of electricity, instructions and diagrams, enabling customers to fit up any ordinary electric bell installation. At the company's Manchester works a very large extension has been made by the laying down of new and most efficient plant for the manufacture of telephone supplies, and it is considered that the telephone catalogue will show that in all branches of the telephone industry a very great advance has been made since the issue of the former edition. Special attention is directed to the general intercommunication telephone sets, and also to the fact that throughout the list the transmitter in use is the Hunningscone Deckert, which has done excellent service. Many new illustrations are in this section, showing the developments alluded to, and as in the case of the bell catalogue, the fitting of the various systems mentioned in the list is dealt with at the end by means of diagrams and descriptive letterpress.

Messrs. Cox-Walkers, of Darlington, send us a blotting square for the desk.

Ediswan's Employés.—The employés at the Ponder's End Works of the Edison and Swan United Electric Light Company, Limited, held their annual Christmas entertainment in the Queen's Hall, People's Palace, on Friday, January 21st. A special train was engaged, left in the afternoon carrying about 1,100 of the workpeople and their friends. The programme included dancing, Mr. Berry's Concert Party, and the Animated Photographs. The employés were admitted free to the East London Exhibition of Trades and Inventions, which adjoins the Queen's Hall.

Ediswan Lampholders.—The Ediswan Company are introducing the "Ediswan" enamelled liner, or "anti-shock" lampholder, which consists of the company's patent "S" insulator, the interior of which is surrounded by a patent enamelled liner, thus entirely preventing any possible contact with the outer case by means of stray ends of wire. The enamelled liner, as shown, is fitted inside the brass case in such a manner that it does not interfere with the present facility of wiring, &c., and the holder may be wired without removing the enamelled liner. The company's lampholder licenses expired yesterday, 27th inst., and the patent "S" holder can be manufactured only by this company, and supplied with or without the enamelled liner.

Experimental Research.—Messrs. F. Hutchins & Co., experimental engineers, 13, Victoria Street, Westminster, announce that they have lately taken new premises at Gray Street, Blackfriars, which are now fully equipped for carrying out experimental work. Besides workshops for the manufacture of technical apparatus and inventors' models of all kinds, they have private rooms which can be placed at the disposal of patentees and others, with engine power, use of tools and instruments, supply of electric current, &c. In connection with electro-chemical and other such work, when in the experimental stage, considerable expense has usually to be incurred in taking special premises and purchasing plant. We understand that special facilities are offered by Messrs. Hutchins & Co. for such work.

Granger's Steam Jet Blowers.—We have received from Mr. W. A. Granger, of Brooke Road, Stoke Newington, an illustrated list of his forced draught furnace, in which the advantages of forced draught are dilated upon, the Granger system described, its good points emphasised, and the saving effected by it mentioned. The statements are supported by results of tests made in every-day practice. A list is given of firms using the system. Another list issued by Mr. Granger gives particulars of his patent variable steam jet blowers. It is claimed that these can be very easily applied to Babcock boilers by placing them either through the back or sides of the ashpit, or under the floor level, so that the front of the boiler remains quite unaltered. We understand that the blowers are in use at large iron and steel works in the Glasgow, South Wales, and other districts, chiefly for blowing ingot furnaces and gas producers. They are also used at several electric light stations, including the Kensington and Knightsbridge works, where they are employed on the Babcock boilers at both Chapel Place and Kensington Court.

Liquidation Notices.—A petition by Henriette R. Gaulard, of 28, Canterbury Road, West Croydon, for the winding up of the National Company for the Distribution ot Electricity by Secondary Generators, Limited, is to be heard at the Law Courts before Mr. Justice Wright, on February 2nd.

A meeting of the Westralian Electric Lighting and Supply Company will be held at 54, Old Broad Street, London, on March 2nd, at 2 o'clock, for the purpose of hearing an account of the winding up from Mr. G. H. Homan, the liquidator.

Notching Armature Discs.—Messrs. Sponholz and Wrede, of Exercier Strasse, 6, Berlin, send us a list of their automatic machines for notching armature discs in dynamo machines and electro-motors.

Parliamentary Bills.—Among the Bills before the Examiners of Private Bills at the House of Commons on Monday that complied with the Standing Orders of Parliament were the Central Electric Supply Company (Powers and Works in Marylebone) and the General Power Distributing Company.

"Sell's Directory of Telegraphic Addresses."—Mr. Henry Sell has just published his well-known directory of telegraphic addresses, which is, as usual, compiled from official lists supplied by the Postmaster-General, and contains all the information received from the Post Office to January 1st, 1898. In addition to telegraphic addresses and telephone numbers, there is much useful data. Telephone and telegraph rates for all parts, both at home and abroad, are set out in handy tabular form. The details of charges for communication on the trunk lines constitute a good feature, and reductions in cable rates are also interesting. There are some general comments and statistics regarding British trade during the past year —a period of prosperity and conflict.

Standard Electric Company.—We are asked to state that on and after February 1st, 1898, the firm of Green & Treacher, established in 1888 for the supply of electrical sundries and as manufacturing electricians, will be conducted under the name of the Standard Electric Company, at 17, Garlick Hill and 191 & 192, Upper Thames Street, E.C.

Steam Mail Carts.—Messrs. Julius Harvey & Co., who have completed their first six weeks contract under the Postmaster-General for conveying mails by steam motor van from London to Redhill, have been asked by the authorities to make another contract for a further period, the trials having been very satisfactory.

"Stearn" Lamps.—The Zurich Incandescent Lamp Company, of Victoria Street, S.W., has issued a new list (January, 1898) of the "Stearn" high voltage lamps, which, we observe, are used by about a score of municipal and company electricity supply establishments in this country. The list is undoubtedly a work of art, the arrangements, illustrations, and printing being of the best. Many of the lamps are shown natural size, including the double carbon, double carbon with filaments in parallel planes, single filament, and high voltage types. Among others included in the list are fancy, changeable voltage, miniature, candle, and other lamps.

The National Company for the Distribution of Electricity by Secondary Generators v. Gibbs.—In the Chancery Division on Saturday, before Mr. Justice Stirling, the above action was mentioned upon a motion for judgment in default of defence. Mr. Gore Brown moved the motion on behalf of the company, and Mr. Rawdon, who had just been instructed on behalf of the representative of the defendant, urged that this matter should not be taken as a short cause, but should go into the general paper, and that he should have leave to defend. It was a case in which injustice would be done unless he had an opportunity of defending it. His client was a foreigner, and her only appearance had been under protest, and he (Mr. Rawdon) wished an opportunity to consider whether he should move to discharge the service of the writ. The lady was in Paris, and that day only had her solicitors here got the affidavit from her. Mr. Gore Brown said that the other side had already had plenty of time. This was a claim made by the company against two gentlemen who assigned certain patents, relating to electrical distribution, for £220,000, with a warranty that the patents were valid.

The price was to be £200,000 in shares, and £20,000 in cash, and the vendors undertook to establish their title to the patents, and transfer them to the company. But the patents had not been transferred, and had been found in great part to be invalid and void. The defendant, Ruell, was administratrix of one of the patentees, and a claim had been made for the assignment, and damages for breach of the agreement. The writ was issued on December 16th, 1896; leave to serve on Ruell was given on February 22nd, 1897, and she entered an appearance under protest on March 3rd. That was not a step in the action which would prevent anyone so appearing from moving within a reasonable time to have service of the writ set aside; but he submitted it must be done within a reasonable time, and here there had been 10 months delay. There had been litigation going on in France in connection with the same matter, and in 1894 the company obtained judgment entirely in their own favour, a decision which was affirmed on appeal, and there was really no ground for disputing the agreement. After some further argument, his lordship said that although there had been very great delay on the part of the defendant, still he thought it necessary, for her proper protection, to give her an opportunity further to consider her position. He accordingly directed that the motion should stand over until the first day on which he took non-witness actions.

The Ward Electrical Car Company, Limited.—Under the winding-up order recently made against this company, the statutory meetings of the creditors and shareholders were held on Wednesday, before Mr. Culley, Assistant Receiver, at the Board of Trade offices, Carey Street, Lincolns Inn Fields. The Chairman said the facts relating to the case were somewhat peculiar. The company was registered in October, 1888, with a capital of £300,000, and was apparently promoted by Mr. Ward, in conjunction with a Col. McMurdo, with a view to the acquisition of certain inventions relating to electricity and belonging to Mr. Ward, also to carrying on the business of electrical engineers. The whole of the capital—except the signatories shares—was issued to Mr. Ward on return for his inventions, and he was also to act as managing director at £1,000 a year, payable only out of profits, or until the formation of a subsidiary company. The whole of the shares having been issued to the vendor. The company had no working capital, but Mr. Ward entered into an agreement with Col. McMurdo for the sale to the latter of 22,500 shares for £10,000 payable as to £1,000 to Mr. Ward, and £9,000 to the company. Col. McMurdo died in May, 1889, having paid £4,362 on account. Mr. Ward then entered into an agreement with the Receiver of his estate, under which 20,000 shares were to be returned to him, and he was to provide the company with £5,000 for working capital. Mr. Ward further undertook to pay the company's liabilities until December, 1890. The money received by the company was used in developing the patents, but apparently without any definite results, and the only property acquired was stated to be a small amount of plant that had been seized by the landlord for rent, and an omnibus which had been seized under a judgment. The directors in April, 1896, authorised Mr. Ward to sell the whole undertaking to a new company for £35,000, payable as to £5,000 in cash, and the remainder in shares. That scheme was not carried through, but subsequently Mr. Ward, and a Mr. Marshall, floated the London Electrical Omnibus Company, Limited, to acquire other inventions belonging to the former gentleman. The purchase price was £20,000 cash, and £80,000 in shares, and was to be divided between the two promoters. Under the agreement with the first company, it was provided that all inventions and improvements thereon, sold to that company, should become its property. The inventions sold to the second company were stated to be improvements on the original inventions, so that a question of title would doubtless arise between the two companies. Mr. Ward had stated his intentions of handing over his shares in the new company for the benefit of the old company, and Mr. Marshall was now bankrupt in the London Court. The directors in August, 1892, resolved to issue debentures to a certain firm, and although there had been no actual issue, a claim to some of the company's property had been maintained with success. The original patents had apparently lapsed, with the result that the only asset belonging to this company was its interest in the London Electrical Omnibus Company, Limited. Accounts had been prepared showing unsecured debts, £863; fully-secured debts, £2,435; and assets, £1 9s. 1d. Mr. Ward intimated that he desired to present the shareholders with shares in the London Electrical Omnibus Company, Limited, which was now in a position to make a considerable profit by running electrical omnibuses. He had no doubt but that the old shareholders would consent to such an arrangement, as the shares would be of considerable value. The matter was left in the hands of the Official Receiver, to be dealt with in the usual manner.

The Year 1897.—Messrs. Drake & Gorham inform us that 1897 fully answered their expectations. The number of installations in country houses completed during the 12 months continues to increase, and twice during the year the firm has engaged new suites of offices. Amongst the country house installations may be mentioned the lighting of Rolleston Hall, for the Right Hon. Lord Churchill, with two large oil engines, and upwards of 300 lights; Brook House, for Mrs. Stephenson Clarke, with two steam engines and 420 lights; Tal-y-Garn, for Mr. Godfrey Clark, with two oil engines and 365 lights. The long list of installations also includes several hundred lights for the Marquis of Lansdowne; the lighting of Dr. Conan Doyle's house; also that of Mr. W. J. Crossley, of Crossley Bros.; Oulton Park for Sir Philip Egerton, &c. One of the largest isolated installations in the kingdom has been put down for the Prudential Assurance, and consists of a generating plant for 6,500 lamps of 16-C.P. An installation of 2,500 lamps, and a number of Jandus lamps, has just been completed for the Auxiliary Army and Navy Stores. The firm's Manchester branch have completed a number of installations in private houses, mills, and public buildings, amongst which may be mentioned the Linotype Company's new works, where 254 "Jandus" arc lamps, as well as 240 incandescent lamps, have been placed. The progress of the "Jandus" lamp, for which the firm are the sole selling agents, has been phenomenal, and a special department has been found necessary to cope with this rapidly extending business. The firm have developed a system of iron conduits, with a patented form of joint, which avoids all screwing, and consequently effects a considerable saving in labour.

ELECTRIC LIGHTING NOTES.

Aberdeen.—Councillor Johnson recently undertook to consult Prof. Kennedy on the question of utilising the dust of the city in producing electricity.

Bath.—Mr. G. F. Metzger has now been officially appointed by the urban sanitary authority as engineer and manager of the electric light works, to carry out the same duties as he has heretofore performed, at a fixed inclusive salary of £500 per annum, and two-thirds of apprentices' premiums.

Bristol.—The electrical engineer, Mr. Faraday Proctor, is to report on the cost of placing the electric light in a Cabot tower which is now being erected.

Bromley.—The Board of Trade have provisionally agreed to transfer the electric lighting order, but after a long discussion the District Council have postponed the question pending information as to the status of the company.

Cardiff.—The Electrical Engineer (Mr. Appelbee) reports that the total number of 8-C.P. lamps supplied on December 31st last was 15,431, compared with 14,136 in the corresponding period of 1896, an increase of 1,298. The lamps connected and applications received during December were 208, and the total number of lamps awaiting connection at the end of the month was 1,296. The number of units generated during December was 63,783, compared with 59,365 in the corresponding period of 1896, an increase of 4,418. The calculated revenue for last month was £78 from arc lamps, and £786 from private supply; total, £864. The revenue in December, 1896, was £819 19s. 1d. The lamp connections were less than could be wished, but the department was hampered for want of plant. The sale of current for the year 1896 was 308,430 units, compared with 342,461 units in 1897, an increase in the latter year of 34,031. The rates now charged were 6d. for the first two hours and 3½d. afterwards. He suggested that the rates should be 7d. for the first hour and 3½d. afterwards.

Chester.—A feeder is to be laid to increase the pressure for the light in Brook Street, Foregate Street, and other thoroughfares, at an estimated cost of £2,050. Councillor Roberts stated at the last Council meeting that the Electric Lighting Committee's expenses had been about £2,400, and their receipts had been close upon £5,000. The winter quarter ending December had realised close upon £1,800. They were told by Mr. Thursfield, who had had the management of the works as Messrs. Parker's representative, that they might look forward to a gross income next year of about £8,000. Notice has been given to Messrs. Parker that the Corporation intend to take over the works at the end of March. The sub-committee were going to recommend that the price during the current year should be 5d. instead of 6d. per unit. Two consumers of 2,000 units had received discount, enabling them to have the light at the net price of 4½d. per unit.

Dingwall.—The Town Council last week discussed the terms of a proposed agreement with the company which intends electrically lighting the district.

Douglas.—The Lighting Committee has considered tenders of the Douglas Gaslight Company and the Isle of Man Tramways and Electric Power Company to light the town respectively by gas and electricity, and has decided to recommend the acceptance of the Gaslight Company's tender, with power to terminate the agreement at any time so far as the sea front is concerned. The Gaslight Company offered to light the town with Welsbach burners at various prices per burner, while the Tramways Company offered to supply the current only for electric lighting at 3½d. per Board of Trade unit.

Dublin.—A member of the Dublin Mercantile Association complains that he has been waiting for a supply of current for about two years, and has not yet been supplied, although, he says, the mains come right up to his shop. He has been informed that the Corporation has not current to supply him with, and somehow or other from this he reasons out that the electric lighting powers should be handed over to the Electric Tramway Company, whose scheme is before the Corporation. The Dublin Mercantile Association consider that the rates now charged are excessive, and that if if the Corporation cannot improve the service, they should invite others to submit schemes.

Edinburgh.—The Lighting Committee recommends the lighting by electricity of various roads with 16, 13, 10, 16, 7, 12 and 16 lamps respectively. The proposal is that the lamps should be lighted at the rate of £15 per annum.

Elland.—The District Council has decided to ask the electrical engineer of Nelson to visit Elland, and make a report as to the character of the installation suitable for the needs of the town.

Finchley.—The Municipal Electric Supply Company has submitted terms of a proposal to light East Finchley with electricity. These have been sent to a committee for consideration.

Folkestone.—Plans of the electricity works have been prepared, and building operations are to be commenced at once.

Fort William.—The charges for current here to ordinary consumers are 9d. per unit from one hour before sunset till 9 p.m., and from 9 p.m., to one hour before sunset the following day 4½d. per unit. In the case of workmen's houses, there is a fixed rate of 10s. per 16-C.P. lamp per annum. The town is lit for the same price as was paid for gas, but instead of 58 gas jets there are six arc lights of 1,000-C.P. each, and 58 16-C.P. lamps. When the town was lit by gas there was the additional cost for lamp lighting, while this is now done from the central station. Three thousand lamps are now being supplied, but the plant has double that capacity.

Glasgow.—Mr. Chamen, the newly-appointed Corporation electrical engineer, will take up his duties from to-day. The Electricity Committee will now proceed with the arrangements necessary for the erection of the new works.

The Corporation has decided to supply the stanceholders in the Dead Meat and Fish Markets with the necessary current for lighting purposes.

Hampstead.—The Vestry has advanced Mr. Cottam's salary from £400 to £450 per annum. The chief assistant engineer has an increase from £200 to £225, and three assistant engineers are to advance from £117 to £130 each.

Hanley.—The Council's charge for electric current for motive power purposes is to be reduced from 3d. to 2½d.

Heavitree.—The Surveyor is shortly to report as to his inquiries *re* electric lighting.

Hornsey.—The Hornsey Gas Company and the Great Northern Railway Company threaten to oppose the municipal electric lighting scheme.

Horsham.—The District Council will spend £20 in obtaining information as to the cost of electric lighting for the district.

Huddersfield.—The borough electrical engineer, Mr. A. B. Mountain, has reported that the number of consumers is now 598, an increase of 30 over the number recorded in December. The lamps connected in the present month were 41,702, and in December 39,977—an increase of 1,725. The Empire Theatre, Huddersfield, is to be electrically lighted, and the management asked for the same rate of charges as were made for lighting the Theatre Royal. Tenders for the extension of the electric lighting station have been accepted. The extension is absolutely necessary in view of the increase of the business.

Islington.—The Vestry decided last week to lay a new cable and conduits from the works through Wellington Street to St. James's Road, and along one side of Liverpool Road to Upper Street, the total cost being estimated by the engineer at £3,164. The arc lighting is also to be extended through Liverpool Road, at a cost of £2,500, including about 40 arc lamps. Application is to be made to the London County Council for sanction to the borrowing of the necessary amounts.

Kingston.—Councillor Collings, chairman of the Lighting Committee, reports that for the past year the electric lighting revenue has been £3,889 17s. 6d., or £193 13s. 10d. less than they anticipated; whilst, on the other side, the cost of their works was £3,061 0s. 9d., or some £148 7s. 6d. below what they anticipated. They really anticipated a balance to the bad of £814 9s., and they found that the actual balance was £835 10s. 11d. The electric lighting undertaking had now reached another stage. Last year he reported that they were able to meet their works' cost, and he was able now to say that they could meet the interest on the principal.

Leicester.—The Gas and Electric Lighting Committee reports that the total output of current from the central station for the half-year ended December 31st last was 204,084 units. There were 350 consumers.

Liverpool.—The electrical engineer reports that up to December 31st the equivalent number of 16-C.P. lamps connected to the supply mains was, for private lighting, 60,690, and Corporation lighting 6,971, making a total of 67,661, being an increase of 2,706 for the month. The number of units supplied during December was, to private consumers, 300,658, and for the Corporation 64,455, making a total of 365,115, against 257,700 for the corresponding period of 1896.

Morecambe.—An arbitration took place on 24th inst. at Morecambe Council Office with respect to matters in dispute between the Council and the Old Electric Light and Power Company, Limited, on the former taking over the latter company's undertaking. The respective arbitrators were Mr. Thursfield, city electrical engineer, Chester, and Mr. Gibbings, city electrical engineer, Bradford. The principal point at issue was that the District Council agreed to give £3,897 for the Electric Light and Power Company's undertaking, and portion of plant, main cables and fittings, and a deed executed in February, 1896, contained a covenant stipulating that until the Local Government Board and the Board of Trade's sanction were obtained, and the undertaking formally taken over, the company were to keep the plant in the same state of repair as at the original valuation. The Council now alleged that the plant had deteriorated in value through being improperly stored, and the main cables not properly looked after, the latter being stated to be now useless for the Council's system, and worth £2,000 less than at the time of the valuation. In support of this contention, Mr. Parkinson, resident engineer, gave evidence as to recent tests, and was corroborated by Mr. Woodson, electrical engineer, Lancaster Waggon Works; Mr. Hedgecock, of the British Insulated Wire Company; and Mr. Burton, of Messrs. Callender & Co., London. The Chairman and Surveyor also spoke to the unsuitable place in which the stores were kept. On the other side it was contended that the mains were practically as good as when originally valued, except for 10 per cent. allowance for depreciation. On behalf of the company, Mr. Olirehugh, consulting engineer, Manchester, and Mr. Davidson, from Messrs. Glover & Co., Salford, who supplied the original cables, were called (says the *Leeds Mercury*) to show that the Council's tests were not taken under favourable circumstances, witnesses' tests giving 4,000 million ohms, as against 45,000 ohms by Mr. Parkinson. It was further contended that the cables could be put right for £50. The proceedings lasted several hours, and at the close the arbitrators intimated they would personally test the mains. At a recent Council meeting Mr. Parkinson, electrical engineer, submitted an amended plan, showing the positions of the arc lamps for public lighting. This was approved. It was resolved that, if possible, without interference with the terms of the present contract with Mr. Krauss, an arrangement be made with him and Messrs. Thomas Parker, Limited, with reference to laying arc light cables and erecting pillars on the promenade from East View to Bare.

Penarth.—The solicitors of the Electric Lighting Company have replied to the Cardiff Parliamentary Committee, stating that there is nothing substantial in the objections put forward to the electric lighting scheme.

Shanghai.—Arrangements were recently made for the electric lighting of Shanghai native city. Preliminary work was to commence in December.

Shoreditch.—The Vestry has been considering a scheme for heating the baths and wash-houses, so as to utilise in the most economical manner the steam supplied from the electric lighting and dust destructor engines. Messrs. Berry & Sons have quoted £4,695 as the cost of the necessary condensers and plant for the purpose. Mr. Henry Ward, C.E., has been appointed consulting engineer, at 5 per cent., to advise the Vestry in the matter, and to supervise the carrying out of the works.

Sittingbourne.—The new Sittingbourne waterworks have been lighted with electricity.

Southend-on-Sea.—Applications for the post of electrical engineer to prepare plans, &c., and supervise the construction of electricity works, have to be lodged with the Town Clerk by February 22nd.

Southport.—The electric lighting extensions have been completed, and the plant now installed has a capacity over five times as great as the original installation of 1893. The last addition includes an "ironclad" dynamo, driven by a 500 H.P. steam-engine, with a capacity of 10,000 lamps, bringing up the total capacity of the plant installed to 22,750 8-C.P. lamps.

St. Pancras.—At the Vestry meeting on 19th inst. Mr. Menzies, Chairman of the Electricity Committee, presented a report with plans and estimated cost of carrying out certain large extensions at the Stanhope Street, Regent's Park, generating station, in order to meet the continuously increasing demand for current. The scheme submitted provides for the erection of a new chimney shaft and buildings, including an additional boiler house, heightening and widening a portion of the engine room, so as to accommodate four 750-H.P. engines. It also provides for general stores, time, storekeeper's, and weigh-offices at the entrance to the yard, battery room over boiler house, condensing plant over engine room, with air pumps on engine room floor, boilers, lock-up coal bunkers under elevated roadway, ash elevator, and other minor accessories. It was unnecessary to instal the whole of the plant in the new buildings at the outset. A proportion only will be required, viz.:—Two 750-H.P. engines and dynamos, the bank of four boilers shown on plan, boiler feed pumps, feed-water heaters, a proportion of the condensing plant, switchboards, overhead travelling crane, ash elevator, lock-up coal bunkers, &c. The new chimney shaft would be some 200 feet high, 8 feet 6 inches internal diameter, and so designed as to accommodate all possible extensions on the present site. Mr. Sydney Baynes, chief electrical engineer, who had prepared the scheme, estimated that the capital expenditure on the portion of the building and plant, completed by the end of the present year, would be about £21,440. That sum included the cost of the chimney and flues, and represented the amount payable to the contractors, inclusive of £9,440, which would be due for the engines already ordered, and the whole completed scheme would involve a capital expenditure of £26,439, which the Vestry was now invited to sanction. Mr. Menzies, in moving that tenders be invited for carrying out the work, said they found as long ago as last March that all their plant and machinery was fully employed, and, therefore, they thought it was time to consider what they were going to do in 1898. They found from experience that it was necessary to order their machinery from 10 to 18 months ahead, and in order to cope with their enormously growing business they must get to work in time. A question to which the committee had given all the consideration in their power, was whether they could utilise the existing station in Stanhope Street for the proposed extensions, or whether they would erect a new and a third station. In the result they had decided on the former course on the ground of economy. Their business in 1897 had increased by 25 per cent. per annum, and at the present moment their plant was so heavily engaged, that it was doubtful the preceding night if they could spare sufficient machinery to try the new street lamps which had recently been erected; and further, it was now a question whether for some time they could accept any new customers. The Vestry had given them two dynamos, but they wanted boilers and housing for the dynamos, and when these were at work the capacity of the station would be doubled, and being capable of turning out 2,500,000 units of electricity a year, would be in a position superior to that of any London electrical station. There were indications that the time had arrived when they should provide for the future. If Mr. Maxim perfected his new incandescent lamp, it would mean that the people would have no more to pay for electricity than gas, and as through many channels they had enormous demand coming upon them, the committee, so as to be ready for any emergency, asked the Vestry to sanction this outlay, and thus be prepared for any demand which might arise during the next three or four years. Mr. Close seconded the motion, which was carried. Mr. Gardner did not object to the extension of the electric light, but he did not think it was a favourable time to ask for more money when the Electricity Committee owed its bankers £26,922 17s. 2d. for the Regent's Park station and £21,711 in connection with the King's Road station.

The L.C.C. Scheme.—The Highways Committee on Tuesday recommended the Council to invite, by public advertisement, tenders for the plant required for lighting the Embankment and Westminster Bridge by electricity. The scheme contemplates the provision of 144 arc lamps. It is suggested that they be distributed as follows:—28 along the kerb on the north side of the Embankment, 29 along the kerb on the river side, 64 along the parapet wall, five on the adjacent piers, eight in Northumberland Avenue approach, and 10 on Westminster Bridge and its approaches. Waterloo Bridge would be lighted free of charge by the Charing Cross and Strand Electricity Suppy Company, in consideration for permission to lay their mains across. The capital expenditure of the scheme is estimated at £25,300, and the annual maintenance cost at £3,509. The matter stands over until next week.

Torquay.—The opening of the electric lighting works has been postponed for another fortnight.

Treeton.—Subject to the approval of the Local Government Board, £140 is to be borrowed for completing the street lighting electric installation.

Turkey.—A Turkish paper just to hand announces that all the military barracks in Constantinople and the provinces are about to be fitted up for electric lighting, and that the necessary apparatus has been manufactured in the electrical department at the Admiralty in the Turkish capital.

Wallingford.—The electric light has been installed at the Wallingford Works of Messrs. Wilder Bros.

Weston-super-Mare.—In connection with the steps being taken by the District Council, for putting down a municipal electric lighting plant, the ratepayers have met together, and passed a resolution against the municipal proposal. They are in favour of a company taking the risk, and they recommend this course. A syndicate is at hand ready to pay all out-of-pocket expenses so far, if the Council will agree.

Wrexham.—The Local Government Board does not approve of the Council's proposal to purchase the Willow Brewery premises for £8,000, for the purpose of converting them into an electric light station, gymnasium, baths, &c. If the Corporation still desire to buy the property, the Public Works Loan Commissioners will be recommended to lend the necessary money.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Belgium.—La Société des Tramway Electriques de Gand is the title of a company which has just been formed in Ghent to acquire the horse tramway in that town owned by the Société des Railways Economiques de Liége-Seraing and the Compagnie des Railways à Voie Etroite, and to convert the same into electric lines. The capital of the company is £140,000.

Birmingham.—According to a Birmingham paper it seems that the negotiations between the Tramway Company and the City Corporation, which were broken off about a year ago chiefly on account of the objection raised by the Corporation to the overhead trolley on the recommendation of its Continental deputation, are about to be resumed. Mr. Ross is shortly to return to Birmingham. The *Daily Argus* in a recent article on the position says that the lapse of time has not improved the position of the company or contributed to an amicable settlement. To begin with the holders of the present lines are one year nearer the termination of the lease. Consequently, whatever necessity existed 12 months ago for an extension of time to replace the capital outlay is more urgent now. "But, on the other hand, the feeling against the extension of the lease is stronger than at that time. Those most completely in touch with the Council, and particularly the department charged with the task of negotiating with the City Council, assure us that members who, 12 months ago, shrank from so serious an addition to municipal responsibilities as the control of a tramway now admit that this course appears to be the only way out of a difficult situation. The force of the company's contention that the 21 years' lease inevitably entails a loss upon those who lay down an underground conduit is generally recognised. But the determination to resist the overhead system is stronger than ever."

Bradford and Leeds.—The promoters of this Light Electric Railway (Power and Traction, Limited; W. N. Stewart and R. A. Smith, M.I.E.E., managing directors) have been circulating a pamphlet respecting the proposed line and its good effects upon the districts touched by it.

Brentford.—The District Council has been considering the proposed trolley electric tramway scheme, which would touch this district, and seems favourably disposed toward the undertaking.

Bristol.—The Bristol Tramway Company are promoting legislation for the use of electricity on all their lines, and for the construction of new lines in several parts of Bristol, and this matter having been referred to at a meeting of the Bristol Sanitary Authority, the Town Clerk stated that the question arose whether the company had complied with standing orders as to the deposit of plans, and he had therefore laid a memorial before the Examiner of Standing Orders, complaining of non-compliance. The Committee approved of this course. The matter came before the Examiner on Friday, when the Corporation of Bristol was represented by Messrs. Dyson & Co., Parliamentary agents, instructed by the Town Clerk. Mr. Warwick Webb, Parliamentary agent, instructed by Mr. H. G. Doggett (Bristol), represented the company, on behalf of whom Mr. Sam. White (secretary), and Mr. Edwards (resident engineer), was also present. On behalf of the Corporation it was alleged that there were defects in notices, bills and plans, but after hearing all the arguments the Examiner decided in favour of the Tramway Company on all points. One of the allegations made by the Corporation was that proper notice had not been given of the proposal of the company to make their horse tramway an electrical tramway. It was a work of so much importance that proper notice ought to have been given. It would necessitate the breaking up of 11½ miles of the city streets. Mr. Faraday Proctor, electrical engineer to the Corporation, was called and said that under the Bill it would be necessary to take up the whole of the road bed for the entire width of the road, and perhaps 18 inches or 2 feet on either side, and to a depth exceeding a foot, in order to put down a concrete bed. At present the rails were on chairs, and these chairs rested upon blocks of concrete, but the rails in the spaces between the chairs merely rested on the road. It was proposed in the Bill to make a continuous bed of concrete along the whole length of the line.

Charing Cross and Paddington Bill "dead."—The Bill for powers to construct, at a cost of £1,225,734, an electric underground railway connecting Charing Cross, *viâ* Knightsbridge, with Paddington terminus, was officially marked "dead" at the Houses of Parliament last Friday, there being no appearance of the promoters when the Bill was called by the Examiner on Standing Orders.

Electric Tramway to the Alexandra Palace.—Preparations at the Alexandra Palace are going on apace. Spaces for industrial exhibits are nearly all let. The necessary repairs are well ahead. Arrangements have been completed to run an electric tramway from the Wood Green entrance up to the top of the hill for the benefit of residents in the Wood Green locality.

Finchley.—The Hampstead Vestry will oppose the scheme as set out in the Finchley, Hendon, and District Light Railways (Electric) Bill. The Finchley District Council has submitted its list of objections to the scheme.

France.—The construction of the new electric tramways in the town of Elbeuf (Seine Inferièure) is approaching completion. The plant at the power station comprises three Garnier steam engines and three Postel-Vinay 100-kilowatt dynamos.

Glasgow.—The German firm is reported to have given up the contract for tramway rails. A sub-committee is now to accept the tender of a Leeds firm, subject to the adjustment of certain details. The amount of this estimate—the only British competitor for the contract—is said to be £1,700 in advance of the German offer.

Hanley.—The Council has resolved "That a conference be arranged with the local authorities in the Potteries and Newcastle with a view of considering the advisability of proceeding unitedly for the purpose of acquiring and working the tramways and extending the same, and that subject to certain specified restrictions, the consent of the Council should be given to the application of the North Staffordshire Tramways Company for a provisional order to lay down further lines within the borough."

Kidderminster-Stourport.—A provincial paper says that it is expected that this line will be completed by about the end of February.

Kirkcaldy.—Prof. Kennedy had a meeting last week with the Tramways and Town Council Committees with a view to reporting on the proposed combined electric lighting and traction scheme. Prof. Kennedy recommended the combined scheme, which had no engineering difficulties, and was being carried out in other towns, and he approved of the overhead electric system of traction.

(*Continued on page* 117.)

THE MANUFACTURE OF TUDOR ACCUMULATORS.

It is hardly necessary to say that the Tudor accumulator had established a splendid reputation on the Continent long before it was introduced into this country. In the most striking developments in electric traction—we refer to the combined trolley and accumulator systems—the Tudor accumulator has been intimately associated, and when we say that the Hanover tramway system and the Zurich tramway rely for their efficient working on this type of accumulator, we are merely stating in another way that it has achieved the distinction of showing that the storage battery is not an impossible factor in tramway traction.

The Tudor accumulator is by no means due to an inventor's lucky inspiration. It has been slowly evolved from the results of protracted experiments and ceaseless observations. Mr. Tudor, who curiously enough is an Englishman, has been for many years developing the type of accumulator that we now associate with his name, and how great a commercial feature the Tudor accumulator is on the Continent, may be gathered from the fact that at Hagen alone there are 800 workpeople engaged upon its manufacture.

Some three or four years ago the Tudor accumulator was brought to this country by Mr. A. B. Pescatore, and the manufacture of it was commenced at Dukinfield, near Manchester, some time afterwards.

We have recently, through the courtesy of Mr. Pescatore, had an opportunity of witnessing the various operations that are carried on in the works at Dukinfield, and by means of the illustrations and notes we trust to be able to reproduce some of the impressions we received.

It is generally well known that the positive plates of the Tudor cells, which are perhaps the most distinctive features of these accumulators, are lead plates of large surface, and are formed on the Planté method. The large surface is due to the peculiar form in which they are cast. The plates are formed by a process very similar to the one originally devised by M. Gaston Planté, modified only so far as to ensure greater adherence and homogeneity, and to obtain greater rapidity in formation, without the use of corrosive acids, such as were employed by M. Planté in his later processes.

The first striking feature in a survey of the Dukinfield Works is the casting shop, in which there are two large melting pots, each capable of holding about two tons of lead. The one pot contains pure lead, from which the positives and most of the negatives are made.

The second pot contains an alloy of lead with a small quantity of antimony, which is used for certain small accessories and for the large type of negatives such as those in the Glasgow batteries referred to later on.

Although the casting shop is a difficult one to show by photography, the illustration gives a fair idea of its arrangements. In the construction of the Tudor cells, the manufacturers attach considerable importance to what appears to us a vital point, namely, the purity of the lead used in the plates. Indeed, we believe the makers are modest enough to affirm that much of the success achieved by the accumulator is due to this fact. However that may be, they certainly insist upon obtaining the best brands which can be guaranteed to contain less than 0·1 per cent. of impurities.

Plumbers' Shop.

The moulds in which the plates are cast are in two halves, each corresponding to one side of the plate, and consisting of a rectangular cast-iron frame, in which are held a number of gun-metal racks, 15 mm. wide, cut with very fine teeth. A very slight space is left between each rack, corresponding to a horizontal rib on the plate; at intervals of about 120 mm., a tooth is cut away on each rack, so as to give an extra strong vertical rib at those points. These vertical and horizontal ribs and the strengthened edges, while giving greater rigidity to the plates, provide paths for the current, of which they thoroughly ensure the even distribution. Slots are cut in the cast-iron frame, so that the lugs and strengthening edges are cast in one piece with the rest of the plate.

The two halves of the mould are mounted in a vice, one side of which is fixed, the other being movable, first for an inch in a direction parallel to itself, and then about an axis, so as to entirely open the mould for the removal of the plate. In the positive plate, when the mould is closed, the apexes of the teeth do not touch, and a thin backing is formed; the pitch of the teeth being about 2½ mm. and their depth 6 mm. In the moulds for the negative plates, which consist of an open grid, the teeth on either side touch when the mould is closed, and the thickness of the teeth on the racks is much greater.

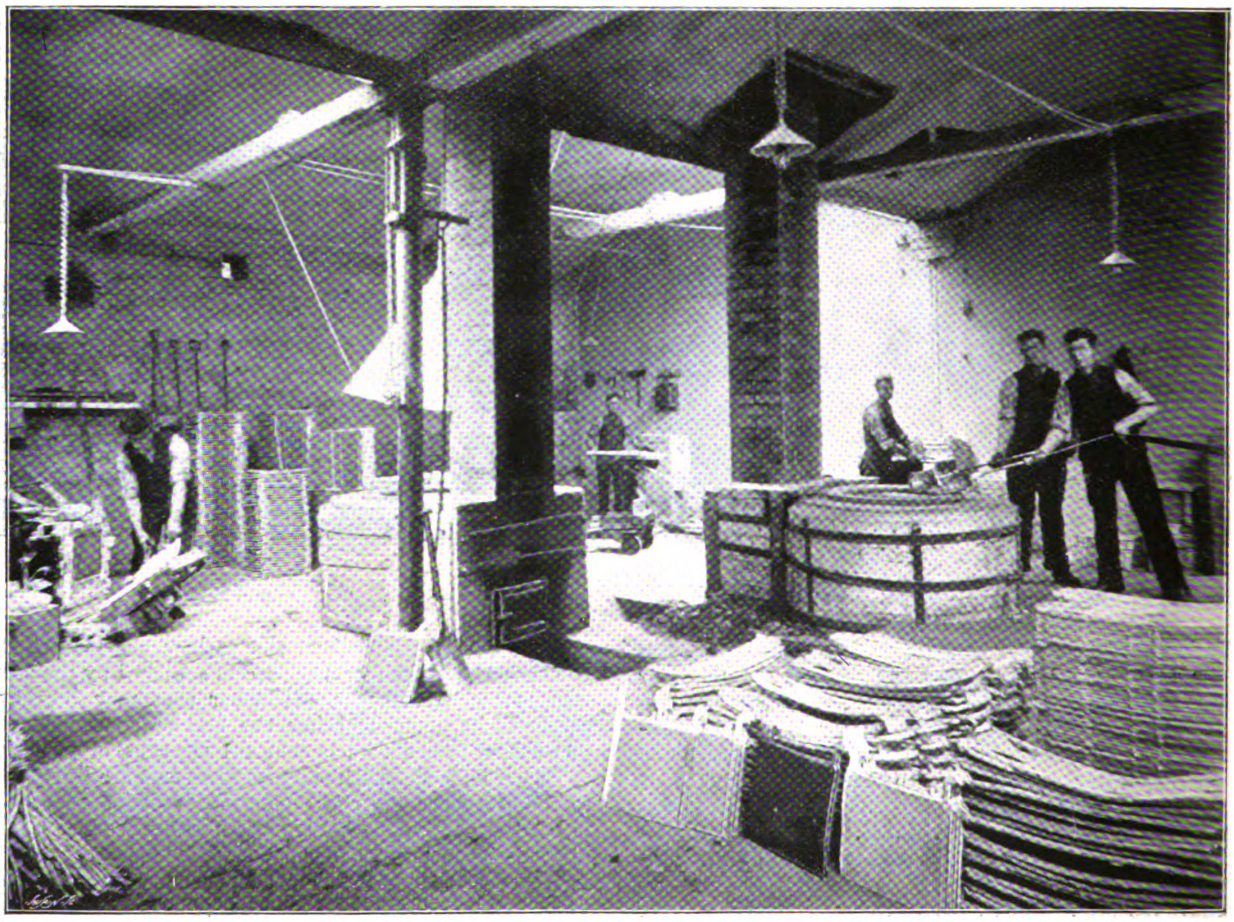
It is, of course, of the utmost importance that the teeth should be cut with great accuracy, and they are made as rectangular as possible, to avoid sharp edges on the surface of the plate, which would rapidly become worn out. Great care has therefore been bestowed upon the design and workmanship of the moulds, and the cost of them is very considerable.

For the purpose of forming the positive plates, they are brought into the formation rooms, a view of which is given, where they are mounted in lead-lined wooden boxes. The plates are hung from glass sheets, and are burnt to temporary lead connecting bars, in much the same way as they are usually mounted in Tudor cells. The plates, both positive and negative, are of the positive large surface type, the cells being filled with dilute sulphuric acid only. The peroxide of lead on the surface of the plates is produced first by alternately charging the cells and leaving them on open circuit, and afterwards by alternately charging and discharging them at frequent intervals throughout the day, the discharge becoming heavier as the formation advances. Finally the cells are charged and discharged under the ordinary conditions, until they attain very nearly the normal capacity, when the plates that have been used as positives in the formation are removed and dried.

Filling Paste in Negative Plates.

The formation period lasts about six weeks, and is carried out as continuously as possible, day and night. There are at present in use about 300 boxes, each containing 21 or 42 plates, according to the type.

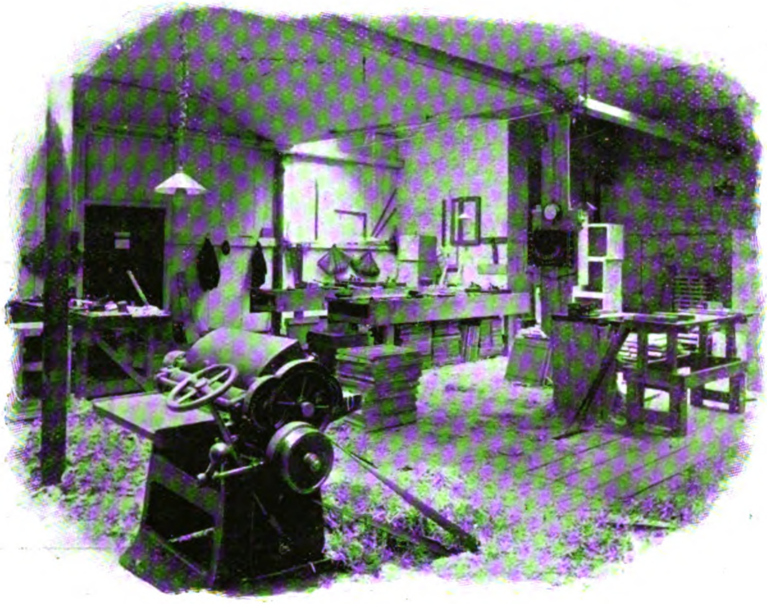
To prepare the negative plates, the grids are first "pickled" by charging them positive with a heavy current for a few seconds. They are then filled in the ordinary way with litharge, formed into a paste with sulphuric acid. The operation of filling in the litharge is shown in one of the illustrations. After being dried, the majority of negative plates are sent out without any further preparation. It has been found that the active material of the negative plates, which is lead in an extremely fine and divided state, oxidises and sulphates so readily, that the time required for reducing



Casting Shed.

them after erection is scarcely lessened by a previous reduction of the litharge at the works. On the other hand, negative plates previously reduced have always a tendency to scale and blister during the first charge, owing to the hard coating of sulphate of lead on their surface.

To simplify the manufacture as much as possible, only two types of plates, A and B, are now used in stationary Tudor cells. The A type has the dimensions 7 inches wide × 12 inches high, and the B type 14 inches wide × 12 inches high; for the purpose of renewals in existing batteries, a third type, D, is made, of which the dimensions are $9\frac{3}{4}$ inches wide × $9\frac{3}{4}$ inches high; but no new cells are supplied with these plates. The thickness of all types of plates is the same, the positive plates being ·5 inch and the negatives ·4 inch thick.

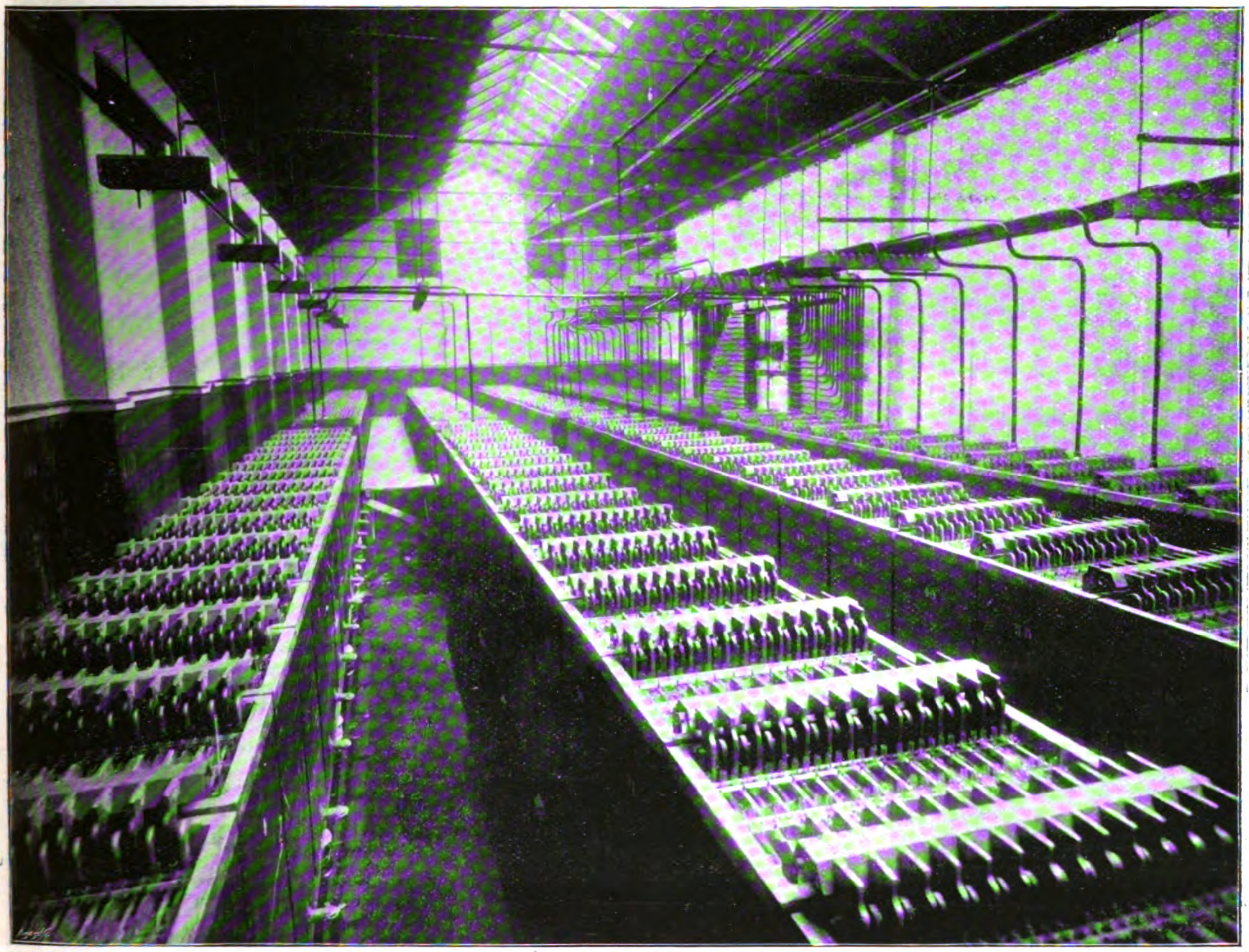


Joiners' Shop.

between the two plates so as to allow for their expansion in ordinary working. The size of the finished plate is about 16 inches wide × 25 inches high, and its appearance is shown in the accompanying sketch. The negative C plates are made of two negative B plates, the lower edge of one being solidly burnt to the upper edge of the other. To give greater rigidity to negative plates of this size, they are made of antimony lead alloy.

The plant at present in use at the Dukinfield works comprises a Marshalls 50 I.H.P. semi-portable compound engine, driving by belts two 20-kilowatt dynamos, and a similar 75 I.H.P. engine driving one 35 and one 20-kilowatt dynamo. Arrangements are already being made for putting down a third engine of 100 I.H.P. with corresponding dynamos.

The switchboard has all the necessary cut-outs, switches



Tudor Accumulators at Glasgow Central Station.

For the largest type of plate, known by the makers as the C type, the lugs are removed from two positive B type plates, which are solidly burnt at either side to two hard lead strips. These side strips are cast in one piece with the connecting and suspending lugs. A space of about half an inch is left

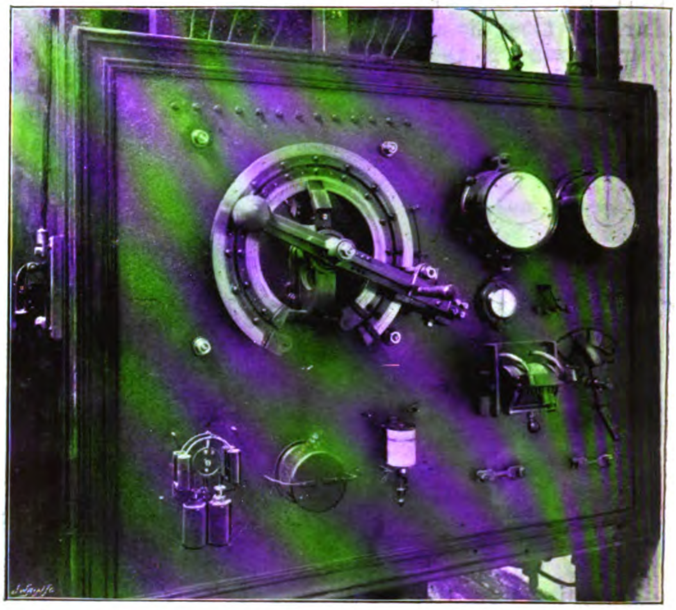
and instruments, and an automatic minimum cut-out on each dynamo. In the circuit of each dynamo is a multiple way switch allowing any dynamo to be put on any of the formation batteries, of which the voltage is so variable that it has been found impossible to group them in parallel. A special boiler for distilling water, is also placed in the engine-room. Distilled water is a feature of the Tudor accumulators, and large quantities are used in the works, both for working the batteries and in the formation cells.

The rest of the works are composed of the plumbers' shop, where the wood boxes are lined, C type plates are made, and all general plumbers' work with the hydrogen blow-pipe is carried out; the joiners' shop, where the boxes, stands, and packing cases are made, a few machine tools being used in this work; a small engineers' shop; the pasting shop, where the negatives are pasted as before described; and, lastly, the packing-shop and stores.

It may be mentioned that all the tools are driven by electric motors, of which there are about half a dozen; these take current from the lighting circuit of the works, which is entirely fed by a special battery, charged twice a day during the winter months. Owing to the sudden variations of output, due to the starting and stopping of the motors, the voltage would be very unsteady, were it not for the automatic regulating switch of the Trumpy pattern, which keeps the voltage perfectly constant. We have previously described the operation of this switch, and we now show an illustration of the one in use at Dukinfield.

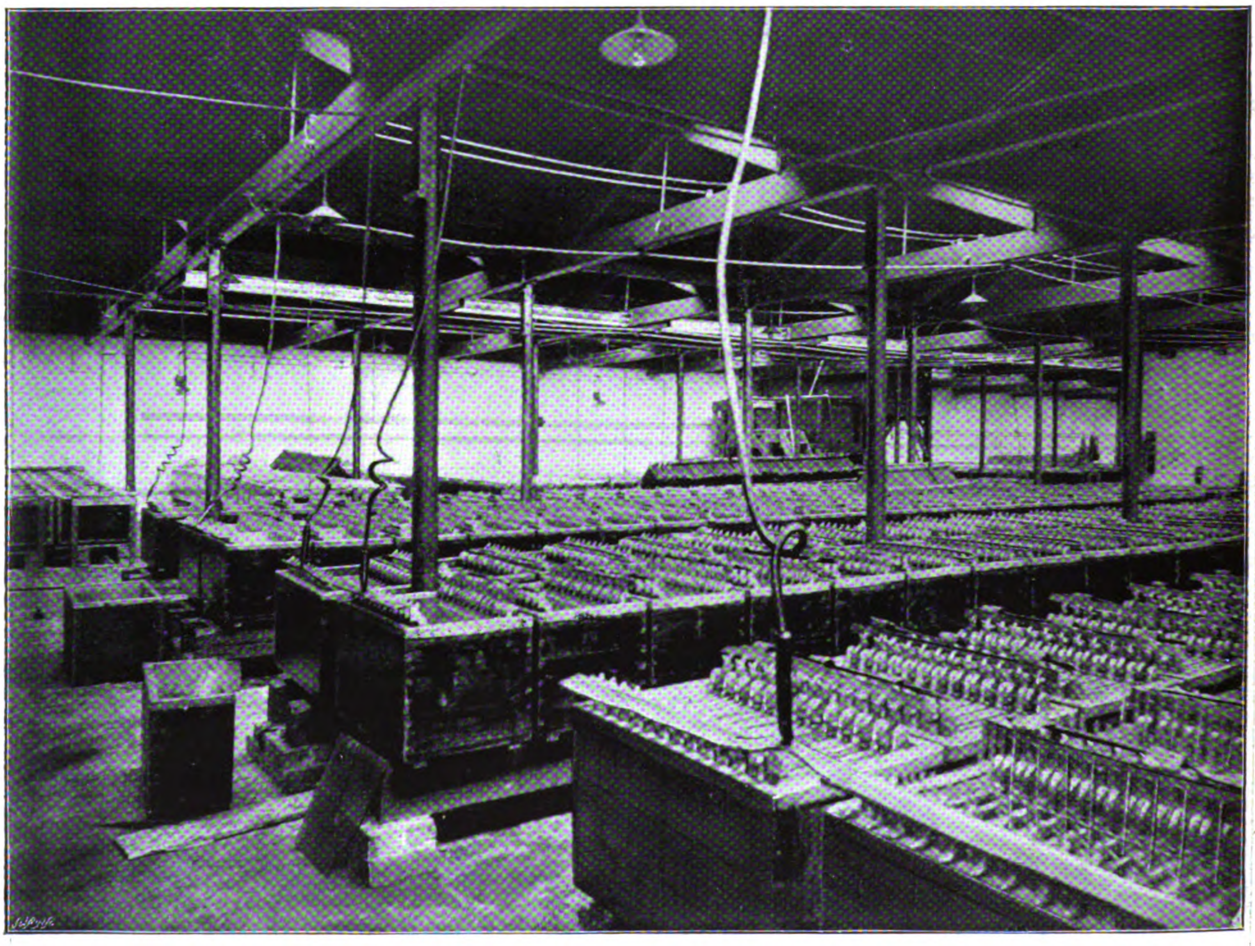
It may be interesting to close the account of the manufacture of Tudor cells with a short description of the two batteries recently put in at the Glasgow Corporation sub-stations.

The general view of one of these batteries, at Tontine Lane, Glasgow, is shown in the accompanying photograph. This battery is composed of 134 cells, type H.C. 27, each containing 27 plates of the C type. The output is 2,080 ampere-hours, or 1,040 amperes for two hours with a minimum voltage of 240 volts. The cells are capable of giving a maximum output of 1,820 amperes for one hour, and may be charged with a current of 780 amperes. The size of each box is 2 feet 9 inches × 1 foot 11 inches × 3 feet high, and the weight of each cell when filled with acid is 18 cwt., making a total weight of 120 tons for the whole battery.



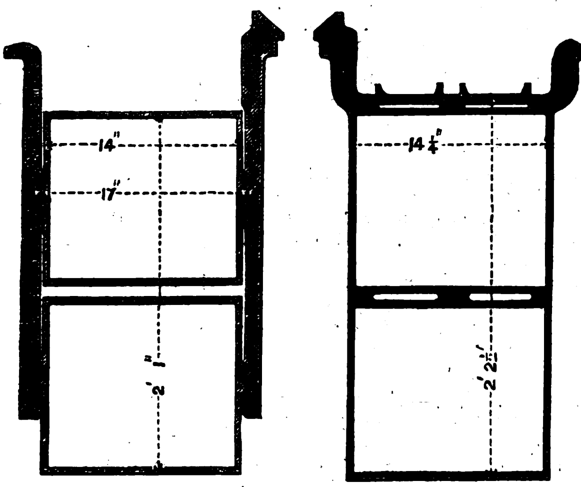
The Trumpy Automatic Switch.

The second battery at Claremont Street, Glasgow, is similar in every respect, but is slightly smaller. There are 126 cells, each containing 25 C plates, the output being 960 amperes for two hours. This battery weighs 110 tons.



Formation Room.

These batteries are interesting as being, we believe, composed of the largest size of cell at present in use in the kingdom; they are, at the same time, a good example of the way in which the floor space required by large batteries may be reduced, without arranging in two tiers, the upper of which is always neglected.



POSITIVE PLATE. NEGATIVE PLATE.

We are much indebted to Messrs. Pescatore for their courtesy in allowing us to inspect the process of making Tudor plates; also to Mr. Jacob for the information embodied in the foregoing description.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

(*Continued from page* 112.)

Laxey and Ramsey Electric Railway.—We are informed that the order for a battery of very considerable dimensions has been placed with the Chloride Electrical Storage Syndicate, Limited, which will be employed in connection with the extension of the Douglas and Laxey Railway, in the Isle of Man, to Ramsey. Their batteries are already installed on the Douglas and Laxey section and the Snaefell branch of the line.

Norwich.—The Town Council has approved of the application to be made to Parliament in the ensuing session by the Norwich Electric Tramways Company, for an Act to authorise that company, amongst other things, to make and maintain additional tramways.

Staffordshire.—At a recent inquiry at Kingswinford held by Colonel J. T. Marsh, R.E., it was stated that the scheme of the British Electric Traction Company involved about 50 miles of tramways, and the company were to have the tramways 24 years, when the local authorities could purchase.

The Power Distribution Scheme.—The members of the South Staffordshire Iron and Coal Masters' Association attended at the Queen's Hotel, Birmingham, last week, to consider the scheme brought forward by the Midland Electrical Corporation for Power Distribution, Limited. Sir Benjamin Hingley, who presided, pointed out that they now depended upon steam, but abroad electrical distribution by means of electric wire attached to machines and tools had been adopted with the greatest possible success and economy. Although changes were sometimes expensive and unpleasant, if South Staffordshire was to hold its ground with its competitors they must face those disadvantages. The local authorities could only distribute power at 3d. per unit, whereas it could be done by private enterprise on a great scale at one-half or one-third the cost. Colonel J. B. Cochrane, chairman of the South Staffordshire Coal Trade, stated that difficulties had been experienced for some time past with regard to dealing with storm water, and preventing their mines being drowned out. If they could get electric power supplied to the low-lying districts they could economically deal with storm and other water by making reservoirs, and so getting rid of the bulk of the storm water, which was so injurious to the mines. The Mines' Drainage Board had spent £30,000 or £40,000 in putting down heavy pumping engines to deal with that water which ought to be dealt with on the surface. Mr. J. F. Albright, on behalf of the Midland Electric Corporation, explained the objects of the undertaking. It was intended to supply the South Staffordshire district with electrical power, and when Parliamentary authority was obtained a large generating station would be erected in a central situation. From the switchboard seven or eight circuits would radiate to different parts of the districts, and the current would be available day and night, and on Sunday, for power and lighting at prices varying from 3d. to 1d. per unit. The Corporation proposed to rent motors to manufacturers, and to act as power bankers. The Chairman proposed a resolution affirming that the proposals were worthy of support, and should be encouraged instead of being opposed by local authorities, subject to fair conditions, so as to secure economical terms to consumers, a copy of the resolution to be sent to each local authority and the Board of Trade. Sir A. Hickman, in seconding, remarked that if the Corporation came to a vague proposal as to price of between 1d. and 3d., he did not think the ratepayers of Wolverhampton would be inclined to admit a competitive company, but if they were prepared to give power at 1d. per unit, all the Corporations would gladly welcome the company. As time went on coal would decrease, and any Corporation that ventured to oppose a scheme of this kind would be taking upon themselves very grave responsibilities. Mr. Hooper (Dudley) suggested that the local authorities should have the right of distributing power in their own areas, taking power from the Midland Electrical Company.—Mr. Albright said that the price would depend upon the nature of the demand. Broadly speaking, they were prepared to supply current at 1d. per unit to customers who would take it for the necessary number of hours. In the course of a discussion, Mr. W. Bassano informed the meeting that at his collieries electric haulage and pumping had been found most successful and economical. He also endorsed the remarks already made as to the advantage which the scheme would be to the work of the Mines' Drainage Commissioners.—Mr. Garcke (British Electric Traction Company) said that a large portion of the scheme for supplying electric traction to the district was lying dormant, because of the difficulty of getting power from the local authorities at anything like the price which the company would offer it.—Mr. A. Keen suggested that "worthy of support" in the resolution should be altered to "worthy of consideration." He contended that the proposal meant a monopoly. He was prepared to consider anything, but to support it was another matter.—The resolution was altered as suggested, and carried with one dissentient.

The Walsall District Council will support the application of the Midland Electric Construction Company for a provisional order for the supply of electricity to the district.

The "Underground."—In connection with the suggestions of the Departmental Committee appointed to go into the system of ventilation of the tunnels on the Metropolitan Railway lines, the directors in their report to the shareholders quote the recommendations to which we referred in the REVIEW some months back. They desire to express their sense of the value and importance of the inquiry, and they have embodied in the company's Bill, deposited for the next Session of Parliament, powers to enable the company to give practical effect to the committee's recommendation. The Bill deposited provides for powers to improve the ventilation of the railway; to authorise the working of the traffic of the railway by electricity; to alter the levels of the railway in the parish of Willesden, and for other purposes.

TELEGRAPH AND TELEPHONE NOTES.

French-American Cables.—A Washington despatch says that the Acting Attorney-General has decided that the President has power, in the absence of any legislation on the subject, to control the landing of a foreign submarine cable. The question was raised by the action of a French Company, which landed a cable at Cape Cod without the express permission either of Congress or the President.

Portsmouth Telephone Service.—The Council of the Local Chamber of Commerce in the report submitted to the annual meeting, states that, at the instance of the Chamber, the promised underground metallic circuit had recently been completed, and had remedied the disturbance to the telephonic system caused by the electric lighting of the town, which disturbance during its existence rendered the telephone practically useless. The Council were now in communication with the National Telephone Company on the subject of the high rentals charged, and the need for better instruments. They were also in correspondence with the Postmaster-General with the view of improving the use of the trunk system, which is at present hindered by all messages having to go through Southampton, and there being only one wire from that place to London. A second wire from Southampton to London is nearly completed, but the Council were of opinion that the only satisfactory remedy as regards Portsmouth is the construction of a trunk line direct to London, so preventing the present delays. It is also thought by the Council that to render the trunk system acceptable to the public, the tolls must be considerably reduced, the present charges being almost prohibitory.

Telegraph Monopoly in Mexico.—The Mexican Government has entered into a contract with the Western Union Telegraph Company and the Mexican Telegraph (Cable) Company, an American corporation, whereby the communications of Mexico by wire with foreign countries are to be concentrated in the federal telegraph system and the systems of the two corporations above mentioned. In other words, says the *Financial News*, the Government, the Western Union, and the Cable Company are to have the exclusive right—the monopoly—of the foreign or international telegraph business of Mexico, to the exclusion of the railway wires and those of any other corporation. This is stated explicitly in Article 26 of the contract. It is declared in Mexico that the deal raises "an important point which will probably become the subject of protracted litigation, until a test case is made of it by a final decision of the Supreme Court."

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1898 ...	...
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Cape Haitien-Puerto Plata	Dec. 31st, 1897 ...	...
Curaçao-La Guayra ...	Jan. 5th, 1898 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Para-Cameta	Jan. 13th, 1898 ...	...
Bundaberg-New Caledonia ...	Nov. 4th, 1897 ...	Jan. 21st, 1898
Teneriffe-St. Louis (Senegal)	Dec. 24th, 1897 ...	Jan. 23rd, 1898.
Saigon-Hong Kong	Jan. 8th, 1898 ...	...
Para-Maranham	Jan. 22nd, 1898 ...	...
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Cartagena-Barranquilla ...	July 4th, 1896 ...	...
Saigon-Bangkok	Jan. 22nd, 1898 ...	...

The Telephone Service.—The Beckenham District Council has unanimously passed a resolution requesting the Postmaster-General to grant licenses for telephone service, without inquiry as to the charges or efficiency of the present service, to any municipalities or companies complying with the requirements of the Treasury minute of May 23rd, 1892.

The *Daily Chronicle* says that, speaking at the annual meeting of the Halifax Chamber of Commerce on Tuesday, Sir James Fergusson, M.P., director of the National Telephone Company, said there were numerous complaints respecting the company's service. Many people expected impossibilities, but a new science which was being gradually developed must for a long time leave a good deal to be desired. The great difficulty was that, unlike the Post Office, the company had no power to place wires underground. But the authorities of every town in England, he believed, had now given the necessary consent, and all would soon be enjoying a vastly improved twin wire underground system.

At a meeting of the North Staffordshire Chamber of Commerce, at Hanley, on 19th inst., it was reported that the replies received to questions submitted by the secretary to the members of the Chamber and to the Town Clerks of about 60 places, with reference to the working of the telephone system, showed the general opinion to be that the present charge for the telephone was not a reasonable one; and that the telephone service at present obtainable was unsatisfactory for a variety of reasons.

The Glasgow Corporation has received no further information regarding Sheriff Jameson's report.

Mr. Morton, according to the *City Press*, has no intention of allowing the question of the telephone monopoly to drop out of sight. At the meeting of the Court, yesterday, he was to propose the convening of a conference at the Guildhall, with a view to the local authorities uniting in a demand for a Government inquiry to be held.

CONTRACTS OPEN AND CLOSED.

OPEN.

Ashton-under-Lyne.—February 2nd. The Baths Committee want tenders for the installation of the necessary wires and fittings for the electric lighting of the Corporation Baths. Consulting engineers, Messrs. Lacey, Clirehugh & Sillar. See our "Official Notices" January 14th for particulars.

Bilbao.—February 28th. The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Consul at Bilbao, reporting that the provisional board appointed in connection with the electric tramway which it is proposed to lay from Zumarraga to Zumaya, in the province of Guipuzcoa, invite plans and tenders, to be received by February 28th, for the construction and equipment of the line. Further particulars of the conditions of the tenders for the above-named tram line and branch, which together measure 30 miles, may be inspected at the Commercial Department of the Foreign Office any day between the hours of 11 and 6.

Belgium.—February 11th. The Provincial Government Authorities in Brussels are inviting tenders for an installation of electric lighting in the offices of the Governor of Brabant in the Rue de Chêne, Brussels. Tenders to be sent to the Gouvernement Provincial, Brussels.

Berlin.—March 15th. The Municipal Traffic Deputation of the Town Council have opened a competition for the construction of several new electric tramways in that city. Exhaustive details concerning this project are contained in the *Elektrotechnische Zeitschrift* of the 13th inst., which mentions that proposals will be received by the Stadtische Verkehrsdeputation Rathhaus III, Berlin, by March 15th.

Bradford.—February 1st. The Corporation is inviting tenders for the electrical equipment of about nine miles of street tramways. There are three contracts for the following sections:—(1) steel poles, bracket arms, &c.; (2) trolley wire, insulators and overhead equipment; (3) cars, trucks, motors and trolley poles. Particulars from the city surveyor or the city electrical engineer at the Town Hall.

Brighton.—January 31st. The Town Council want tenders for dynamos, motors, switchboards and wiring for the electric lighting of the Municipal School of Science and Technology. Specifications from the town clerk's office.

Edinburgh.—February 5th. The Corporation want tenders for the wiring of the Police Station, Abbeyhill. See our "Official Notices" for particulars.

France.—March 31st. Tenders are being invited by the Municipal Authorities of Saint Chamond (Loire) for the concession for the lighting of the public streets of the town, either by gas or electricity. Particulars from, and tenders to be sent to, La Mairie de Saint Chamond (Loire).

Harrogate.—January 31st. The Corporation wants tenders for the supply of hard steam nuts for six or twelve months' supply (minimum quantity 1,500 tons per year). Particulars from the electrical engineer, Mr. Geo. Wilkinson, Corporation Electricity Department.

Leicester.—January 31st. The Leicester Corporation invites designs and tender for motor vehicles for the collection of house refuse. Specifications and particulars, with drawings, to be sent to the Chairman of the Sanitary Committee, to the office of Mr. E. Geo. Mawbey, C.E., borough engineer, Town Hall, Leicester.

London, E.C.—February 2nd. The City of London Electric Lighting Company is inviting tenders for the purchase of various quantities of superior secondhand cables which has recently been in use on the company's continuous current series arc circuits, but has been found unsuitable for the high pressure (about 3,000 volts) required. It is stated to be adapted for house-wiring or for making connections to supply mains. See our "Official Notices" this week for fuller details.

Madrid.—February 22nd. The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Chargé d'Affaires at Madrid, enclosing copy of a Royal decree announcing that a public auction for the contract for repairing the national submarine telegraph cables during the next five years will be held at Madrid on February 22nd. Further particulars as to the cables in question may be inspected at the Commercial Department of the Foreign Office any time between the hours of 11 and 5.

Redditch.—February 14th. The District Council want tenders for the supply of buildings, gas producing plant, gas engines, alternators, cables, transformers, &c., for the electric lighting of the district. Consulting electrical engineer, Mr. J. A. McMullen. See our "Official Notices" this week.

Rochdale.—February 19th. The Corporation want tenders for steam dynamos, balancer, and boosters, &c. Engineers, Messrs. Lacey, Clirehugh & Sillar. See our "Official Notices" January 14th.

Roumania.—March 15th. Tenders are being invited by the General Direction of the Roumanian Post and Telegraphs in Bucharest for the supply of 56,000 metres of galvanised iron and steel wire.

Spain.—The municipality of Sophia is inviting tenders for the joint concession for (*a*) electric lighting of the town; (*b*) electric tramways in the town and suburbs. *Daily Tenders* for 26th inst. gives the conditions of tendering.

Spain.—February 1st. Tenders are being invited by the Municipal Authorities of Tarifa (Cadiz province) for the 20 years' concession for the lighting of the public streets of the town by electricity, acetylene or gas. Tenders to El Secretario del Ayuntamiento de Tarifa (Cadiz) from whom particulars may be obtained.

Spain.—February 8th. Tenders are being invited until February 8th by the Municipal Authorities of Tordesillas, a small town in the province of Valladolid, for the concession for the electric lighting of the public streets during a period of 20 years. Particulars may be obtained from, and tenders should be sent to, El Secretario del Ayuntamiento de Tordesillas (Valladolid).

Spain.—February 11th. Tenders are being invited by the Municipal Authorities of Valderas (Leon province) for the concession for the electric lighting of the public streets of the town during a period of 17 years. Particulars may be obtained from, and tenders to be sent to, El Secretario del Ayuntamiento de Valderas (Leon).

St. Helens.—February 21st. The Corporation want tenders for various plant and machinery, &c., in connection with the proposed electric tramways. See our "Official Notices" this week for particulars. Consulting engineer, Dr. J. Hopkinson.

Stockport.—February 3rd. The Corporation is wanting tenders for various plant and machinery for electricity supply works at Millgate, Stockport, including Lancashire boilers, steam dynamos, feed water heater, storage battery, electrical instruments, electrical connections, wiring, &c., at the generating stations, also underground cables. Electrical engineer, Mr. James N. Shoolbred, 47, Victoria Street, S.W. See our "Official Notices" January 14th, and supplementary notice this week.

Wimbledon.—February 2nd. The District Council wants tenders for the supply, delivery and erection of water tube boilers, condensing plant, overhead crane, high speed steam engine and alternator, switchboard, underground mains, conduits, &c. Consulting engineer, Mr. A. H. Preece. See our "Official Notices" January 14th for particulars.

CLOSED.

Barking.—The Council has accepted the tender of the Sunderland Forge Company for an overhead crane at £70. The order for 66 lamps with switches and fuses at 35s. each, also 300 lamps with switches but without fuses at 20s. each, has gone to the Reason Manufacturing Company, Limited. Mr. Sharpe's tender has been accepted for the erection of the electric light station and shaft at £2,666.

Canterbury.—The list of tenders recommended for acceptance in connection with Mr. Hammond's electric lighting scheme, which were noted in our issue of January 14th, came before the Town Council last Friday, and the tenders were accepted.

Hammersmith.—On Wednesday last week the Vestry gave out the contract for the supply of two alternators, exciter and spare parts, at £3,600, to the Electric Construction Company.

Melbourne.—Messrs. C. A. Parsons & Co., of Newcastle, have, according to a Sydney paper, received a contract from the Government Railways Department for four steam alternators, the amount being £7,604 odd.

Sydney.—For the feeder cables and junction boxes for the Sydney electric tramways (George Street and Harris Street) the tender of Messrs. Noyes Bros., of Sydney, has been accepted at schedule rates.

FORTHCOMING EVENTS.

1898.

Friday, January 28th, at 8 p.m.—The Institution of Civil engineers. Students' meeting. Paper to be read on "Condensing Apparatus," by H. Williams, Stud.Inst.C.E.

Saturday, January 29th.—Institution of Junior Engineers, Westminster Palace Hotel. Reception at 6.30 p.m. Dinner at 7 p.m.

Monday, January 31st.—Yorkshire College Engineering Society. Mr. J. A. McLaren on "Electrical Engineers' Specifications."

Latest date for tenders for electric lighting plant of the Municipal School of Science and Technology. Also Leicester tenders.

Tuesday, February 1st.—Latest date for Bradford electric tramway plant tenders.

Wednesday, February 2nd.—Institution of Electrical Engineers. Students' meeting. Paper to be read entitled "Comparison of Gas and Electricity as used in Tramway Work on the Continent," by O. M. C. Heyl, student.

At 8 p.m.—Society of Arts. "The Cinematograph," by Jules Fuerst. Captain W. de W. Abney, C.B., F.R.S., will preside.

Liverpool Engineering Society. Paper by Mr. W. H. Preece, C.B., F.R.S.

Latest date for Ashton-under-Lyne tenders.

Latest date for electric lighting plant tenders for Wimbledon.

Thursday, February 3rd, at 8 p.m.—Chemical Society. Papers to be read:—"On the Dissociation of Potassium Platini-Chloride in Dilute Solution, and the Production of Platinum Mono-chloride," by E. Sonstadt; "Effect of the Mono-, Di-, and Tri-chloracetyl Groups on the Rotatory Power of Methylic and Ethylic Glycerates and Tartrates," by Percy Frankland, F.R.S., and Thomas Stewart Patterson, Ph.D.; "The Rotation of Ethylic and Methylic Di-monochloracetyl-tartrates," by Percy Frankland, F.R.S., and Andrew Turnbull, Ph.D.; "The Volumetric Estimation of Sodium," by H. J. H. Fenton, M.A.

Meeting of the Chemical Society at Burlington House.

Friday, February 4th, at 8 p.m.—The Institution of Junior Engineers, at the Westminster Palace Hotel. Paper on "Electro-Magnetic Brakes, and their Capabilities," by Mr. Louis H. Walter, A.I.E.E., of Cambridge.

Royal Institution. Mr. A. A. Campbell Swinton on "Some New Studies in Cathode and Röntgen Radiations."

Saturday, February 5th.—Institution of Electrical Engineers. Student's visit to the works of Messrs. Siemens & Co., Woolwich. Train from Fenchurch Street, 10.5 a.m. Applications to join the party, to the Student's Hon. Sec. (Mr. S. Grant, 28, St. Mary Abbot's Terrace, W.)

Tuesday, February 8th.—Liverpool Overhead Railway Company. Meeting at Liverpool.

Thursday, February 10th, and Friday, February 11th.—The annual general meeting of the Institution of Mechanical Engineers, at 25, Great George Street. The discussion on Mr. Philip Dawson's paper on "Mechanical Features of Electric Traction," will be resumed. A paper will be read and discussed as follows: "First Report to the Gas Engine Research Committee; Description of Apparatus and Methods, and Preliminary Results," by Prof. Frederic W. Burstall.

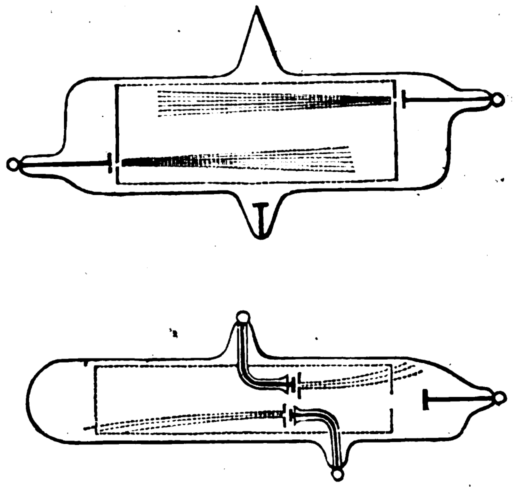
NOTES.

Electrolysis by Traction Currents.—Though there can be no doubt, from theoretical considerations, that the corrosion of underground pipes is accelerated by the leakage currents from electric railways, it has always been difficult, for obvious reasons, to obtain statistics of the exact amount of damage done. In the *Street Railway Review*, December 15th, 1897, an interesting fact is mentioned, which seems to show that traction leakage currents are not the only cause of electrolytic corrosion. "One of the best railway electricians in the country discovered what, to all appearances, is a most pronounced case of electrolysis in a gas pipe in this city, but which, at the time he made the excavation, was many miles removed from any electric line, and, indeed, was separated from the nearest line by a river. It is valuable evidence and convincing, that destruction of water pipes can and does occur without the presence of trolley lines, and the question naturally arises whether the electrolysis in the past, which has been discovered since the advent of electric lines, was due to them to any such extent as has been supposed. While there were in the early days unmistakable cases traced to these lines, it is not unlikely that natural earth currents and acids in the soil largely contributed to the results in many cases, which were discovered by reason of the construction of electric railway lines." In the same journal is given an account of several cases of corrosion due to traction currents that occurred in Salt Lake City and Chicago. In one of these cases, the corrosive action was strongest about a crack in the pipe, from which water had been slowly leaking into the ground. It was supposed that the superior conductivity of the wet ground had concentrated the current on this part of the pipe. The reports of the engineers of these lines shows that faith has not yet died out in such old-fashioned and exploded remedies as bonding the pipes to the rails, or bonding the rails to an uninsulated return conductor. In several cases an overhead return conductor connected to the rails at short intervals is recommended, though it is not explicitly stated whether this conductor is insulated or not.

Effect of Röntgen Rays on Plants.—An exhaustive series of experiments has recently been made by Prof. Atkinson, of Cornell University, to determine the action of the Röntgen rays on growing plants. (*Science*, January 7th, 1898). The results, unfortunately, are of a very negative character. He found that, though plant tissues absorb the Röntgen rays quite freely, there is no marked influence on the growing parts. There are no visible external injuries, even when the parts are exposed at close range a large part of the time during several days. This is the more remarkable, since the general impression is that the rays, even with comparatively short exposures, are injurious to the human tissues. The rays were found to have no toxic or turning influence on plants. No difference in growth was produced by exposure to the Röntgen rays; the rays neither inhibited or hastened growth. Bacilli were exposed for hours to the rays, but it was found that they had no influence on the distribution of the bacilli in the liquid, nor on their vitality for the length of time of the exposure.

Electrical Installation Rules.—The new edition for 1898 of the Electrical Installation Rules of the Liverpool and London and Globe Insurance Company, forms the third year's issue of the new copyright compilation, displacing their former rules dating from 1888 or earlier. The value of this periodical re-issue is shown in the present edition by the inclusion of several added rules this year. For instance, the growth of the adoption of "free wiring" in various districts has necessitated rules specially dealing with the lead-covered twin wires used in this class of work, and the extension of the use of electricity for tramway work has lead to the prohibition of the use of trolley wires or of dynamos feeding trolley wires as a direct source of current for lighting or power upon insured premises other than the power stations, sheds, &c., of the tramway people. Further slight additions deal with precautions desirable in specific risks, such as corn, oil, and textile mills.

Mutual Influence of Cathode Rays.—Some interesting experiments, accompanied by rather hesitating conclusions, are contributed by Julius Bernstein, in *Weid. Ann.*, on the subject of the apparent repulsion between two beams of cathode rays, first observed by Crookes, and interpreted by him on the supposition that cathode rays consist of projected particles, and are equivalent to elastic conductors carrying a current. As might have been expected from a German source, says the New York *Electrical Engineer*, Bernstein's results tell against this view, and in favour of some kind of wave hypothesis. In the first place he investigated the influence of the direction in which the rays travel. Mounting two cathodes, one at each end of the tube (see fig. 1) with a slit in front of each, he obtained two opposite beams running side by side, which did not affect each other



Figs. 1 and 2.

in any way. But when the cathodes were placed side by side (fig. 2), the beams were bent outward as long as the glass funnels protecting the wires left the cathode plates bare. When they projected beyond their surfaces, no effect was produced. The direction of the emerging rays is, therefore, of no account. Further experiments proved that the action is probably exerted by one cathode upon the beam from the other cathode at its origin. But to this action an electrostatic effect between the cathodes may be added.

Accumulator Boxes.—The high price of these "recipients"—as they are termed on the Continent to distinguish them from what is technically termed the "cell," and also from the outer boxes—has long been an inducement for the invention of a new material to be used in their construction. In a recent discussion at the Institution, Mr. Wallis Jones referred to the "breakages of ebonite cells, which, on the average, may be taken to cost 10s. a piece." Celluloid has been proposed and used to some extent; it is not liable to fracture, but its great combustibility constitutes so great a danger that its employment on a large scale is out of the question. We have seen some samples of a new material, invented by Mr. Desmond FitzGerald, and called by him "Acrematin," which seems well adapted for the manufacture of these receptacles, being acid-proof, strong and comparatively cheap. It would appear to be adapted also to many other purposes.

Vacuum Tube Lighting.—An American correspondent writes as follows:—"With reference to Tesla's vacuum tube light mentioned in the current electrical journals, D. McFarlan Moore, of Newark, N.J., who lit a room by vacuum tubes at the electrical exhibition in New York in May, 1896, has just made a statement, claiming Tesla's present system to be a copy of his. There is certainly a similarity. Moore interrupts a self-inductive circuit in a vacuum, and connects one terminal of the tube to be lighted to one side of the break, and the other terminal to the opposite side. Tesla interrupts a self-inductive circuit in the open air, and to light a tube, raises the potential of the induced current by a step-up transformer, the secondary of which is connected around the break, and has a condenser of suitable capacity in its circuit. This arrangement he calls an electrical oscillator."

Electric Cranes in Railroad Shops.—Electricity is very largely used for working the cranes at the Crewe shops of the London and North-Western Railway. The motors, says *Engineering*, have field-magnets of the Manchester type, and Paccinotti armatures. In starting a motor, a variable resistance is switched in to diminish the starting current, being cut out when the motor is fairly running. All the motors used are designed to run at 1,500 revolutions per minute, the speed being afterwards reduced by worm gearing. In the case of the 30-ton cranes used in the erecting shops for lifting locomotives, the load is lifted at a speed of 2 feet 6 inches per minute, at an expenditure of 70 amperes at 120 volts. The long travelling is performed at a speed of 100 feet per minute, with an expenditure of 60 amperes at 120 volts, and the cross traverse at a speed of 50 feet per minute, with an expenditure of 30 amperes at 120 volts. In the case of light weights the speed of lifting is 10 feet per minute. In the case of the 15-ton crane, which has been provided in connection with a boiler-riveting plant, the crane is 50 feet above the floor level, and all its movements are controlled by switches on the ground, a magnetic brake being provided on the armature shaft to arrest the motion as soon as a rivet-hole has been brought into place for the closing of the rivet. The cost of repairs has, Mr. Webb states, so far been very small; no renewal of commutators has been necessary, but they are lightly skimmed up in the lathe about once in 12 months. The carbon switches and brushes are renewed once in six months.

Cabby's Farewell to his Steed.—The *St. James's Gazette* recently had the following:—

So long, old 'oss; you're jest played out, you've taken your last fare,
Your quarters are the knacker's nah, and mine are Lord knows where;
There ain't no room in London nah for either you or me,
We're crahded aht by cabs as go by electricitee.

It warn't all beer and skittles, even in the palmy days,
What with the cove with principles, his legal fare as pays;
But when the "biz" was pretty brisk, and cabby got the pull,
I could plank dahn for the Derby for my fancy arf a bull.

It's nuts, it is, on some fine day, to pick up some young nob,
And drive 'im all the morning till the fare is nineteen bob;
And then he stops at Gresham 'Ouse, and shahting, "Cabby, wait,"
'E takes 'is 'ook the other end aht into Bishopsgate.

Or on a lovley autumn when the rain came dahn in sheets,
Or when a bloomin' blizzard set us skatin' in the streets,
And after you 'ad planked dahn to the yard each bob you 'ad,
And fahnd yerself to balance up a dollar to the bad.

Then to take yer to the stables at the other end of tahn,
And strip yer frozen 'arness off, and rub yer old 'ide dahn;
And yer got yer jolly skin full, and a decent place to doss,
Which was often more nor *I* got by a jolly site, old 'oss.

But nah—so long, my beauty; for this latest style I bar—
I ain't a going (what do *you* think) to run a motor-car;
While there's a crossing to be swept, a job to do—no fear—
I reckon I'm too old to turn a bloomning engineer.

American Electrical Apparatus for England.—With respect to Mr. Justus Eck's recent visit to the United States, the *Street Railway Journal* says that the purpose of this visit was to make arrangements with American houses to represent them in Great Britain, and in this he was highly successful. Mr. Justus Eck's company (Messrs. Laing, Wharton & Down) already represents the well-known Walker Company here, and among the new agencies secured is that of the Ward-Leonard Company, manufacturers of Carpenter enamel rheostats and other appliances; that of the Wagner Electric Manufacturing Company, of St. Louis, for its alternating current apparatus of all kinds; that of the Q. & C. Company for its rail-sawing apparatus, and that of the Pearson jack. The Buda track drill, for which the company has been for some time agent, has been quite largely sold in Great Britain through its efforts. Mr. Eck also made arrangements for establishing a permanent purchasing agency in New York for any supplies needed in this country for carrying out the extensive work which Laing, Wharton and Down are now organising to undertake in Great Britain and elsewhere.

The Royal Society.—Among the papers down for reading yesterday afternoon were the following:—E. Wilson: (1) "The Kelvin Quadrant Electrometer as a Wattmeter and Voltmeter." (2) "The Magnetic Properties of almost Pure Iron."

The City and Guilds of London Institute.—The Finance Committee of the City Corporation have recently reported on the application of the Council of the City and Guilds of London Institute, for a renewal of the grant from the Corporation to the funds of the Institute. They state from inquiry that the work of the Institute has been successfully and economically managed, and the results achieved are fully commensurate with the expenditure involved. Although in the past season there was a decrease in the total number of students in regular attendance, the work of the Institute was, on the whole, well maintained. At the Central Technical College, 214 students were attending special courses, and an average of 170 were under instruction in each of the four departments which constituted the regular curriculum of the Institute. The technological examinations attracted 29,494 students, as against 27,583 in the previous year. At the Technical College, Finsbury, there were 184 day and 900 evening students—a slight decrease in both categories. Since it opened in 1884, nearly 1,200 day students had entered. The development of the chemical department was remarkable, and the high quality of the work done by the students fully maintained. The income of the Central Institute, including school fees, was £33,079, and the cost of the several branches £28,578. The gross cost per student was £54. The Corporation of London has, in consequence of this report, voted £400 in respect of last year towards the funds of the Institute, to be devoted to the Finsbury Technical College. This will make upwards of £16,000 contributed in all by the Corporation towards the Institute.

Testing Extraordinary.—Mr. S. L. Corson, writing to the *American Electrician*, says:—"That there are 'tricks in all trades but ours,' is a foregone conclusion among the members of the various crafts, and the thought and ingenuity expended upon some of the tricks and dodges would, if expended in true work, increase the salary and standing of the trickster to a notable degree. A case in point:—The engineer of a small isolated lighting plant, not 1,000 miles from New York City, was informed that a test of his plant would be run to determine the cost of lighting the building, after which, current from Edison street mains would be turned on, and the cost of thus lighting for a similar period be ascertained. The engineer knew that if the Edison service cost less than it did to make the current by the plant that he was in charge of, his occupation would be forfeited. Therefore, when the trial run was made, never was boiler, engine or dynamo in better condition than his, and the coal burned was very small. When the Edison trial was made, he had figured out the cost of everything, and knew to a dot what current could be received, and still retain his place. A cunningly concealed water rheostat in the adjoining building was connected by concealed wiring, and the economy of the Edison current received so severe a set-back during the test run, that the engineer is sure of his job for some time to come, unless he gets found out. While not speaking well for the trustworthiness of the engineer, it speaks still worse for the skill of the Edison 'expert' who conducted the test for his company. He should have detected the fraud immediately."

The Extraction of Metals and Metallic Alloys by Means of Electrical Heat.—A new process, which is being exploited at Cassel, in Germany, by H. Aschermann, consists in the extraction of metallic alloys and pure metals by electric heat from a mixture of the oxide, of a metal and the sulphide of another metal or of a metalloid, or of the oxide of a metalloid and the sulphide of a metal, the object being to accelerate the reduction, and eliminate the carbon and other impurities. The metal is obtained in the form of an alloy, from which the more fusible metal can be separated by distillation if desired. Sulphide of antimony is preferably employed as the flux; for instance, in the preparation of chromium, 10 parts of chromium oxide are mixed with 23 parts of sulphide of antimony, and placed as cathode in an electric fusion furnace, and treated by a current of 20 to 25 amperes, and the antimony is driven from the resulting alloy by reheating. Similarly, aluminium may be obtained from a mixture of 10 parts of its oxide with 37 parts of sulphide of antimony, and directions are also given for the preparation of ferrochromium, ferromanganese, and ferrocerium.

The Victory of the Storage Battery.—One of the most encouraging features in modern central station operation, whether light or power, is the attention which is being paid to the running economies. It would be unfair, says the New York *Electrical Engineer*, to say that no attention had ever been paid to getting the last bit of energy out of the coal burnt under the boiler by some of our large operating companies; but it is certain that nine-tenths of the stations existing five years ago paid little attention to those so-called refinements which, as events frequently prove, make the difference between a dividend and a deficit. But these are the days of small things, and with them central station managers have come to understand that they can improve their balance sheet by other means than mere improvements in steam apparatus. They are gradually, but surely, coming around to the practice, long since in vogue in Germany, particularly, of operating their steam plants in connection with storage batteries. It would be a work of supererogation to rehearse at this late day all the advantages which the storage battery offers to the central station; the proof of the pudding is in the eating thereof. To carry out the metaphor, those who have tasted a good one want more, as shown by the fact that scarcely a single station has put in the battery that has not followed it up by one or more additional equipments. We are well aware that even some of the most progressive and intelligently managed companies in the country have held aloof from the storage battery, notwithstanding that New York, Boston, Brooklyn, Philadelphia, and other cities had put them to good use. Among these was the Chicago Edison Company, but we are now informed that this company has also fallen into line and, if we may judge by the size of its plant just ordered, is making up for lost time with a vengeance. This contract was referred to in the ELECTRICAL REVIEW, page 931 of our last volume. In this connection we note also the intention of the Buffalo Railway Company to instal accumulators to be charged from power obtained over the high tension lines from Niagara. As their load is a fluctuating one, and is particularly low during the night the battery will be able to absorb all the surplus energy available and thus permit the company to utilise fully the power for which they are paying. This battery, we understand, will also be the largest ever installed for railway purposes. The *Electrical Engineer* says it is gratifying to be able to note the growing popularity of this valuable station auxiliary.

The Central London Locomotives.—Once again information regarding the electrical equipment of the Central London Railway comes direct from America. The New York representatives of the daily papers telegraphed at the end of last week that the General Electric Company, of Schenectady, New York, have just received a large order for 32 electric locomotives for the Central London Underground Railroad. Owing to the size of the tunnel through which the underground trains will pass, these locomotives will be of a small pattern. They will have a capacity of 800 horsepower, and will weigh 45 tons, and will be able to draw a train of five cars weighing 150 tons at the rate of 15 miles per hour. Work on this order is to be begun at once.

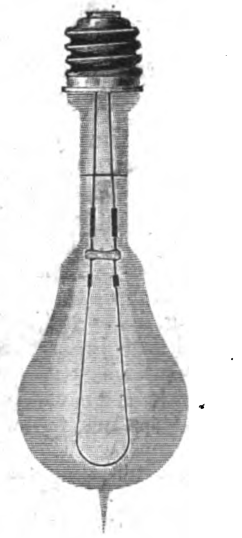
Lectures.—Mr. Wm. Lynd lectured on 20th inst. at the Grosvenor Hall, Belfast, his subject being "Wireless Telegraphy."

At the St. Michael's Working Men's Institute, Pelsall, on 15th inst., Messrs. S. Thacker and Bishop, of Walsall, lectured on "Experimental Electricity."

"Electricity a Transmitter of Power; its Application to Mining," was the title of a paper read by Mr. F. H. Headley, at Camborne, on 19th inst., to a meeting held under the auspices of the Mining Association and Institute of Cornwall.

Useful Reference Book.—"Clubs," a list of over 2,500 clubs frequented by the English in all parts of the world, for 1898, has just been published by Messrs. Spottiswoode and Co. The book is printed in tabular form, and gives much more information than in previous years; for instance, it notes the names of secretaries, dates of establishment, entrance fees and subscriptions, and has, in some cases, remarks on the qualifications for membership, &c.

A Renewable Incandescent Lamp.—Since no substance will probably ever be discovered which will stand a higher temperature than carbon, no improvement in the efficiency of the glow lamp is to be looked for by substituting other materials for the carbon filament. There is room, however, for a considerable reduction in the cost of renewals. The life of a glow lamp is limited, and usually before the filament is burnt out it becomes so wasteful of energy that it pays to replace it by a new lamp. At present the whole lamp is rejected when the filament only has been worn out. Herr Ch. Howard has designed a lamp on a more rational principle, in which the worn-out filament can be replaced, while the remaining parts of the lamp are still utilised. From the description of this lamp (*Zeit f. Elektro Heft* 23, 1897) it appears that the ordinary pear-shaped bulb has a tubular extension, to the end of which the socket is attached. (See fig.) The ends of the carbon filament are connected to two short lengths of nickel wire, which are held together by a glass crosspiece. The ends of these wires are pushed into two sockets fixed on the ends of another pair of nickel wires connected to the platinum terminals of the lamp. When it is desired to renew the carbon filament, the glass neck of the bulb is cut at the line shown in the fig., and the carbon filament is removed by pulling its nickel terminal wires out of the sockets. A new carbon filament is then inserted, and the parts of the glass bulb are placed in position and fused together. The bulb is then exhausted of of air in the usual way. This lamp has been patented, and is said to have already been proved to be a practical success.



The Alleged Failure in the Madrid Supply.—As we go to press, the following comes to hand from the secretary (Mr. Chas. Hill) of the Electricity Supply Company for Spain:—"In your issue of 21st inst. you publish a note from a Madrid correspondent, stating that at about the beginning of the present month the greater part of the district supplied by this company was without light for 48 hours. I shall be greatly obliged if you will kindly correct this statement, which is very much exaggerated. The breakdown in question, caused by an accident to the cables, affected only a comparatively small area, and the lighting was resumed the same evening, after only a few hours' interruption."

The Purchase of the Fowler-Waring Cables Company.—As we announced in our issue of January 7th, the Western Electric Company, Limited, have concluded arrangements with the Fowler-Waring Cables Company, Limited, of 110, Fenchurch Street, E.C., and North Woolwich, to take over their business as from January 1st, 1898. The notice is also confirmed by the Fowler-Waring Cables Company, who state that all debts due to them in respect of the business up to January 1st should be sent to the secretary, at 110, Fenchurch Street, and all debts and liabilities in connection with the said business incurred, accrued, or owing at the close of December 31st, 1897, fall to be discharged by this company.

The Electric Cab Mishap.—The daily press would seem to be short of matter just now, judging by the amount of attention given to the mishap with an electric cab in Fleet Street. It is not altogether the right thing to prejudice the general public against these vehicles before they have had a fair trial, but this seems a very likely result of some of the high-falutin and imaginative accounts which have been printed regarding, what is officially termed, the skidding of the hind wheels. The only damage to the vehicle seems to be the straining of one of these wheels, and the following day the cab was working as usual. The daily sensationalist made it appear that the cab was smashed to pieces, and half of Fleet Street ploughed up.

The Memorial to Ferraris.—We hear that the proposed memorial to the late Prof. Ferraris is receiving considerable pecuniary support from America, France, and Germany, but, though we say it with feelings of keenest regret, not one penny has been received from this country. It is to be earnestly hoped, for the honour of English science, that the occasion will not be allowed to pass without some appreciation being shown to the services which Ferraris had rendered to science.

New Paper.—On Tuesday next Messrs. Cordingley and Co. will bring out the first number of a new penny daily, called the *Daily Contract Recorder*.

Appointment Open.—The St. Helens Corporation want a resident electrical engineer for electric lighting and traction plant, at £200 per annum. See our "Official Notices" for particulars.

Improved Electric Glow Lamp Company v. Edison and Swan United Electric Light Company, Limited.—Yesterday in the Queen's Bench Division, before Mr. Justice Mathew, this case came on for hearing. It was an action to recover damages for breach of contract. The case for the plaintiffs was that by an agreement in writing in a letter from plaintiffs to defendants, of November 3rd, 1896, and in a letter from the defendants to the plaintiffs of November 9th, 1896, the defendants agreed to manufacture for plaintiffs 100,000 electric incandescent lamps of their own make, one-third to be round lamps, and two-thirds to be conical shaped. The defendants agreed to deliver a minimum weekly quantity of 2,000 lamps, delivery to commence within five weeks from the date of the acceptance of the contract. Plaintiffs alleged that defendants had failed to deliver the minimum quantity, by reason of which the plaintiffs, who were unable to purchase the lamps elsewhere, had been unable to carry on their business, and had lost the large profits they would have made out of the sale of the lamps, and had been greatly injured in their business. The defendants, in their defence, did not admit the contract, and alternatively they pleaded that if they did do so, they were prevented by the acts of the plaintiffs from delivering the lamps on the agreed dates. They had otherwise delivered all the lamps contracted for, and they denied that the plaintiffs had suffered any damage.—Mr. Bousfield, Q.C., M.P., Mr. Wallace, Q.C., and Mr. A. J. Walter, were counsel for the plaintiffs, while Mr. Fletcher Moulton, Q.C., and Mr. J. C. Graham represented the defendants. In the course of the case the defendants admitted that there had been delay in the delivery, and after consultation between the parties a verdict was, by agreement, entered for the plaintiffs for £750 and costs.

Dr. Cornelius Herz.—Dr. Cornelius Herz went out for a short drive on Saturday last, this being the first time he has left the Tankerville, Boscombe, for six years.

Personal.—Mr. Thomas H. Blakesley has resigned his seat at the Council board of the Physical Society. He is, therefore, no longer honorary secretary of that Society.

Lecture.—On 17th inst. a lecture on "Electric Currents, their Ways and Adaptation," was delivered in the Marine Engineers' Institute, King Street, South Shields, by Mr. G. Smith, of H.M. Customs.

New York Electrical Society.—Mr. S. Dana Greene read a paper before the above society, at New York, on the 10th inst., his subject being "The Relations Between the Customer, the Consulting Engineer and the Electric Manufacturer."

Storage Batteries for Buffalo.—An American Exchange says that in December the announcement was made that the Buffalo Railway Company would instal at once a set of storage batteries at its Niagara Street power station to act as a station auxiliary. There will be about 290 cells, which will be contained in a fireproof structure built especially for the purpose. The building will measure 40 feet × 70 feet, and the Buffalo Railway Company expects to have the installation in operation early in March.

The L.C.C. and Lantern Projection.—In some regulations which have just been issued by the L.C.C. respecting the uses of limelight in premises licensed by that body, we observe that the employment of ether and other inflammable liquids is forbidden, and it is suggested that in all cases where possible, the electric arc light shall be used as an illuminant instead of limelight.

Webb Testimonial.—The presentation dinner to Mr. and Mrs. Webb has been postponed to Monday, February 21st, owing to the rooms of the Hotel Metropole being required on the 14th (the date originally fixed) for a dinner at which the Prince of Wales is to be present. Early application for tickets should be made to Mr. H. Edmunds.

Fatality.—An inquest was held on Friday last at the St. Bartholomew's Hospital on the body of Herbert Mewcross, aged 25, a labourer, who was crushed to death by a crane at the Electric Railway Works, in Moorgate Street, on the 13th inst. The jury returned a verdict of "Accidental Death."

Electric Mail Carts.—It is stated that the Post Office on Monday last started a service of electric delivery vans between St. Martin's-le-Grand and Paddington Station.

James Watt Anniversary Dinner.—The 11th James Watt anniversary dinner, in connection with the Institute of Engineers and Shipbuilders in Scotland, took place at Glasgow last Saturday evening. Lord Kelvin was present, and in proposing "the memory of James Watt," made a very interesting speech.

Appointment.—Mr. Frank Clowes, on taking the position of chief chemist to the London County Council, has been elected Emeritus Professor of Chemistry of the University College, Nottingham.

Explosion at an Oldham Electrical Supply Station.—We take the following paragraph from yesterday's *Liverpool Mercury*. We have, however, been unable to verify this extraordinary statement:—"An alarming explosion occurred on Tuesday evening at the Oldham Corporation Electrical Supply Station, Rhodes Bank, and effected damage to the extent of between £200 and £300. At six o'clock a loud report was heard and the place was enveloped in steam. It was found that the cylinder ends of two engines, connected with dynamos, had been blown out. These lay smashed a few yards away, and one, weighing two tons, came very near striking Mr. Newington, electrical superintendent."

Sludge and Dust Destructors.—Yesterday a large number of professional gentlemen were invited to visit the Leyton Sewage Works for the purpose of inspecting the "Beaman & Deas" destructors, and to meet Sir Douglas Galton, K.C.B., D.C.L., &c., Chairman of the Council of the Sanitary Institute. A luncheon in the Town Hall followed, at which Sir Douglas spoke at great length on the subject of refuse destruction and the methods in use, but we must defer a detailed description of the Leyton plant till next week, when we hope to deal very fully with the matter. Sir Douglas Fox and Mr. Francis Fox, as engineers, with the assistance of Messrs. Stanger and Blount, consulting chemists and analysts, have given a most favourable report upon the apparatus as a most efficient and economical refuse destructor without injury to the neighbourhood.

NEW COMPANY REGISTERED.

Moutrie & Co., Limited (55,696).—Registered January 18th with capital £5,000 in £1 shares to acquire the business of Moutrie & Co., of 17, Berners Street, W., and to carry on the business of electrical and mechanical engineers, machinists, fitters, gas engineers, founders, wood and metal workers, electro-platers, &c. Registered without articles of association. Registered office, 17, Berners Street, W.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Salisbury Electric Light and Supply Company, Limited (41,414).—This company's annual return was filed on January 8th, when 1,307 shares were taken up out of a capital of £20,000 in £1 shares. £1,013 15s. has been paid, and £293 5s. is in arrears.

CITY NOTES.

Bedford Lighting Accounts.

THE result of the year's working at Bedford discloses a loss of £1,200, which is a considerable increase upon that of last year, when the figure was £914. The net revenue shows a considerable increase, being, in fact, nearly £700 more, but if we take the whole of the figures on the debit side, the interest on mortgage debt accrued to date (£1,157), and the instalments of principal of money borrowed (£1,560), the undertaking will have to call upon the rates to the extent of £1,200. With a considerably increased output the cost of production shows only a small reduction. Probably the works are not yet obtaining the full benefits from the extensions of plant that have been made during the past 12 months.

The following table gives the cost per unit:—

	1897.	1896.
Total capital expended	£46,890	£38,670
Number of units sold	255,990	158,238
Number of lamps connected	—	—
Revenue from sale of current	£4,606	2,939
Net revenue	£1,593	£842
Average price obtained per unit	4·30d.	4·47d.

Cost of production.	£		Per unit.	1896.
Coal	1,322		1·24d.	1·35d.
Oil, waste, water and engine room stores	135		·13d.	·16d.
Salaries and wages at generating station	771		·72d.	·93d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	320	Works' cost 2·39d.	·30d.	·12d.
Rent, Rates and taxes	142		·13d.	·18d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	349		·33d.	·40d.
Depreciation of buildings and plant account	—		—	—
Renewal fund account	—		—	—
Total	£3,039		2·85d.	3·14d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	4,606	0	0	4·30d.
Meter rents, &c.	—			—
Total	£4,606	0	0	4·30d.

Total cost per unit (exclusive of depreciation and renewal accounts), 2·85d.; works' cost, 2·39d.

Total loss on year's working, £1,200.

Direct United States Cable Company, Limited.

The forty-first ordinary general meeting was held on Tuesday at Winchester House, when Mr. E. M. Underdown, Q.C., presided. He stated that the revenue for the six months ended the 31st ult., after deducting outpayments, amounted in round figures to £50,098, while the working and other expenses, including income-tax, but exclusive of the cost of cable repairs, absorbed £19,723, leaving a balance of £30,375 as the net profit of the half-year, making, with the amount brought forward, £34,303, out of which two interim dividends of 3s. per share each for the quarters ended September 30th last and the 31st ult. had been declared, and £12,000 had been transferred to reserve fund account, leaving £4,090 to be carried forward. The revenue had continued to increase during the half-year, and was still improving. The increase in the past six months had been £2,497, or about 5½ per cent., as compared with the earnings in the corresponding period of 1896. The expenses in London remained practically the same, while those at the stations had been only slightly higher, consequent on the additional work done owing to the increased traffic. The remaining expenditure was more or less fixed, but, generally, it showed a small reduction as compared with that of the same period of 1896. The cable renewals in the past half-year had cost £8,325, which, with the amount written off the Ballinskelligs buildings account, £2,000, had been debited to the reserve fund account. On the other hand this account had been credited with £5,604 for interest on the investments and the £12,000 set aside, as he had already mentioned, out of revenue, leaving the balance of the reserve fund standing at the increased figure of £345,767. Many of their investments had recently increased in value, and during the past half-year they had been added to by £12,220, bringing the total up to £330,786 at cost. The present market value of the investments was about £385,800, showing a profit on their cost price of about £55,000. Their relations were most cordial with the allied companies, the Anglo-American and the Western Union Companies, and every kind of mutual accommodation was afforded between them. This company's share in the pool was very satisfactory, but he found that the advantages to the public from their combination were not generally understood. The public thus had the advantage of seven cables; and when traffic accumulated it must be manifest how well it could be dealt with, with this number of cables, owing to the arrangement between the companies. Moreover, when interruptions to the cables occurred, as must happen, the traffic was practically never suspended or interrupted. At the same time the independence of the companies was maintained—that was to say, any member of the public who chose to forward his message by the Anglo-American, the Direct, or the Western Union companies could do so, and this was done from time to time. It was true that the proceeds were shared among the different companies, but many people preferred one route to another. The short cable, as it was called, had been interrupted, and two repairs were made to it during the half-year. It had been thought advisable to put a considerable piece of new cable, 57 miles, into that part of the line which was in comparatively shallow water, and to move the cable into deeper water, where it was practically safe from damage from ships' anchors. He concluded by moving the adoption of the report and accounts. Sir James Pender, M.P., seconded the motion, which was carried unanimously; and at the instance of Captain Goodsall and Mr. John Newton, a suggestion was unanimously approved recommending the board to distribute an amount equal to 5 per cent. on the salaries of the staff as a bonus in celebration of the Diamond Jubilee year.

London Electrical Cab Company.

The directors of this company are offering for subscription an issue of 86,388 £1 ordinary shares, completing the issue of the £150,000 authorised nominal capital. The shares are offered at 2s. 6d. premium. The proceeds of two-thirds of the shares already issued were, by arrangement with the vendors, retained for working capital, and the balance of one-third only was paid to the vendors on account of the agreed purchase price (£50,000). The proceeds of the present issue will be similarly dealt with, so that the working capital will continue to be two-thirds of the total share capital issued.

Although the outlay up to date includes the cost of altering and adapting the extensive buildings in Juxon Street, Lambeth; also fitting up the same with electrical plant, machinery, &c; also all preliminary expenses and the cost of the cabs now on the streets, and parts of further cabs, the company still have at their bankers nearly half the working capital received.

A much larger number of cabs might have been placed upon the streets within the same period, but in the interests of the company it was decided to first practically test a smaller number.

Immediately the directors were satisfied as to these, contracts were placed for further cabs, which will have several very important improvements, and which, when completed, will absorb nearly the whole of the working capital at their disposal. These vehicles will be delivered as quickly as possible, and there will then be three times the number of electric cabs than there are now on the streets.

It is with the object of still further increasing the number of the company's vehicles that this issue is made.

With the prospectus is given a copy of a report by Messrs. Kincaid, Waller & Manville, dated January 17th, 1898, on the prospects of the company. The list closes to-morrow (Saturday).

House-to-House Electric Light Supply Company.

According to the *London Gazette*, the petition presented on January 13th, 1898, for confirming the following special resolution, will be heard on February 5th before Mr. Justice Romer in the Chancery Division:—"That the agreement dated November 29th, 1897, and made between the company of the one part, and the several persons, corporations and firms executing the same in the Schedule thereunder written (thereinafter called 'the holders of the founders' share') of the other part, be approved and confirmed, and that having regard to the terms thereof, the capital of the company be reduced from £200,000 divided into 40,000 shares of £5 each, of which 27,900 are ordinary shares, 12,000 are preference shares, and 100 are founders' shares, to £199,500 divided into 39,900 shares of £5 each, of which 27,900 are ordinary shares and 12,000 are preference shares; and that such reduction be effected by cancelling the whole of the said founders' shares; that is to say, the shares in the company numbered 1 to 100, both inclusive."

Gutta Percha Corporation.

The statutory meeting of this Corporation was held at Winchester House on Wednesday. Sir Edward Thornton, the chairman of the Corporation, after referring to the composition of the Board, pointed out that while the patent was lying idle in inexperienced hands, it had been worked by others in France where they had been producing as much as 140 lbs. per day. Of course they were not going to have their patents infringed in that manner, consequently they sent their manager to France, who inspected the works, and as a result of negotiations the French Company had agreed to hand over the factories on satisfactory terms. Pending the time, therefore, it would necessarily take to erect a factory in London, they would be in possession of a factory which was earning money. There would be no difficulty in obtaining leaves, their agents being prepared to supply thousands of tons per annum. After extracting the gutta from the leaves, they could be sold for paper pulp at a price which would cover cost of freight.

After the usual vote of thanks the meeting then terminated.

Central London Railway Company.

The report of the directors of the Central London Railway Company for the half-year ended December 31st last, to be submitted to the general meeting to be held in London on February 2nd, states that the expenditure during that period amounted to £460,728, which, added to the amount previously expended, makes a total outlay to date of £1,606,948. The sum of £228,448, which appears in the accounts as owing to the contractors, is due to them for work done as certified by the company's engineers. The latter report that satisfactory progress has been made with the works during the half-year, and that at the present time three-fourths of the main line tunnels, one-half of the station tunnels, and nearly the whole of the lift and staircase shafts have been constructed. At the Bank Station, the very difficult work in connection with the subway for pipes is complete, and the public subways are in an advanced stage.

Anglo-American Telegraph Company, Limited.—The directors, after placing the sum of £12,000 to the credit of the renewal fund for the half-year, have resolved to recommend at the meeting on February 4th next, the declaration of the following dividends:—(1) A balance dividend of 19s. 6d. per cent. upon the ordinary consolidated stock for the year ending December 31st, 1897; (2) a balance dividend of £1 19s. per cent. upon the preferred stock for the year ending December 31st, 1897, both payable on February 5th next, less income tax, to the stockholders registered on the books of the company on the 21st inst. After paying the foregoing dividends, there will be a balance of about £200. The above dividends, together with those already paid, will amount to £3 per cent. on the ordinary consolidated stock and £6 per cent. on the preferred stock for the year 1897. The register of transfers will be closed from January 22nd to February 4th, both days inclusive.

Stock Exchange Settlements.—The Stock Exchange Committee has appointed Wednesday, February 2nd, a special settling day in Edison & Swan United Electric Light Company, Limited—£194,023 4 per cent. debenture stock, and has ordered the undermentioned securities to be quoted in the Official List:—Commercial Cable Company—Further issue of £264,711 sterling 4 per cent. 500-year debenture stock. Edison & Swan United Electric Light Company, Limited—£194,023 (part of £200,000) 4 per cent. debenture stock.

Applications have also been made to appoint a special settling day in, and to grant a quotation to:—City of London Electric Lighting Company, Limited—Further issue of 10,000 ordinary shares. Electric Construction Company, Limited—4 per cent. perpetual first mortgage debenture stock, and a further issue of 8,657 7 per cent. cumulative preference shares, and to allow to be quoted in the Official List:—City and South London Railway Company—Further issue of 832 5 per cent. perpetual preference shares, Nos. 8,420 to 9,251.

The Electro-Chemical Company, Limited.—An issue of £30,000 5 per cent. first mortgage debentures of £100 each is announced. The debentures are secured by a first charge on the freehold property and British patent rights of the company, the value of the property alone, exclusive of goodwill or patent rights, being estimated at £73,100. The debentures are redeemable on July 1st, 1910, at par, or they may be redeemed, on six months' notice, at £105.

Venezuela Telephone and Electrical Appliances Company.—Coupon No. 15 of the 5 per cent. mortgage debentures, due on 31st. inst., will be paid from that date at the Capital and Counties Bank, Limited, 39, Threadneedle Street, E.C., and at Messrs. Westendorp & Co.'s Bank, Amsterdam.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending January 23rd, 1898, were £1,075; week ending January 24th, 1897, £1,114; decrease £39; total receipts for half-year, 1898, £4,384; corresponding period, 1897, £4,387; decrease, £53.

The Cuba Submarine Telegraph Company. The receipts for the month of October were £2,885, as compared with £4,314 in the corresponding month of last year.

The Liverpool Overhead Railway Company. The receipts for the week ending January 23rd, 1898, amounted to £1,354; corresponding week last year, £1,217; increase, £137.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending January 21st, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,011.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, Jan. 19th.	Closing Quotation, Jan. 26th.	Business done during week ended Jan. 26th, 1898. Highest.	Lowest.
137,400*l*	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	...	...	100 104	100 — 104	...	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	6 — 7	6 — 7	...	...
125,000	Do. do. 5% Debs. Red.	100	...	...	...	93 — 96	93 — 96	...	...
923,900*l*	Anglo-American Teleg., Ltd.	Stock	£2 9s	£2 13s	3 %	61 — 63	61 — 63	62	61⅝
3,038,020*l*	Do. do. 6 % Pref.	Stock	£4 18s	£5 6s.	6 %	111 112	111 — 112	112½	111½
3,038,020*l*	Do. do. Defd.	Stock	..	...	...	13½ 14	12⅞ 13½	13 11/16	1[illegible]
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	...	...	16½ — 16⅞	16½ 17	17	16⅞
75,000*l*	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	...	...	112 — 116	112 — 116	...	...
44,000	Chili Teleg., Ltd., Nos. 1 to 44,000	5	4 %	4 %	...	3 — 3½	3 — 3½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	...	185 — 190	187 — 192	...	...
653,586*l*	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	105 — 107	105 — 107	107	106½
224,850	Consolidated Teleg. Const. and Main., Ltd.	10/-	1½%	2 %	...	1/16 — 3/16	1/16 — 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	...	8 — 9	8 — 9	8½	8½
6,000	Do. 10 % Pref.	10	10 %	10 %	...	18 — 19	18 — 19	18	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	...	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	...	10 — 11	10 — 11	10½	...
30,000*l*	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	...	103 — 106%	103 — 106%	...	...
60,710	Direct United States Cable, Ltd.	20	2½%	2½%	...	10½ - 10⅞xd	10½ — 11	10⅞	10½
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	...	17⅞ 18½xd	18 — 18½	18 7/16	17 13/16
70,000	Do. 6 % Cum. Pref.	10	6	6%	...	18½ - 19½xd	19 — 20	19½	19½
89,900*l*	Do. 5 % Debs., repay. August, 1899	100	5 %	5%	...	102 — 105	102 — 105	...	...
1,302,615*l*	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4%	...	131 — 134	131 — 134	132½	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7%	...	18⅞— 19½xd	18⅞ - 19½	19½	18⅞
25,200*l*	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5%	...	99 — 103	99 — 103	102	101½
100,500*l*	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5%	...	100 — 103	100 — 103	...	...
320,000*l*	Do. 4 % Deb. Stock	Stock	4 %	4%	...	132 — 135	132 — 135	...	...
51,100*l*	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5%	...	99 - 103	99 — 103	102	100½
69,200*l*	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5%	...	100 - 103	100 — 103	...	...
300,000*l*	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1906	100	4 %	4%	...	104 - 107	104 — 107	108	107
200,000*l*	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4%	...	108 111 %	108 — 111%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	...	11⅞ - 12½	12 — 12½	12½	12
180,042	Do. do. 6 % Pref.	10	6 %	6%	...	17⅞ 18½	17⅞ - 18½	18 3/16	18
150,000	Great Northern Teleg. Company of Copenhagen	10	10 %	10%	...	27 — 28	27 — 28	27½	2[illegible]½
160,000*l*	Do. do. do. 5 % Debs.	100	5 %	5%	...	101 — 104	101 — 104	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10%	...	52 — 55	52 — 55	54½	53
100,000*l*	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6%	...	108 — 111	108 - 111	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	...	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5½%	5½%	...	6⅝ - 6⅞	6⅝ - 6⅞	6 13/16	6½
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	15 — 17	15 — 17	16 13/16	..
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	14 — 16	14 — 16	16	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	...	6 — 6½	6 — 6½	6½	6½
130,766	Do. do. Nos. 119,235 to 250,000, £5 paid	5	...	...	...	6 — 6½	6 — 6½	...	...
339,471*l*	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	...	102 — 107 xd	104 — 109	106½	103⅞
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	⅝ - ¾	⅝ - ¾	11/16	...
100,000*l*	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	...	105 — 108	105 — 108	...	.
11,839	Reuter's Ltd.	8	5 %	5 %	...	7½ - 8½	7½ - 8½	8½	8½
3,261	Submarine Cables Trust	Cert.	...	...	...	138 143	140 145	141½	...
58,000	United River Plate Teleph., Ltd.	5	4 %	...	...	4 — 4½	4 — 4½	...	...
146,733*l*	Do. do. 5 % Debs.	Stock	5 %	...	...	101 — 106	101 — 106	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	nil	...	4 — 5	4 5	...	...
213,400	Do. do. do. 5 % Debs.	100	5 %	5 %	...	103 - 106	103 — 106	104½	...
64,268	Western and Brazilian Teleg., Ltd.	15	2 %	2 %	...	9⅞ - 10½	9⅞ - 10½	10½	9⅞
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	...	7½— 8	7½ - 8	7½	...
33,129	Do. do. do. Def. Ord.... ...	7½	1 %	...	...	2¾— 3½	2¾ - 3½	...	...
362,230	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	104 — 107	105 — 107	106½	...
88,321	West India and Panama Teleg., Ltd.	10	½%	1 %	...	⅜ - ⅝	⅜ - ⅝	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	7 — 7½	7 — 7½	7⅜	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	5 — 7	5 — 7	...	...
80,000*l*	Do. do. 5 % Debs. No. 1 to 1,600 ...	100	5 %	5 %	...	105 — 108	105 — 108	...	...
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7%	...	105 — 110	105 110	...	...
160,100*l*	Do. do. 6 % Ster. Bonds. ...	100	6 %	6%	...	100 — 105	100 105	...	...

ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share.	1895.	1896.	1897.	Closing Quotation, Jan. 19th.	Closing Quotation, Jan. 26th.	Highest.	Lowest.
30,000	Charing Cross and Strand Electy. Supply	5	5 %	6 %	...	12½— 13½	14 — 15	14⅞	13 7/16
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6½— 6⅞	6½ - 6⅞	6½	...
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	...	10½— 11	10⅞— 11½	11	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	4½%	4½%	...	112 — 114	112 — 114		...
40,000	City of London Elec.Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	7 %	...	27½ — 28½	30 — 31	3[illegible]⅛	28½
10,000	Do. do. Prov. Certs.	5	...	...	...	27 — 28	29½— 30½	30	...
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	...	17 — 18	17 — 18	17⅞	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	...	129 — 134	129 — 134	...	...
30,000	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1- 30,000	10	nil	nil	..	13⅞— 14½	15 — 15½	15⅜	14½
20,000	Do. do. do. 6% Pref., 40,001—60,000 ...	10	6 %	6 %	...	15½— 16	15⅞— 16½	16	15⅞
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5	...	...	...	9 — 10	10 — 11	10⅝	9⅝
10,000	Do. do. 7 % Cum. Pref. ...	5	...	..	...	11 — 11½	11½— 11⅞	11⅝	...
48,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	4 %	5 %	...	18 — 19	19½— 20½	19⅞	18 15/16
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem.	10	...	...	...	18 — 19	19 — 20	19½	19½
220,000	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	117 — 121	117 — 121	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	2 %	4 %	...	17½— 18½	18 — 19	18½	...
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	7½%	10½%	14½ %	17½— 18½	18 — 19	18⅞	18
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	10 — 11	10 — 11	10⅝	10⅜
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	4 %	101 — 104	101 — 104	...	...
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2⅞— 3½	2⅞— 3½	3 1/16	2⅞
79,900	Westminster Electric Supply Corp., Ord., 101 to 80,000 ...	5	7 %	9 %	12 %	16 — 17	17 — 18	17⅞	16½

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation Jan. 19th.	Closing Quotation, Jan. 26th.	Business done during week ended Jan. 26th, 1898. Highest.	Lowest
30,000	British Electric Traction	10	...	...	...	17½—18	17½—17¾	17⅝	17⅜
90,000	Brush Elec. Enging. Co., Ord., 1 to 90,000...	2	...	...	...	2—2¼	2⅛—2⅜	2 5/16	2 3/16
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	...	...	2¼—2½	2⅛—2⅜	2 5/16	2 3/16
125,000*l*	Do. do. 4½ % Perp. Deb. Stock... ...	Stock	...	...	...	109—113	109—113	...	...
50,000	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	102—105	102—105	104½	...
19,126	Central London Railway, Ord. Shares	10	...	...	...	9¾—10¼	9¾—10¼	10⅛	...
143,106	Do. do. do. £6 paid	10	...	...	...	5½—6	5¾—6¼	6	5⅞
58,830	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1¼—1¾	1½—1¾	1 7/16	...
61,777	Do. do. Def. do. £5 pd. ...	...	...	...	...	4—4½	4¼—4¾	4 9/16	...
630,000*l*	City and South London Railway	Stock	1 3/16%	1 9/16%	1⅞%	69—71	69—71	70½	69¾
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	nil	...	...	2—2½	2¼—2¾	...	...
99,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 99,261	5	5 %	5½%	...	2½—3	2½—3	2¾	2½
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5½%	...	4½—5½	4½—5½	4⅝	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	5 %	6 %	...	2⅝—2⅞	2¾—3	2 15/16	2 13/16
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 ...	2	7 %	7 %	...	3⅛—3⅜	3⅛—3⅜	3⅜	3 3/16
91,195	Elmore's Patent Cop. Depostg., Ltd., 1 to 70,000	2	...	...	...	½—¾	½—¾	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	...	...	...	½—¾	⅜—⅝	...	...
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	10½%	...	...	9—11	9—11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	8 %	10 %	...	21—22	21—22	22	21½
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	...	18½—19½	18½—19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	...	110—115	110—115	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	...	23½—24½	23—24	23 11/16	23 9/16
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	103—107	103—107	...	...
87,500	†Liverpool Overhead Railway, Ord.	10	2⅞%	2⅞%	...	11⅜—11½	11⅜—11½	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	...	16—16½	16—16½	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	15 %	...	38—41	39—42	...	...
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	...	102—105	102—105	...	...
54,000*l*	Waterloo and City Railway, Nos. 1 to 54,000	10	...	...	...	12½—13	12¾—13¼	13⅛	12⅞

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0 %; 1891—7 %; 1890—8 %.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

* Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 11.

Electric Construction Corporation, 6 % Debentures, 105—106.

House-to-House Company, 4½% Debentures of £100, 108—110.

Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 15—15½; 1st Preference Cumulative 6 %, £5 (fully paid), 8¼—8¾. Dividend, 1896, on Ordinary Shares 7 %.

London Electric Supply Corporation, £5 Ordinary, 3—3½.

* T. Parker, Ltd., £10 (fully paid), 11⅝—12⅛.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8¼—8¾. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount 3 per cent. (October 14th, 1897).

WHAT IS THE FATAL E.M.F.?

By W. S. HEDLEY, M.D.

Four recent cases of death from accidental contact with electric lighting wires carry the mind back to the Board of Trade Inquiry which resulted in raising the limit of low pressure supply. It may be remembered that one gentleman present at that inquiry asserted that he had felt no ill effects from a 600-volt shock. The present writer commented on that statement in the following words*:—"Did he touch one pole only of a 600-volt circuit? If so, what was the earth insulation of the other pole? Was his body in contact with the earth, or, presuming that he simultaneously placed one hand on each pole of the 600-volt circuit, what was the surface area of skin contact and what was the condition of the skin? In the absence of information in these points the statement referred to cannot be considered to have any real value."

The four fatal cases above referred to are reported in the *Elektrotechnische Zeitschrift*, December 30th, and occurred in a chemical factory, the name of which is withheld. The first case was that of a man whose business it was to raise and lower an arc lamp by means of a wire rope, windlass and iron crank. He had instructions never to attend to the lamp excepting when standing insulated on a wooden stool. Instead of this he stood with bare feet upon the ground. Having accidentally forced up the lamp too high its support was bent and touched an upper pulley, in consequence of which a current at 115 volts was communicated to the cable, the windlass and the crank, and proved fatal to the man. In the second instance a labourer, contrary to instructions, seized an alternating current conductor which was outside a window. In the third case two insulated wires were enclosed in an iron tube, and it happened either that one of the joints of the tube getting loose, cut the insulation of the wire, and so the wire and tube were brought into contact, or that a wire having become unscrewed its end came into contact with the unearthed pipe, and the fatal shock was received from the latter. In the fourth instance a faulty flexible conductor or lamp fitting seems to have been the cause of the accident. In at least three of these cases a good contact and considerable contact area had evidently been obtained by firmly gripping the conductor—the contact was probably of some duration—a most important factor in producing fatal results, the skin resistance of the hands had probably been much reduced by handling chemicals, by the dampness of the place, or by processes carried on in the factory; and when to these circumstances it is added that the labourers not being provided with dry boots were in the habit of going about on a damp floor with wooden slippers or with bare feet, it is evident that every condition had been secured to enable the available electromotive force to pass a large current through the body.

What is the minimum fatal electromotive force? This has yet to be defined, and with the definition must come also a statement of the necessary conditions. Nature, area and duration of contact, condition of skin, maximum electromotive force, periodicity. The question is complex, but in the opinion of the present writer everything seems to point to the fact that all commercial forms of electric lighting currents, varying as they do from 80 volts upwards, are dangerous to human life under certain conditions. Fortunately the required conditions do not often occur in actual practice, and when they do occur they admit of remedy.

* "Current from the Main." Lewis & Co., London.

Such cases as the above would be met by a concentric system of wiring with the outer conductor earthed and with switches, &c., on the inner.

WINDINGS OF POLYPHASE ARMATURES.*

By J. P. STONE.

(*Concluded from page* 70.)

Regarding choice of winding, in some cases, undoubtedly, one is preferred to the other. In such cases as with

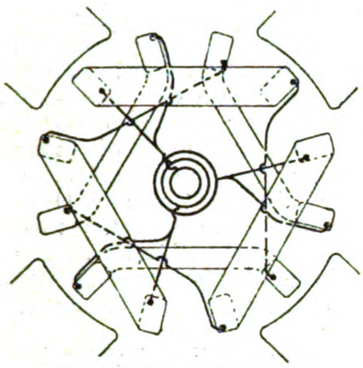


Fig. 9.—Delta Winding.

alternators where rectified current is used for compounding, the Y-connection adapts itself more readily, as the commutator can be connected in the common junction of the three phases. The delta winding, however, is essential in generators which shall combine direct-current output or input, with alternating current output or input, such as a rotary converter, where, on account of the direct-current feature, the winding must be of the delta form; that is, must be continuous, as shown in fig. 5, which represents a continuous winding tapped off at three points 120° apart. Furthermore, by the choice of one or the other it is often possible to make a decidedly better motor, both mechanically and electrically.

An armature designed for a given working voltage measured between the lines, would, if planned for Y-connection, have fewer turns of larger wire than if intended for delta connection. This is sometimes convenient, and is use-

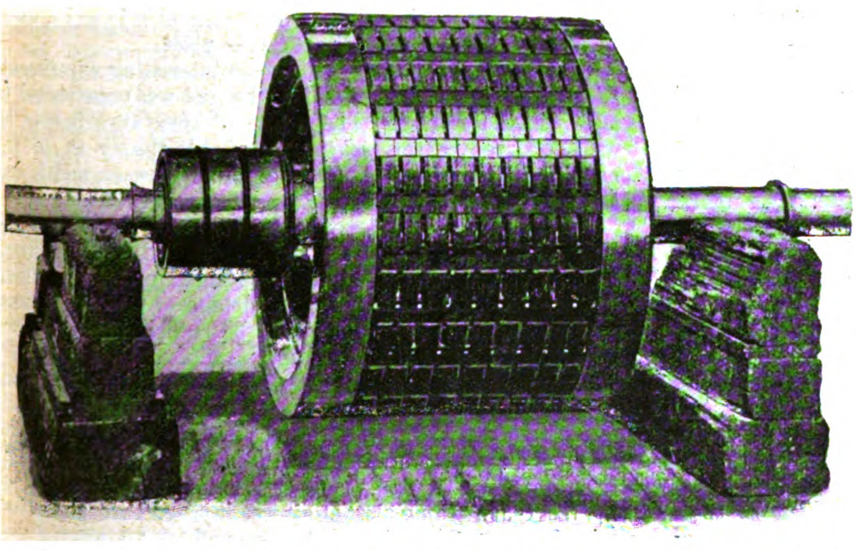


Fig. 10.—Polyphase Armature.

ful in keeping the voltage between coils low. The delta connection, on the other hand, has more turns of smaller wire, as the current is diminished while the E.M.F. in each coil is the full E.M.F. between the lines. This property is useful under certain conditions, as it makes the E.M.F. between any two lines somewhat less; for instance, in a machine with very large currents, the delta winding would be preferable, since in that winding the current in each wire is smaller than the line current (the line current being supplied from two phases as illustrated in fig. 5). The contrary

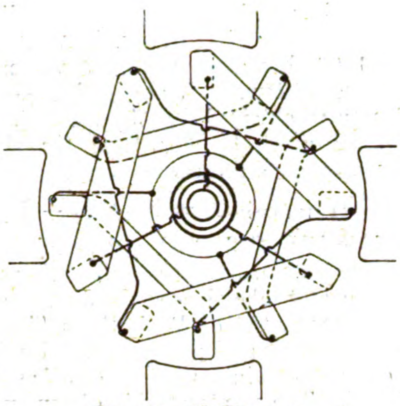


Fig. 11.—Y Winding.

is the case in a machine for very high potential; it is often possible to get a simple winding by a Y-connection, since then the number of turns necessary to give the requisite voltage are less than those in a delta-connected winding.

The same winding can, of course, be connected Y or delta according to the dictates of convenience, as in figs. 9 and 11, which show the same armature connected delta and Y respectively. Thus it will be seen that the manner of connecting the windings of a multiphase armature is largely a matter of convenience, and thus does not influence the working of the machine.

A completed armature for a polyphase generator is shown in fig. 10, the winding and connection of which are covered by a shield at each end to protect them from injury.

* *American Electrician.*

THE JACQUES CARBON CELL.

The Jacques carbon cell, which was some time ago described in the Electrical Review,* has recently given rise to interminable discussion in the American technical journals. It may be necessary to remind our readers that this cell consists of an iron pot, containing caustic soda or potash, which is kept in a fused condition by the application of external heat. A rod of carbon is immersed in the fused alkali, and a current of air is forced into it in such a way as to come in contact with the surfaces of the electrodes.

The original theory of the inventor appears to have been that the air forced into the electrolyte combined with the carbon, in such a way that the energy of combustion was transformed into electric energy, that the carbonic acid gas produced by the combustion escaped in bubbles, and the electrolyte remained practically unchanged. Taking into account only the carbon consumed inside the cell, Jacques calculated that the efficiency of his generator was 82 per cent. A subsequent calculation, in which the carbon consumed in heating the pot was taken into account, reduced the first sanguine estimate to 32 per cent.† A letter by Mr. C. J. Reed in the *American Electrician* for this month, shows that the efficiency of the Jacques "generator"

* Vol. 38, p. 826.
† Electrical Review, Vol. 39, p. 802.

must undergo a still further reduction; that, in fact, the raw material or fuel consumed by the Jacques cell will cost at least 34 times as much as that required by a steam engine doing the same amount of work.

The serious blunder made by Jacques and his supporters lay in the assumption that carbonic acid gas arising from the combustion was given off in the gaseous condition, and did not combine with the caustic alkali. The correct theory (as far as it went) of the reactions in the Jacques cell was given by Mr. Fitzgerald in the ELECTRICAL REVIEW, Vol. 39, p. 10, July 3rd, 1896, but at that time it was neglected by the American investigators, as it appeared to contradict the experimental results obtained by Jacques. The electro-chemical equation given by Fitzgerald for the Jacques arrangement "so far as it constitutes a voltaic cell," was

$$2\,(Na\,HO) + C + O_2 = Na_2\,CO_3 + H_2\,O. \quad (1)$$

Prof. Ostwald and Mr. C. J. Reed, with certain reservations, agree in accepting this equation as representing the electro-chemical reactions that take place in the Jacques cell.* It is now stated, on the authority of Prof. Elihu Thomson, that the whole of the carbonic acid gas produced by the combustion of the carbon combines with the caustic soda to form carbonate of soda. The result of this discovery is that the Jacques cell is as much a means of getting electricity direct from potash or soda as "direct from carbon."

Taking into consideration the whole of the materials consumed in the production of electric energy, Mr. Reed makes the following rough estimate of the comparative cost of energy produced by the Jacques cell and a steam engine.

"Leaving now the question of efficiency for the more important question of commercial economy, we find that if the carbonate is formed, instead of the carbon dioxide, the battery ceases to have any possibilities. Its use would mean the displacement of a steam engine, using for each H.P.-hour $1\frac{1}{2}$ lbs. of coal, worth \$3 per ton, by an apparatus using $2\frac{1}{2}$ lbs. of caustic soda, worth \$60 per ton, in addition to ·36 lb. of coal, worth \$3 per ton, and ·24 lb. of carbon in sticks, worth at least \$20 per ton. The comparison is, for raw material alone, or fuel,

Steam engine ...	...	...	... \$·00225 per H.P.-hour.
Jacques battery:—			
Caustic soda ...	... \$0·075		
Coal ...	...	·00054	
Carbon	...	·0024 ...	·07794 " "

"The raw material for the Jacques battery will cost at least 34 times that for a good steam engine, and about 75 times that necessary for a gas engine. The weight of raw material to be handled for the Jacques battery is more than twice that used in the steam boiler, and the residue or 'ash' from the battery would weigh 10 or 12 times as much as that from the boiler. The figures are based on using 60 per cent. caustic soda, which would probably be the cheapest material that could be used."

Mr. Reed considers that the net efficiency of Jacques cell must be put at 8 per cent., when allowance is made for the power required to drive the air pump.

Though Prof. Ostwald and Mr. Reed agree as to the nature of the electro-chemical reactions which take place in the the Jacques cell, they differ *in toto* as to the source of the E.M.F. which propels the current through the battery circuit. Prof. Ostwald considers that the operation of the Jacques element is exactly analagous to that of the Lalande element, which consists of copper oxide and zinc, immersed in sodium hydrate. This cell has an E.M.F. of 0·8 volt, and under the action of the current, the zinc dissolves, forming sodium zincate, while the oxide of copper is reduced to copper. The cell becomes exhausted as soon as any one of the three substances, zinc, copper, and sodium hydrate is used up. In case all the oxide of copper is reduced to copper, the cell can be restored to action by exposing the plate to air so as to re-oxidise the porous copper.

In the Jacques cell, the *rôle* of the zinc is played by the carbon; the *rôle* of the oxide of copper by ferric oxide or sodium ferrate. "The cell," says Ostwald, "will work until one of the three necessary constituents is exhausted. Since in the Jacques arrangement ferric oxide is the constituent present in smallest quantity, the activity of the cell depends entirely upon the renewal of the exhausted ferric oxide; *i.e.*, upon the amount of air or oxygen conveyed to the iron cathode."

Ostwald points out that the energy set free by the combination of the oxygen with the iron in the Jacques cell, is lost as far as the electric process is concerned. There is practically no way known, as yet, for preventing this loss.

The analogy between the reactions in the Lalande cell and the Jacques cell suggested by Prof. Ostwald is fully admitted by Mr. Reed, and from this analogy he deduces the full and complete equation of the Jacques cell, which, as we shall see, was only partially represented by the Fitzgerald equation given above. The reaction in the Lalande battery is

$$Zn + 2\,Na\,OH + CuO = Na_2\,ZnO_2 + H_2O + Cu \quad (2)$$

and that of the Jacques battery

$$3C + 6\,Na\,OH + 2\,Fe_2\,O_3 = 3\,Na_2\,CO_3 + 3\,H_2O + 4Fe \quad (3)$$

This latter equation shows clearly that the oxygen which passes through the electrolyte and oxidises the carbon, is derived from the oxide of iron and not directly from the oxygen which is blown into the fused alkali. The Fitzgerald equation does not make this quite clear, since taken without qualification, it means that the oxygen of the air is directly used for combustion of the carbon.

Notwithstanding the fact that Prof. Ostwald understood and stated clearly this important point, he uses the Fitzgerald equation to calculate the E.M.F. of the Jacques cell, from the heats of combination of the compounds represented by the equation. He obtains by this calculation a positive E.M.F. of 2·66 volts.

Mr. Reed calculates the E.M.F. of the Jacques cell from equation (3), and finds that the sum of the formation-heats of the reagents in the left-hand side of the equation exceeds the sum of the formation-heats of the products in the right-hand side of the equation. This means that the reactions in the Jacques cell will not generate an electric current, but that they will require an electric current generated by an external electric force to bring them about.

Mr. Reed's theory is that this external electromotive force is thermo-electric,* and, in short, he considers that the Jacques cell is a thermo-electric battery, not a voltaic battery. Ostwald asserts that it has been shown by Bouty and others that the thermo-electric forces between metals and electrolytes are very small, and that therefore there is not the slightest ground at present for the assumption made by Mr. Reed of the existence of large unknown thermo-electric forces between metals and electrolytes. But Mr. Reed has certainly scored a point by showing Ostwald that out of his own mouth he has condemned himself; and Mr. Reed may well ask where the E.M.F. comes from, if it is not thermo-electric. Reed's well-known experiments, in which he obtained a higher E.M.F. by substituting iron for carbon in the Jacques cell, appear to indicate the existence of considerable E.M.Fs. where no electro-chemical reactions can take place.

Mr. Reed has recently made some interesting experiments with a Jacques cell, in which the pot was constructed of silver instead of iron. The results of these experiments, he considers, proves the correctness of his theory as to the existence of large thermo-electric forces between metals and electrolytes. Describing these experiments Mr. Reed says†:—

"I have also found experimental proof of the correctness of this theory in a Jacques cell constructed of pure silver, instead of iron. The results were entirely different from those obtained with iron. The details of this experiment will be published later. It will be sufficient to say here that with the silver apparatus and pure caustic soda, metallic sodium was given off from the walls of the crucible and burned with explosive reports in 12 minutes after the circuit was closed, and the crucible had become alloyed with metallic sodium. The liberation of metallic sodium increased from that time until the end of the experiment, notwithstanding the fact that a strong blast of air was injected through a silver tube into the electrolyte. At the end of 20 minutes the potential of the cell had fallen to zero and reversed. In 30 minutes after the closing of the circuit, the explosions from the combustion of metallic sodium became so violent that the operation had to be stopped, and the room (a large one) was filled with a white cloud of dust of sodium oxide. The crucible was $1\frac{1}{2}$ inches in diameter and 3 inches deep. The

* *American Electrician*, January, 1898.

* ELECTRICAL REVIEW, Vol. 39, p. 350.

† *American Electrician*, January, 1898, p. 20.

carbon rod was ½ inch in diameter. The lower part of the crucible was found to be so thoroughly impregnated with metallic sodium, that it became spongy on washing with water. Water, which was afterwards allowed to stand in it, soaked through it in 24 hours, as it would through porous earthenware. On slight pressure the bottom of the crucible crumbled to powder, resembling a brittle amalgam of zinc.

"The reduction of sodium requires a much greater absorption of energy than that of iron, and its reduction cannot be explained on any theory except that of absorption of heat and the agency of a powerful thermo-electric current."

Whatever may ultimately turn out to be the correct theory of the Jacques element, it has now undoubtedly been shown to be commercially worthless.

ELECTRIC MOTORS ON THE NEW YORK ELEVATED RAILWAY.

According to the *New York Sun*, of January 11th, 1898, Mr. George Gould has authorised the publication of the following statement:—

"We have decided to introduce electricity on the elevated system, and we will now proceed to effect a general installation with as little delay as possible. I wish it understood that we purpose to work energetically along the lines indicated in Mayor Van Wyck's message, and leave nothing undone to adapt our accommodations in the fullest possible degree to the requirements and comfort of the public."

The full meaning of this announcement from the President of the Manhattan Railway Company may, perhaps, be gathered best from that part of Mayor Van Wyck's message to which Mr. Gould refers. Mayor Van Wyck, in speaking of the rapid transit problem and its solution, said:—

"You should demand and insist upon the substitution, in the place of the present motive power, of electricity, which can now be safely utilised in the operation of these roads, affording a more cleanly and less noisy service, and that, too, with an improvement in speed; and, again, the number of through express trains should be considerably increased, their running time improved, and their use continued throughout the day and night, and not, as now, restricted to a few hours in the morning and evening.

"The trunk elevated lines should be so extended as to furnish more convenient communication with the ferries, and, most important of all, these lines should not be confined through the greed or indifference of the corporations operating them to the thickly populated and therefore profitable residence and business districts. The corporations should be compelled to continue the present routes to the more sparsely settled and more distant localities, even if for a time some loss is entailed by so doing.

"It is essential to the prompt relief sought by the people that the time allowed for the completion of the improvements here suggested should neither be unreasonable nor unlimited. A definite period should be fixed, within a fair and sufficient limit, compelling promptness in the beginning and vigorous prosecution to the end of the work; and a bond of full proportions should be exacted to guarantee that the time limit would not be exceeded."

Mr. Gould's announcement indicates that no action on the part of the Municipal Assembly is needed to give New York its much needed facilities for travel through the only practicable means—the extension and improvement of the service of the elevated roads. The change in motive power which Mr. Gould promises will require the approval of only the State Railroad Commission, and there can be no doubt but that this can be secured. It is within the power of the managers of the system to provide for running faster trains and more express trains, and the increased speed is one of the earliest benefits which will arise from the use of electricity instead of steam motors. So long as the Rapid Transit Railroad Commission exists, it may put barriers in the way of additions and extensions of the elevated railroad lines. Such extensions and improvements require the approval of this Commission, and its approval has been withheld heretofore from such changes as the road has applied for permission to make, except upon terms which were not satisfactory.

People who travel across the Brooklyn Bridge know what a success the electric motor cars have been there, and how much they have added to the comfort and efficiency of the bridge car service. The substitution of electricity for steam has freed the bridge stations from the noise, steam, smoke and gases of the steam locomotives formerly employed. When the steam motors disappear from the elevated railroads, these annoyances will go with them. With the steam motor there will also disappear a considerable part of the noise which the running of trains now makes. Electric motors run with a true rotary motion, and produce no vibrations either in the car or upon the rail structure. For this reason higher speeds can be attained than are safe with the steam motor and its engines. Electric cars have been run at speeds between 80 and 100 miles an hour. At such speeds an ordinary locomotive would be apt to jump itself off the track. Every vibration saved in the engine means just so much less transmitted to the track, and turned into noise by the shaken structure.

It is going to be a great piece of work to instal electricity as the motive power for the elevated railroad system. There is no road in the world which is called upon to do such an amount of work, to carry so many passengers, to run so many cars and trains, and to make such a train and car mileage as the elevated system. In a single year the cars on the four elevated roads and the suburban line run 44,000,000 miles. In every day of 24 hours there are 3,500 trains despatched upon those lines, and 330 locomotives are kept in service for the work. Each of these locomotives is capable of exerting from 200 to 250 horse-power, and a fair estimate of the total average power needed to operate the road, according to General Manager W. J. Fransioli, is about 75,000 horse-power.

The installation of a plant or plants to supply this power will be the biggest enterprise of the kind that has ever been undertaken. Whether the whole amount of the power will be produced at one station or whether a number of stations will be built at convenient points along the lines, has yet to be determined, for this will depend upon a comparison of the cost of the enormous copper conductors which would be required to distribute the great currents to be employed and the cost of separate power plants. It is probable that several plants will be built at points convenient for receiving the great quantities of coal needed. At the present time the road burns in its locomotives 200,000 tons of coal a year. There will probably be a saving of one-half of this fuel at once by the more economical production of power in great stationary boilers and engines.

There is little doubt that the system adopted for supplying the electric current to the motors of the trains will be the third-rail method. For supplying the heavy currents required the overhead trolley is not suited, and the third rail system, as it is used on the Brooklyn Bridge and on the Chicago elevated roads, is a success. The next question which the engineers will have to settle is whether the trains shall be drawn by separate electric locomotives, like those used in the Baltimore tunnel and the one just put into service on the Hoboken Junction road, or by motor cars, such as are used on the Brooklyn Bridge. There is a third method of applying electric power to railroad trains, which is in use upon a road in Chicago. This is the Sprague unit system, under which each car on the road is provided with motors and controllers. Each car can be run separately, like a trolley car, or, by means of a system of wiring, the cars can be hitched together in any numbers, and the whole train operated from any car. Where the traffic varies very much in different parts of the day, and is subject to large fluctuations from day to day, this method has decided advantages, but on the elevated roads here, the general manager says, the traffic is very steady. The system, therefore, will probably not be adopted, and there are good reasons for believing that separate electric locomotives will not be used. It is probable that in place of the 330 steam motors, an equal number of motor cars will be used. Motor cars, like those now in use on the bridge, but with the motors wound to produce much higher speed, would be powerful enough to draw the trains on the elevated roads. Each of the bridge motor cars has four motors, each of 62½ horse-power, or 250 horse-power altogether.

To people living away uptown the most important improvement that will come with the introduction of the electric motors will be the saving in time which can be made. This will come from the ability of the electric motor to get up speed faster than the steam engine. In experiments made recently upon the two-mile experimental track of the General Electric Company at Schenectady it was found possible to attain a speed with the electric motors of more than 40 miles an hour within 20 seconds. In the same time one of the steam motors of the elevated roads would not have attained one-half that speed. It takes 40 minutes to go from the Battery to 129th Street by either the Second or the Third Avenue Road, making 25 intermediary stops, and 42 minutes and 49 minutes respectively to go from the Battery to 155th Street by the Ninth and the Sixth Avenue Road. The electrical experts say that one-third of this time could be saved by using electric motors, and a conservative estimate is that ten minutes could be saved on each trip without reducing the time now spent in taking on and letting off passengers. With a like saving of time on the suburban road, on which it now takes 17 minutes to run from 129th Street and Third Avenue to 177th Street, the entire trip might be made in about 43 minutes instead of 57.

Another advantage which would probably come from the change of motive power would be the running of two-car or three-car trains at night, at short intervals, instead of the regular four or five-car trains at intervals of 10, 15, or 20 minutes. This could be done with economy to the company and to the great advantage of the passengers.

The change of motive power will cost millions of dollars. Estimates which have been made have varied from $7,000,000 to $10,000,000. One considerable item of loss will be the putting out of service of the present motors. Each of these cost about $5,000, or $1,650,000 in all, and could not be replaced to-day for less than $1,000,000; yet it is likely that they will prove so unsaleable as to be almost a total loss. The elevated railroads of Chicago now have a large number of steam locomotives for sale and customers for them are few. To offset this loss, however, is the economy of maintaining an electric plant. It costs about 2 cents for repairs for each mile that a locomotive runs on the elevated roads, or $200,000 a year for 10,000,000 miles covered by the locomotives. Probably one-half of this sum would suffice to keep the necessary electric plant in order.

ELECTRIC TRAMWAYS IN GERMANY.

The *Elektrotechnische Zeitschrift* of January 6th, publishes several pages of tabular matter relating to existing electric tramways in Germany, and to those lines either in course of construction or which have been definitely decided to be carried out. In a summary of these tables reference is made to the towns equipped with electric tramways during the present decade, the figures given in the following representing the number of towns so situated at the close of the years mentioned.

Year.	Towns.
1891	3
1892	5
1893	11
1894	20
1895	32
1896	44
1897 (September)	56

In addition to the 56 instances cited for September of last year, there were 34 other towns at the beginning of that month where electric tramways were either in progress or finally decided upon, whilst in 30 other towns extensions of existing lines were either being carried out or were projected. At the close of 1897 eight of the lines promoted in the 34 towns in question had been completed, so that on January 1st, 1898, no less than 64 towns were in possession of electric tramways.

The following figures indicate the general position on September 1st, 1897:—

Length of lines, in miles, whether single or double track	593
Mileage of track	840
Number of motor cars	2,255
„ trailers	1,601

The total output of the electrical plant (except accumulators) required for the operation of the tramways amounted, as far as given by the tables printed by our contemporary, to 21,465 kilowatts. If, however, we assume an average of 21·7 kilowatts per kilometre of track for those lines where no information was forthcoming as to the machinery power—this average being based upon that of the following table—the total performance of the plant is increased to 24,920 kilowatts.

The table gives the name of the town, the maximum gradient in percentages, the kilowatts required per kilometre of track, and the number of kilowatts per motor car:—

	Maximum gradient in percentages.	Kilowatts per kilometre of track.	Kilowatts per motor car.
Bad Aibling	1·68	11·7	25·1
Barmen	20	23·2	8·9
Berlin:			
Gesundbrunnen-Pankow	0·3	22·3	18·1
Bochum	4·24	14·7	11·6
Bremen	5	14·4	7·8
Breslau	2	22·9	10·9
Charlottenburg	1·5	25·6	13·3
Chemnitz	3·3	10·4	6·9
Danzig	3·3	15·7	10·5
Dortmund	4	22·5	10·4
Dresden:			
Blasewitz-Laubegast	2·5	50·0	46·0
Düsseldorf	3	19·6	15·4
Elberfeld:			
Nord-Süd	6·25	43·0	13·3
Elbing	4	30·3	14·3
Erfurt	5	24·1	10·0
Essen	6·7	14·6	8·2
Frankfurt a. M.-Offenbach	3	14·3	10·0
Gelsenkirchen	3·7	19·5	17·7
Gross-Lichterfelde	4·3	13·8	15·4
Halle a. S.	5	14·8	6·7
Hamburg	5	14·4	7·8
Hanover	3·5	10·8	7·6
Kiel	7	19·7	8·8
Königsberg, Prussia	4	13·2	7·5
Leipzig:			
Leipsic Electric Tramway	4·6	16·9	9·4
Grand Leipsic Tramway	3·6	16·7	7·6
Lübeck	5	22·9	12·9
Mülheim a. d. R.	5·5	24·6	21·3
Nürnberg-Fürth	6	10·1	7·0
Oberhausen	2·8	48·3	39·6
Plauen, Saxony	8·3	24·8	13·1
Remscheid	10·6	33·3	22·2
Ruhrort	4	11·1	14·3
Solingen	5·6	24·1	13·3
Spandau	0·5	15·9	8·3
Stettin	7·5	16·7	10·3
Türkheim-Wörishofen	4	11·7	35·0
Wiesbaden	5	63·1	28·6
Average	—	21·7	14·6

Our contemporary, in discussing these statistics editorially, states that they have been drawn from official sources, and mentions incidentally that many months, and at times even years, elapse between the promotion of a tramway scheme and the inauguration of the line, owing to the tardy manner in which it is possible to conclude negotiations with municipal and the State authorities.

It is specially noteworthy that during the past year some of the largest towns in Germany, namely, Berlin, Frankfort-on-the-Maine, Cologne, Konigsberg in Prussia, and Munich, have resolved to completely abolish the use of horses for tramway purposes, and have authorised the substitution of electric traction on all the tram lines in those towns. In addition to these, various important industrial districts are more and more endeavouring to connect up the localities by means of electric tramways, both for passenger and goods traffic. Among these may be mentioned the districts of Aix-la-Chapelle, Dusseldorf-Vohwinkel, Elberfeld-Barmen, Bochum-Gelsenkirchen, Gladbach-Reydt, Werne, Essen-on-the-Ruhr, the Saar locality, and the mining districts around Beuthen and Kattowitz in Upper Silesia.

Referring to the above table of powers required per kilometre of track and per motor car, our contemporary points out that both averages indicate in general a better utilisation of the generating plant. Thus, for instance, the average of 21·7 kilowatts per kilometre of track compares with 25·6 kilowatts in the previous year, this difference being mainly due to extensions of existing lines. The kilowattage per motor car of 14·6 is almost the same as in the previous year, when the average per car worked out at 15 kilowatts.

The overhead wire method on different systems is almost exclusively used on the German tramways, and only short lengths of line in Berlin and Dresden are worked with power supplied from underground conductors. Accumulator cars are used on the following lines: Charlottenburg-Berlin, Eckesey-Hagen in Westphalia, Frankfort-on-the-Maine, Gallluswarte railway station, Hagen-Kückelhausen-Haspe, Ludwigshaven-on-the-Rhine, Untertürkheim-Kornwestheim, and partly in Hanover. Mixed systems of working with overhead wire and accumulators, the latter being charged from the trolley wire during the journey over the trolley section, are used largely in Hanover, and to a small extent in Dresden. It is, however, proposed to introduce this method of working on the lines of the Grand Berlin Tramway Company in Berlin, and those of the Halle Tramway Company.

SOME AMERICAN METHODS.

Seeing that English employers are likely soon to be in a position to put into practice the advice of Mr. John Burns to follow American methods, which same advice seems to have been given in complete ignorance that it was in doing this that all the trouble of the strike arose, a few notes from *Machinery* on the way work is done in Cincinnati may be of interest. Cincinnati is supposed by a stretch of courtesy to be somewhat western, but we in England are apt to look further west than Cincinnati for our ideas of the west. The correspondent of *Machinery* has been calling on some of the works, and has made notes on some of the things he has seen.

At the Cincinnati Milling Machine Company's works, a three-floor building of nearly 30,000 square feet of floor space—a building, say, 200 feet × 50 feet—nothing is made but milling machines and cutter grinders, and 140 men are employed. The system is to have a casting storage room, and here all castings are received and kept in suitable bins. The paint shop is 70 feet × 20 feet, and here five men do the painting for the establishment, the room having steam coil and hot air pipes for use in the different weathers, variously to warm or cool the room and to dry paint. Another room is the stock storage room, which contains a centering and countersinking machine to prepare pieces for the shops.

The shop is replete with special devices for economical manufacture. The machine for cutting the dials of the milling machines takes in from 2 to 14 inches diameter, and finishes in three minutes a dial with 300 divisions. Every movement seems provided for, and bevil-faced dials are as easily cut as plain ones. At 100 strokes per minute, of any length, the graduations can be anything from 1 to 360. Then there is a special device for turning up the ⊥ slots in the cross slides of the machines, both in and outsides on both undercuts being done at one operation.

The holes in the bases of this company's machines are tapped. This is for moving purposes. Carrier trucks are in the form of a U, and have four suspension screws, which enter the tapped holes. The machine is thus lifted and wheeled off in a moment.

In the Egan Machine Tool Company's shop the floor space is 130,000 feet. On the unfinished parts of castings awaiting machining, are to be noticed small labels, thus—

Charge all time on this job to		
2,834	Screw machine Rot.	37

a device very much simplifying the entering up of time, which seems to be so great a difficulty in many shops.

A multiple planer tool is used for roughing off the sides of planer tables. It has six cutters, and finishes a side when it has been fed simply the distance of the cutter centres. Lathe V's are finished by a large V-tool at one full width cut. It leaves the surface nearly equal to a scraped surface, all jigs and fixtures are kept in proper places in cupboards. When the door is opened the electric light is turned on to permit correct and rapid finding of the tool. Forming tools are tested for form, before being hardened, upon a bar of Babbitt metal, when any inaccuracy can be corrected. Samples of all work done are kept in the grinding room to show the men what class of work is expected from them, each sample with its own particular place in the automatically lighted cupboard with a pair of buckskin gloves to be used in handling. We wonder if Mr. John Burns knows of this when he calls for American methods, and if he is disposed to still recommend them, and to advise the members of the A.S.E. to give their aid in advancing such a system if asked to do so. We propose to return to this subject.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

ABSTRACT OF INAUGURAL ADDRESS.

By J. W. Swan, F.R.S., President.

Sixteen years ago, I had the honour of bringing under the notice of the Society of Telegraph Engineers the question of a new mode of electric illumination by means of incandescent lamps. When the gas was lowered, and the current was turned on, there was an audible expression of surprise as the lamps lighted up; and when, after a breathing space, it was realised that the room was for the first time entirely lighted by incandescent lamps, the manifestation of satisfaction was, I remember, very strongly pronounced.

That occasion marked, in an emphatic manner, the beginning, or almost the beginning, of a movement that has gone on with increasing activity, until now it may be truly said that a great revolution in the means of producing artificial light for common use has been accomplished, a new and profitable industry has been created, and, incidentally, an impulse and inducement given to the larger and more general utilisation of electricity. I am looking back, and are such universally familiar objects now. Sixteen years is not a long time in the history of industrial evolution, and yet what changes have occurred in the last 16 years! The entire space is crowded with electrical invention and electrical work, not confined to electric lighting, but extending over the wide and varied fields of electrical power transmission, electric traction, and electro-chemistry. The successful introduction of electric lighting, and the great incidental improvements made in the machinery for transforming dynamic energy into electric energy, gave the impulse required to produce the immense activity that we witness to-day.

The domain of electrical engineering has broadened. When this Institution was founded, telegraph engineering was its principal feature; later, there grew up the new branches of electric lighting, electric traction, and the electrical transmission of power. These have so flourished that, if they have not overshadowed the older branch, they have at least sheltered and supported it; and there is another branch vigorously growing and giving promise of immense enlargement—that of electro-chemistry.

This brings me to a subject of great interest to the electrical engineer, and especially to the young electrical engineer—"the world is all before him, where to choose;" and, in my belief, a moderate proportion of those who are aspiring to make their mark as electrical engineers would choose wisely in making a very special study of that portion of the field within which lies the application of electricity to chemical manufactures.

The field is a wide one, and so far only a small corner of it has been cultivated, but that portion is already yielding rich harvests. There are now three or four flourishing electro-chemical industries of capital importance—the electrolytic refining of copper, the electrolytic extraction of aluminium, the electrolytic recovery of gold, and the electrolytic production of chlorine and of soda. Besides these, there are *other* successful chemical manufactures which rest on an electrical basis. Their importance is great even now, and is increasing. They afford opportunities for the advantageous exercise of special knowledge and skill on the part of the electrical engineer, who may be called upon to design suitable apparatus for carrying out known processes, or to invent new or improved means of effecting some unattainable but desirable end.

Considering the importance of this branch of electrical engineering, it seems to me—and I hope you may take the same view—that the time custom places at my disposal to-night will not be ill spent in a general review of *the rise and progress of electro-chemical industries.*

Early Work in Electro-Chemistry.

Two years hence there should be celebrated, in the city of Como, the centenary of Volta's great discovery, to which we owe the origin of electro-chemistry. Electrical phenomena had been diligently studied long before his time. But if we except the action of the electric spark, utilised by Cavendish to induce the combination of gases having an affinity for each other, no marked electro-chemical effect had been observed up to Volta's time. There was in fact no knowledge of phenomena due to the sustained operation of an *electric current*, as distinct from those due to *intermittent discharges.*

Closely following upon the announcement of the discovery of the voltaic pile, its analytical power was made known through the electrolysis of water by Carlisle and Nicholson. But it was Davy who first fully realised and demonstrated the transcendent power of the voltaic current to effect chemical decomposition. Davy made for ever memorable the year 1806, by the electrolytic extraction of potassium from potash. Distinctly prophetic as this was of other far-reaching kindred discoveries, I suppose that not even the imaginative mind of Davy ever entertained the idea that out of this embryo would grow any of these great manufacturing processes that are to-day shaking the foundations of some of the oldest and most important of our chemical industries.

Davy, fortunate in almost everything, was supremely fortunate in his *assistant, Faraday*. Never, surely, in the history of experimental science did the mantle of genius fall on worthier shoulders than when Faraday became the successor of Davy, and the inheritor of his methods and of his work. Great, immensely great, as is the debt owed by electrolytic chemistry to Davy, the debt is doubly great to Faraday. To Faraday we owe the discovery of the law of electrolytic conduction, without which knowledge industrial progress in the field of electro-chemistry would have been impossible; and, above all, it is to Faraday that we owe the first principles of the dynamo—principles applied to practical electrolytic work much earlier than is commonly supposed.

Even as early as 1842 there were at work in Birmingham, for the electrolytic deposition of silver and gold, power-driven electric current generators, based on the dynamo-magneto-electric principle discovered by Faraday. One of these machines I saw not long ago, still doing duty at Messrs. Elkington's factory.

During the 30 years following Faraday's discovery of magneto-electric currents, and its primitive application to electro-plating, I cannot recall in this connection any of those striking events which make a moment memorable, but the tools were being fashioned wherewith the way was to be cleared and the work of progress carried on.

Towards the end of that quiescent period, Wilde was building powerful machines for the electro-deposition of copper; and those great incentives to electrical engineering enterprise and progress, the telegraph and electric lighting, were already beginning to quicken the pace along the collateral lines of scientific and industrial advancement. To speak only of electric lighting, it should be noted that in the fifties Holmes and De Meritens had designed efficient, if costly, magneto-electric apparatus for lighthouse illumination.

The principle of magnetic self-excitation in an electro-magnetic generator was made known in 1867, and four years later the first really practical continuous-current machine was constructed by Gramme.

The two succeeding decades saw the evolution of the modern dynamo; and at the end of this period the critical point was reached when there was demonstrated, with sufficient clearness to captivate the commercial mind, the fact that for *lighting*, for *transmission of power*, and for effecting several important chemical operations, *electricity*, as produced through the dynamo, by the steam engine or by water power, was a thing of *utility*, and could be turned in all these ways to commercial advantage.

These great uses of electricity have been for several years established on the secure basis of commercial success. This result has been reached through the co-operation of many minds, and especially by the union of the *skill* of the *mechanical engineer* with the *specialised knowledge* of the *electrician* and the *chemist.*

Copper Refining.

At the outset, 60 years ago, the only electrolytic industry then in existence was comprised in that small and closely related group, electro-plating, electro-gilding, and electrotyping. Since then, and comparatively in recent years, the principle of electrotyping has been applied to copper refining. This has developed to such an extent, that now one-third of all the refined copper required in the world is produced electrolytically. In 1896 the production was 137,000 tons. The product of one works alone—the Anaconda Works—was over 30,000 tons. One great advantage of electrolytic copper refining over the old method is the saving of the gold and silver from the unrefined copper. But there is a further advantage, and one that electrical engineers especially appreciate, viz., the *higher conductivity* of electrolytic copper.

The process of electrolytic copper refining is, as you know simply electrotyping on a grand scale. An impure copper anode is dissolved, and pure copper is deposited upon a cathode in an electrolytic bath of acid sulphate of copper solution.

In this connection, I may mention experiments I made to ascertain how far it is possible to go in the direction of increase of current density without detriment to the physical properties of the metal deposited.

I found that under proper conditions it was possible to obtain tough copper with a current-density ranging from 1 ampere to 1,000 amperes per square foot of cathode surface. The conditions necessary to be observed were, to adapt the strength of the solution to the strength of the current, using, of course, the strongest solution with the largest current; and, when the current-density was high, to take suitable means to obtain extremely rapid circulation of the electrolyte. I found that regularity and smoothness of deposit were almost entirely dependent on the absence of solid particles held in suspension in the electrolyte, and that excrescences could be entirely avoided by taking care that the electrolyte was free from solid floating particles. I found also that an exceedingly rapid flow of the electrolyte over the cathode surface tended to the suppression of a crystalline condition of the deposit. This effect was most strikingly shown when the electrolyte was projected against the cathode surface with considerable force from a submerged jet. In the *Philosophical Magazine*, 1881, Vol. xii., p. 300, Tribe published an exceedingly interesting series of observations on the distribution of the lines of conduction in a liquid undergoing electrolysis; these showed me the causes of the wasteful growths round the edges of electrotypes. By applying remedies suggested by Tribe's results, I was able almost wholly to prevent this waste, to obtain nearly complete uniformity in the thickness of deposits, and entirely to prevent excrescent marginal growths. The general principle followed was the restriction of the sectional area of the electrolytic bath to, as nearly as possible, that of the plate intersecting it, so as to prevent curvature of the lines of flow.

In considering this branch of the subject, the question occurs whether it is economically possible to take advantage of the greater purity and higher conductivity of electrolytic copper that has not undergone fusion after electro-deposition. The common practice is to fuse electrolytic copper and cast it into ingots, and then proceed to roll and draw the ingots into the various sizes of bars and wire required in electrical work. This treatment results in a slight loss of conductivity. Some years ago I worked out a process in which a copper wire stretched in an electrolytic bath was, whilst receiving a deposit of copper, continually subjected to the action of wire draw-plates. This resulted in unlimited extension of the wire without increase of its thickness: all the deposit went to increase the length; and this might go on to an indefinite extent. The original wire formed a core, which, as the process proceeded, dwindled towards nothing. There are on the table some pieces of wire made in this way, in the different stages of its growth. I ascertained the possibility of producing wire in this manner; but even with a rapid rate of deposit, such as I was able to use, I found the apparatus would be excessively costly, relatively to the output; and, being allowed, by the kindness of Messrs. Bolton, to witness the method of wire-drawing employed at their works, I was so impressed by the rapidity and simplicity of their process as to feel that, looking at the matter from a non-scientific point of view, unless there was something much more to be gained than 1 or 2 per cent. extra conductivity, the play was not worth the candle. I do not know whether, by the method proposed by Mr. Elmore of cutting a spiral from an electrolytically deposited cylinder, a sufficient degree of economy of production can be obtained; but, so far, the ordinary process has not been interfered with by direct electrolytic methods of producing wire. Nevertheless, the greater purity and slightly higher conductivity of electrolytic copper that has not been subjected to the fusion treatment common in commercial practice, give to those attempts to produce wire from electrolytic copper that has not undergone fusion, at least a scientific interest and value.

A characteristic feature of electrolytic *copper refining* is that the *anode* is formed of the *same kind of metal* as that *deposited*, and *dissolves* to keep up the supply of metal in the electrolyte. There is an equal and opposite action going on at the cathode and anode. But there is another class of electrolytic operations of perhaps even greater interest to the electrical engineer, and certainly of great economic importance, namely, that class in which the *ore*, and not the already reduced *metal*, furnishes the metallic supply to the electrolyte. This opens a very large subject, since there is included in it not only the extraction of copper, nickel, zinc, gold, aluminium, and sodium, but also the great question of the electrolytic production of caustic soda and chlorine, and other substances hitherto produced by purely chemical operations.

There have been many attempts to utilise the fact that copper matte or sulphide can be *cast* in the form of *plates* or *slabs*, and that such plates have a sufficient degree of conductivity to allow of their being used as anodes in an electrolytic bath. These attempts have not always been successful, but there is an interesting exception in the case of the copper-nickel mattes worked by the Canadian Copper Company, who refine copper and nickel electrolytically, and use the matte as anodes. The mattes contain about 40 per cent. each of copper and nickel, and 14 per cent. of sulphur, together with small quantities of silver, gold, and platinum. The power used in the production of 1 lb. of nickel is nearly 1 electrical horse-power-hour.

(*To be continued.*)

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1898.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents*, 322, *High Holborn, London, W.C., to whom all inquiries should be addressed.*]

632. "Improvements connected with electric lamps and switches." W. M. Walters. Dated January 10th.

665. "Improvements in electric switches." J. L. Hinds and H. H. B. Crouse. Dated January 10th. (*Complete.*)

678. "Method of diminishing the affinity of electrolytically produced chlorine." C. A. Jensen. (A. Linding-Larsen, Norway.) Dated January 10th.

698. "Improvements in or relating to the electric illumination of railway trains." B. de Szwantowski. Dated January 10th.

729. "Electric rotary cutters." F. Gardner and D. J. Smith. Dated January 11th. (*Complete.*)

735. "Improvements in switches for use in electric light installations." H. Taffs and J. Hill. Dated January 11th.

756. "An improved electrical apparatus for railway signalling during fogs." R. W. Gay. Dated January 11th.

783. "Improvements in portable electric alarms and bell sets." J. Davidson. Dated January 11th.

809. "Improvements in automatic calling devices for telephone exchanges." W. P. Thompson. (The Strowger Automatic Telephone Exchange, United States.) Dated January 11th.

812. "Improvements in or relating to dynamo-electric machinery." P. R. Jackson & Co., Ltd., and J. S. Lewis. Dated January 11th.

814. "Improvements in the means for controlling the lighting and extinguishing of electrically illuminated signs and other advertising and show tablets." J. T. Gent. Dated January 11th.

817. "Improvements in electric railway conduit systems." R. F. Thompson and E. J. Sullivan. Dated January 11th. (*Complete.*)

831. "A system of conducting electricity for propelling, heating, lighting, and telephoning from railway vehicles." H. W. Libbey. Dated January 11th.

834. "Improvements in single-phase induction motors." L. B. Atkinson. Dated January 11th.

835. "Improvements in single-phase and multiphase alternate current motors." L. B. Atkinson. Dated January 11th.

848. "An improved galvanic battery." J. von der Poppenburg. Dated January 11th.

885. "Apparatus for electro-plating articles in bulk and in large quantities." G. Langbein. Dated January 12th. (*Complete.*)

913. "An improved electropathic sock for boots and shoes." A. F. McGaw and W. A. Woodford. Dated January 12th.

932. "Improvements in the manufacture or production of electrodes for secondary batteries. C. Pollak. Dated January 12th.

933. "Improvements in electrolytical condensers and electric current directing devices." C. Pollak. Dated January 12th.

935. "Improvements in, or connected with, pole-pieces of dynamo-electric machines." C. W. Dawson. Dated January 12th.

953. "An improved telephone line switch." G. Lay. Dated January 13th.

1,002. "Improvements in electric measuring instruments." A. A. Voysey and R. L. Wilson. Dated January 13th.

1,011. "Improvements in electric incandescent lamp sockets or holders." R. J. Bott. Dated January 13th.

1,017. "Improved method of, and apparatus for, signalling or advertising by electricity." A. Ginisty. Dated January 13th. (*Complete.*)

1,021. "Improvements in the manufacture of filaments for incandescence electric lamps." C. H. Stearn. Dated January 13th.

1,046. "An improved method and electro-magnetic cut-out for automatically disconnecting charged conductors in the event of breakage or short circuit, applicable to overhead systems of electric traction and the like." R. C. Quin. Dated January 14th.

1,073. "Improvements relating to graphic or writing telegraphy." R. Hurley. Dated January 14th.

1,114. "Improvements in telephone exchanges." J. O. O'Brien, of the firm of W. P. Thompson & Co. (G. Ritter, Germany.) Dated January 14th.

1,127. "Improvements in electrical safety devices." H. M. Salmony. Dated January 14th.

1,140. "Improvements in electro-magnets for electric traction." H. H. Leigh. [The Gesellschaft zur Verwerthung elektrischer and magnetischer Stromkaft (System Schiemann and Kleinschmidt) Ad., Wilde & Co., Germany.] Dated January 14th.

1,145. "Improvements in electric cables." G. C. Allingham and W. Fennell. Dated January 15th.

1,194. "Improvements in secondary batteries." G. Philippart. Dated January 15th. (*Complete.*)

1,213. "Improved apparatus for the electro-decomposition of water." Sir C. S. Forbes, Bart. Dated January 15th.

1,216. "Method and means or apparatus for facilitating the erection of overhead telephone, telegraph, and like wires or conductors." J. Hallet. Dated January 15th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free,* 9d. (*in stamps*).]

1896.

19,469. "A means of surrounding electric or other lights with a vessel or lining of glass or other material containing liquids." E. J. Macready. Dated September 3rd, 1896. Globes, lenses:—Oil, gas, electric or other lights are placed in or near glass, porcelain or other vessels containing coloured or other liquids between the walls. The vessels may be ornamented and divided to contain several liquids.

19,501. "Improvements in electric light conduits." B. M. Drake and J. M. Gorham. Dated September 3rd, 1896. Tubes or conduits are joined together or to junction boxes by means of slightly coned ferrules. The ends of the tubes may be slightly tapered and may be cemented in.

19,650 "Improvements in insulators." T. Blenkinsop and J. W. Brown. Dated September 5th, 1896. Insulators for electric incandescent lamps are formed of glass and have a metal core passing through the screw and shoulder. A cutting edge under the shoulder seals the screw opening. The head of the insulator is formed with a nut, a wire groove and a shed.

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CONTENTS:

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THE BURNING QUESTION.

No branch of business connected directly or remotely with the electrical industry is at present showing more activity than that concerned with the much-debated dust destructor. We were witnesses of and participators in an enterprising event on the 27th inst., when some 200 engineers, surveyors, chairman of committees, and other influential gentlemen, from all parts of England, inspected the dust destructor at Leyton. The guests came by invitation of the Urban District Council, but the syndicate that built the destructor was very much in evidence. "The voice was the voice of Jacob, but the hands were the hands of Esau."

That veteran sanitarian and eminent engineer, Captain Sir Douglas Galton, R.E., was the "lion" of the occasion, just as Lord Kelvin was the "lion" of a similar function held at Shoreditch some time ago. Each guest was provided with a neat little brochure having a picture of the works as a frontispiece. The brochure first describes briefly the problem and afterwards the solution. In our opinion the problem is insufficiently set forth, and the statement of the solution gives as a sole result the total amount of refuse and sewage sludge burnt in tons during the year 1897, and as a deduction therefrom the amount burnt per cell per 24 hours.

The destructor is next described and the two 96-horse-power water-tube boilers in connection therewith. It is stated that the temperature of the combustion chamber frequently reaches 2,500° Fahr. Favourable opinions of Sir Douglas Fox, C.E., and Mr. Francis Fox, C.E., are next given, and also an extract from the report of Mr. William Dawson, C.E., engineer and surveyor of the Urban District Council. Finally, the Council state that their reason for putting these facts before their visitors is their desire to share with other municipal authorities any ideas that may prove of assistance and value to them. The facts referred to should also prove of considerable assistance and value to the enterprising makers of the destructor, the Beaman & Deas Syndicate; and we may say that we welcome this attitude of a local authority in assisting a firm that has, in their opinion, served them well, by joining with them in such a function as that of last Thursday. Too often local authorities discourage any attempts at legitimate advertising undertaken by the firms whom they employ.

But when we come to criticism from an engineering point of view, we must confess that we think far more is embodied in the problem than the mere destruction of the refuse and sludge, and as regards its solution, it will be necessary fo us to know what is the cost per ton burnt—for labour, repairs, interest on first cost, and so forth, before we can arrive at a fair judgment. As we have stated before in these columns, we regard the problem as not admitting of a single solution, but it requires first that the apparatus shall work without nuisance, either from smoke or dust; second, that the refuse, or refuse and sludge, shall be completely burnt; third, that the temperatures shall be high enough to ensure complete combustion with maximum steam raising capacity; and, finally, and most emphatically, that the cost of labour per ton burnt should be as low as possible consistent with fair wages and fair hours of labour to the workmen employed. The brochure is unfortunately quite silent on every one of these points, except as to the temperatures, and deals only with the amount burnt per cell, which we regard as quite a minor consideration. The amount burnt per cell is high, but that is not a special feature of any destructor, as it is simply a question of the strength of blast and the number of men employed. Given a strong enough blast, and a sufficient number of men, a very large amount of refuse can be burnt per square foot of grate per hour, and an instance is on record in which in a destructor of another type, 26·75 tons were burnt in a cell in 24 hours. This was at Leeds, and the figures were published by the Medical Officer of Health, Dr. Spottiswoode Cameron. As regards steam raising, we noticed that the boilers were blowing off at 105 lbs. on the occasion of the "Public Inspection," and 95 I.H.P. was stated to be about the amount of the power daily used. This is approximately about what might be expected, and it may be considered a good result in view of the wet nature of 30 per cent. of the material being burnt. It is, no doubt, somewhat of a feat to burn sewage sludge successfully, while at the same time raising a fair amount of steam; but it is a curious fact that sludge is not difficult to deal with in a destructor, as is proved by the fact that Mr. Jones, C.E., the well-known surveyor of Ealing, has successfully burnt it in a natural-draught low-temperature destructor for many years past, in proportions just about the same as those adopted at Leyton, namely, one-third sludge, and two-thirds refuse. This seems to have escaped the notice of the directors of the Beaman and Deas Syndicate, who state that no destructor has hitherto been capable of destroying wet sewage sludge, but a perusal of the letter from the Ealing surveyor, which will be found in our "Correspondence" columns, may serve to point a moral, if it does not adorn the tale of the "remarkable new departure" at Leyton. The temperature stated in the brochure as attained in the furnace, namely, 2,500° Fahr., is a somewhat fanciful figure. We venture to surmise that no such temperature has ever been accurately measured; but probably somebody has judged it "by eye." It might as well be estimated by "rule of thumb." So far as we know, such a temperature as that has not hitherto been reached in burning ordinary house refuse, much less in burning such wet stuff as sewage sludge. The electric light plant is employed in lighting the works only, and the current is generated by a 3-kilowatt machine. There is, therefore, no fitting opportunity for a further outburst of correspondence in our columns, similar to that which has recently raged around the Shoreditch plant.

While at Leyton we were also presented with the report referred to in the brochure of Sir Douglas and Mr. Francis Fox. This interesting report supplies, to some extent, the information omitted from the brochure. The results given are based upon a 12 hours' trial and must be judged accordingly. The sludge was found to average nearly 65 per cent. of water. We may note that the term "pressed sludge" is used, but it is very questionable whether the expression can be legitimately applied to sludge which contains so large a percentage of water, and, further, it may be pointed out here that this water requires only to be warmed to a temperature of 212° in order to send it up the chimney, leaving a comparatively small amount of dry material to be dealt with.

In spite of this the residuum from the refuse and sewage sludge, taken together, is 29·4 per cent., which we regard as somewhat high, considering the nature of one-third of the material. The weight of water evaporated per lb. of material is given as 0·426 lb., or 0·507 lb., from and at 212°. The pressure of air in the ashpits, namely, 2 inches of water, is excessive, as might be expected from the amount burned per cell. The temperature of the combustion chamber is given as 1,562° F., which we may point out is a very different figure from the 2,500° F. of the brochure. The very hot appearance of the combustion chambers seemed to us to be partly due to the red hot particles of dust blown up from the surface of the fire by the excessively strong draught.

Sir Douglas Fox's Report also omits all mention of the fact which we consider of most importance, namely, the cost of labour per ton burnt, in relation to the wages paid, and the number of hours worked by the men. Until these figures are forthcoming, it is impossible to judge between the Leyton plant and destructors of other types.

The City Electric Lighting Service.

The high rates per unit charged by the City of London Electric Lighting Company are naturally, and, we think, very properly, creating a great deal of dissatisfaction among consumers. The City authorities have over and over again expressed regret that the company's powers run over so long a period, and they have brought weight to bear upon the company to secure a reduction in the charges. The company, however, not having inclined its ear unto these words of advice, may have to grapple with the bug-bear of competition, if the propositions now receiving attention by the Court of Common Council come to anything. Whether the Court has or has not the necessary power to compete with the company to which it has granted certain clearly defined concessions, is a matter which will arise in connection with the Court's deliberations directly; but we think the City company would be acting under good advice if it lowered its rates as other companies have done which touch the borders of its own area, without inviting competition in any shape or form. That in the long run a competitive supply would be beneficial to the general City public, and detrimental to the interests of the present company, there is hardly room for doubt. From all accounts, the City Company is doing remarkably well and can easily afford to consider the interests of its consumers in this way. It will perhaps be said that if the rates are reduced there will be a much greater demand for light beyond the company's present or immediately prospective capacity, but that, we venture to think is a matter that can be easily arranged. Of all things the company should avoid a short-sighted policy.

Electric Motors on Hire.

Mr. Alfred H. Gibbings, the Bradford Corporation electrical engineer, who is showing so much enterprise in popularising electricity supply in his city, has sent us a copy of a circular which his Corporation has issued, giving the conditions, charges, and so forth, as to the hire of electric motors. This is mainly for the benefit of small power users in the district to whom a heavy outlay on motors and equipment would be prohibitive. The motors on hire range from ½ to 6 H.P., the rates exclusive of fixing, being from 10s. to 30s. per annum. These low rates bring the advantages of electric power within easy reach of the power consumer, and we should think some good work will thus be done at Bradford and the other towns where the hire of motors is proposed. The gas companies find their best customers among those who consume gas for driving gas engines, and for heating and cooking, and there is every reason to believe, now that the use of small electric motors is becoming more general, that electrical engineers will do much by this means to improve the electricity works' day load.

HIGH ELECTROMOTIVE FORCE.*

By Prof. JOHN TROWBRIDGE.

I have lately perfected a large plant for the study of the discharges of electricity through gases which I believe is more extended, and on a larger scale, than any at present in existence; and I have obtained some results with it, especially in the subject of high electromotive force, which throw light upon many mooted points. The source of electricity which produces the electrical discharges is obtained from 10,000 storage cells. From these cells I obtain very approximately 20,000 volts, and by means of a peculiar

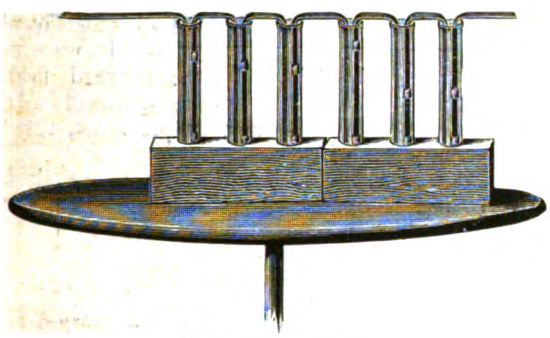


Fig. 1.—The Cells.

apparatus called Planté's rheostatic machine, I am enabled to obtain over 1,000,000 volts—which enables me to experiment with powerful discharges in air, more than 4 feet in length.

By the employment of storage cells in the subject of the discharges of electricity through gases, one can form a fair estimate of the amount of energy that is employed to

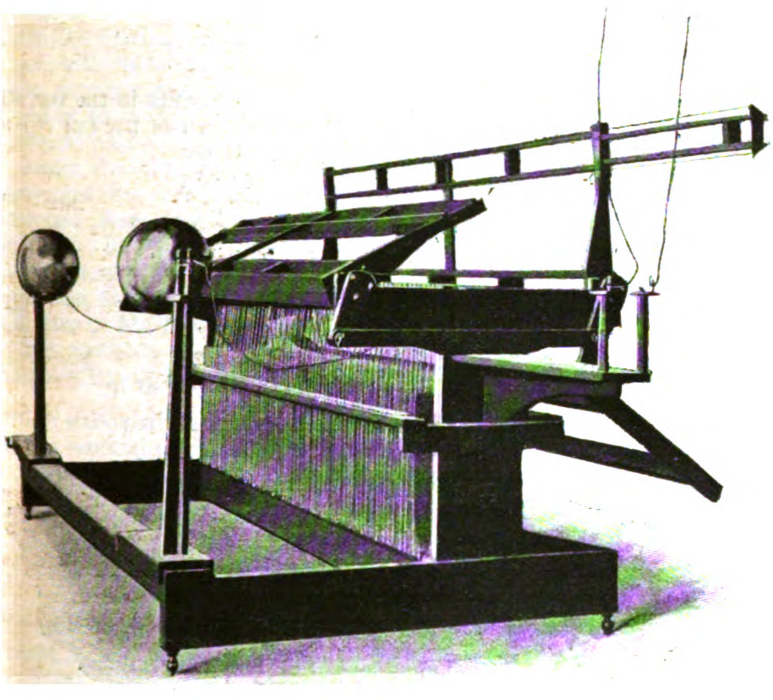


Fig. 2.—Plante Rheostatic Machine.

produce the desired effects—for instance, the X rays; while with the use of electrical machines or induction coils and transformers it is extremely difficult, if not impossible, to form an accurate estimate. Fig. 1 is an illustration of the type of cells of which the battery consists. Each cell is composed of a test tube $5\frac{1}{2}$ inches long and $\frac{3}{4}$ of an inch internal diameter containing two strips of lead which are separated from each other by rubber bands and are immersed in dilute sulphuric acid. The surfaces of the lead strips are roughened by a mechanical device, and the cells are charged in multiple circuit by means of a dynamo machine. When the cells are properly formed, each one gives two volts and has an internal resistance of one-quarter of an ohm. The problem of insulating these cells was a serious one; but it was practically solved by mounting the cells in sets of threes, in holes bored in a block of wood which had been carefully boiled in paraffin. The mechanician of the laboratory, Mr. George Thompson, devised a simple switchboard which enables me to throw the cells into multiple or into series—to use the entire 10,000, or suitable portions of this number. The battery gives 8 amperes of current with 20,000 volts, and this amount of energy is amply sufficient to kill a man. By accident an operator received the shock from only 1,000 of the cells and was badly shocked and burned. It is prudent therefore in experimenting with this battery to use rubber gloves, even in throwing the switches, and it is recommended to employ only one hand covered with a rubber glove and to keep the other hand in a pocket.

I had at first intended to use this large battery in the study of electrical discharges through Crookes tubes, but I speedily found that X rays could not be excited by a difference of potential represented by 20,000 volts. I found that at least 100,000 volts were necessary to produce them strongly, and I, therefore, resolved to construct a Planté rheostatic machine. This machine is simply an apparatus by means of which Leyden jars are first charged in parallel and are then discharged in series or by cascade. That is, all the inside coatings of the jars are connected to the negative terminal of the 10,000 cells, and all the outside coatings are connected to the positive terminal of the cells. When the cells are charged, the inside of one Leyden jar is connected to the outside of the next, and so on. In this way a very high electromotive force can be obtained. I use 60 Leyden jars in the form of plates of glass 15 × 18 inches coated on both sides with tinfoil. Starting with 20,000 volts, I can exalt this to 1,200,000 volts. The accompanying illustration (fig. 2) shows the Planté machine. The mechanician of the laboratory has introduced a notable improvement in the apparatus of Planté. Instead of a revolving commutator such as was used by the latter, Mr. Thompson employed lever arms, by means of which the jars were first charged in parallel and then discharged in series. It was found that the apparatus designed by Planté could not be used for higher voltages than one or two thousand without serious error and loss. By means of this apparatus I can study electrical discharges at least 4 feet in length—of great body—which are produced by an electromotive force of 1,200,000 volts. This apparatus possesses the great advantage that it enables one to obtain a fairly exact measure of such high voltage. When we reflect that the trolley car employs only 500 volts, and in the system of transmission of power from Niagara Falls it is proposed to use only 10,000 volts, it is evident that the effects produced by voltages of over a million must be of great scientific interest.

The study of such high electromotive forces immediately showed that previous estimates of the electromotive force necessary to produce a spark of a certain length were highly erroneous. For instance, Heydeweiler, a German investigator, believes that Prof. Elihu Thomson's statement, that a spark of 5 feet in length which he produced required a voltage of 500,000, is very wide of the mark, and Heydeweiler maintains that 100,000 would be nearer the truth. I find that even Prof. Thomson's estimate must be more than doubled. Experiments with my apparatus show conclusively that the length of the electric spark between points

* *Scientific American.*

separated by more than 1 inch varies directly with the electromotive force. A spark 48 to 50 inches in length requires an electromotive force of 1,200,000 volts, and a discharge of lightning one mile long would therefore require the enormous number of over 100,000,000 volts. In reflecting upon the development of such enormous energy in the air, we can understand why telephone bells ring during a thunderstorm; why subsidiary sparks occur in networks of wires; and why telegraphic messages are interrupted. The world beneath the thunderstorm throbs and pulsates with the oscillatory discharges of lightning.

One of the most interesting results of my study of powerful disruptive discharges is the discovery that such discharges will pass through glass tubes which are exhausted to such a high degree that they are said to contain a vacuum; for the 8-inch spark of a Ruhmkorff coil prefers to jump around the tube to passing through the extremely rarefied space in the interior of the tube. Such tubes, however, are brilliantly lighted by a difference of potential of 1,000,000 volts and readily show the X rays, and exhibit the skeleton of the hand in a fluoroscope. The so-called brush discharge from the positive terminal of the Planté machine extends visibly to a distance of over a foot. If the hand is exposed to this brush, it produces the well known X ray burn, such as various investigators have received in taking photographs of the skeletons of their hands, or in testing the condition of Crookes tubes by exposing their hands before a fluoroscope. The skin of the hand becomes irritable and turns a bright red colour, especially after exposure to cold winds.

This result interested me greatly; for it proved that the so-called X ray burn could be produced by the brush discharge of very high electromotive force. The extent of the influence of this powerful brush discharge is very great. For instance, photographic plates in a plate-holder carefully insulated from the ground and covered with a plate of glass half an inch in thickness show the inductive action of the brush discharge from the positive terminal, which is distant at least a foot. These inductive effects are manifested by star-shaped figures on a photographic plate. They are surrounded by dark clouds. When the burn on the back of one's hand produced by such brush discharges is examined by a microscope, similar centres of disturbance (in this case points of inflammation) are seen. Although the Leyden jars of my machine are carefully insulated on supports of vulcanite which are mounted on dry wood, which in turn is supported on rubber, I can obtain a discharge of more than 2 feet in length when I bring a point connected to the steam pipes to the neighbourhood of one terminal of the machine. The other terminal of the machine is carefully insulated. This experiment shows conclusively that it is of no use to insulate lightning rods. My experiments thus far show that no vacuum which I can produce can resist the discharges which are caused by 1,000,000 volts. It now becomes an interesting question whether there exists mechanical or chemical means by which a so-called vacuum can be produced which will resist such discharges.

SOME NOTES ON SINGLE-PHASE MOTORS.

By A. C. EBORALL.

(*Continued from page 68.*)

The following conclusions may be arrived at, considering the oscillating field of a single-phaser to be of the nature indicated above:—

1. At starting, two equal and opposite torques are exerted on the rotor by two equal fields rotating with equal velocities in opposite directions. Hence there can be no initial torque.

2. As the rotor slowly increases from zero up to a speed near synchronism, the backward rotating field becomes weaker and weaker, and since the backward and forward fields have together to produce a definite back E M.F. in the stator windings, the forward rotating field must increase in strength, and consequently the resultant torque on the rotor rapidly increase.

3. When the rotor is nearly synchronous, the backward rotating field is reduced to a very small amount. Hence it may be said that on starting, the resultant field is purely oscillating, but when running, the effect of the rotor currents is to produce a nearly pure rotating field. In the rotor bars a complicated current exists, it being the sum of two currents of different frequency, they being of approximately equal strength. The one is due to the very small backward rotating field, and is of high frequency, the other to the main forward rotating field, and is of low frequency. The $C^2 R$ losses in the rotor must, therefore, be nearly double of those in a multiphase rotary field motor. In other words, nearly half the $C^2 R$ losses in the rotor of a single-phaser are due to the backward torque × speed of rotor, this amount of power being simply wasted in heating the rotor conductors. The iron losses will also be greater than in a multiphase motor, owing to the effect of the backward high frequency field.

4. There is a limit of speed before synchronism at which the torque on the rotor again falls to zero. If we consider the rotor running synchronously, the forward field can evidently produce no torque, whereas the backward field gives rise to a negative torque. The zero torque must, therefore, be before synchronism is reached.

5. The effect of leakage or self-induction is entirely detrimental. It has two effects: (1) it diminishes the main torque due to the forward rotating field, and (2) it likewise causes the backward field to be larger in proportion to the forward field. This can be seen from the following:—Let ϕ be the lag of the current behind E.M.F. in one rotor bar. Then the diagram of E.M.F. for this bar is that shown in

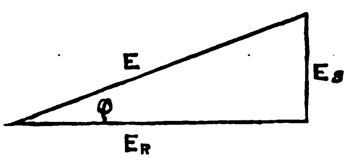


Fig. 5.—Diagram of Rotor E.M.F.

fig. 5, E being the resultant of E_s, the E.M F. of self-induction, and of E_r, the E.M.F. for the ohmic resistance. From this

$$\sin \phi = \frac{E_s}{E}.$$

Now $E_s = 2 \pi n L C$, where C is the current in the bar, and n the slip. Also the E.M.F. induced in one bar (E) $= \pi n N$ where N is the strength of field. Hence

$$2 \pi n L C = E \sin \phi$$

$$\text{or } C = \frac{\pi n N \sin \phi}{2 \pi n L} = \frac{N \sin \phi}{2 L}.$$

$$\text{But } \sin \phi = \frac{2 \pi n L}{\sqrt{R^2 + 4 \pi^2 n^2 L^2}} \qquad \text{(Fig. 6).}$$

$$\text{Therefore } C = \frac{N \pi n}{\sqrt{R^2 + 4 \pi^2 n^2 L^2}}.$$

From this it is clear that when the self-induction is already the main term in the impedance factor, an increase of L produces a proportionate decrease of C. Where, however, the

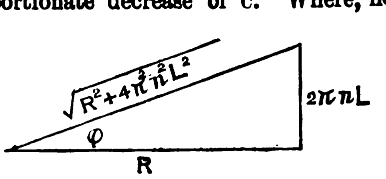


Fig. 6.—Diagram of Rotor Impedances.

self-induction term is but small, the decrease in C is small for a given change in L. The result of this is that the backward field produces a smaller value of backward high frequency rotor current, and consequently where the two currents are equal to one another, the backward field is larger in proportion to the forward field for an increase in L.*

* It is a common error to suppose that self-induction in the motor is absolutely necessary in a successful single-phase motor. It has arisen by not considering that the backward rotating field tends to disappear for the small slips that are met with in practice. The best induction motor of any kind is the one with the least leakage, that is, self-induction.

The construction of single-phase induction motors can now be gone into. Briefly, it may be said that they are constructed in exactly the same way as multiphasers, but with slight modifications, caused by the fact that they are not self-starting, and that the considerations mentioned above have to be borne in mind. The methods used by different designers, in order to get over the starting difficulty, will be described later; generally speaking, these methods take the form of splitting up the single-phase current at starting into two currents differing less than 90° in phase, one of these currents being sent round the working winding of the motor, the other going round a starting winding, the coils of which are wound in between those of the main winding. Hence an irregular two-phase rotating field is produced, which causes the rotor to run up to a speed somewhat short of synchronism, and this being attained, the starting winding is cut out, the working winding put direct on the supply mains, and the load transferred from the loose pulley or other device to the motor pulley. The starting torque depends on the efficiency of the phase-splitter, on the current taken, and on the design of the motor, and is, generally speaking, not very great.

Before considering the construction of these motors in detail, it will be as well to briefly enumerate the general points that must be followed in regard to their electrical and magnetic design.

Firstly, a very essential point is, that both stator and rotor should be quite smooth all round—large polar projections on either must be avoided. If this is not attended to, there is (especially at starting) a tendency for the stator and rotor fields to cog into one another, and as a consequence the effective starting of the motor is rendered impossible.

Secondly, the air-gap must be only just large enough to permit the rotor to run freely without danger of touching. As the no load current and power factor at all loads depend mainly on the size of the air-gap, it is clear that it must be as small as possible. Further, the larger the air-gap, the greater the leakage, and hence the motor will not start so well, and will have a greater slip when running, and diminished power factor.

Thirdly, if the induced rotor currents are not confined to proper paths, so that they may be always properly contributing to the driving forces, there will be false rotor currents which will waste power by heating, and which may even under certain circumstances exert a torque in the opposite direction to that of the forward stator field, and help the backward field.

Lastly, the arrangement of the stator winding and iron parts must be such that the leakage field is a minimum, otherwise there may be eddy currents in the motor frame, and even in the stator conductors themselves, causing loss of energy; furthermore, if there is much leakage from any cause, the bad effects before mentioned will be present to a greater or less extent.

The methods adopted in practice to satisfy these conditions will now be considered.

(*To be continued.*)

SMALL LIGHTING PLANTS.

An article headed "Small Lighting Plants," by Mr. Fred. C. Reeve, in the *Electrical World*, deals with three important questions, namely:—

1. Can the lighting companies materially lower the present rates if brought into competition with the "isolated plant?"

2. Are very small plants, varying in size from 25 to 300 lights, practical?

3. Under what conditions can they be made a success financially?

The basis of his calculations are taken on the average prices charged in America for the four most popular illuminants, and are as follows:—

(*a*) Ordinary gas light, costing ·875 cents per 16-C.P. hour.

(*b*) Incandescent gas light, costing ·65 cents per 16-C.P. hour.

(*c*) Incandescent electric light, costing ·90 cents per 16-C.P. hour.

(*d*) Enclosed arc light, costing 6 cents per 1,500-C.P. hour.

In cases where the demand for current is spread over a large number of hours, such as large factories and workshops, where the items of interest and depreciation would therefore be spread over a large number of units, it is shown by a table of costs of operating plants that electricity can be generated privately at a less cost than the average price generally charged.

Persons will gladly pay for the convenience afforded by the central station supply in their houses, but in the store, factory, or workshop where economy has to be practised, the matter is treated differently, and these considerations account for the large number of isolated plants in America, and no doubt also at home in England.

The rapid spread of electricity within the last few years, and the publicity given to the details of cost in generation, management, &c., have set probable large consumers thinking, and their education has in many cases led to the loss of good customers, for knowing that dynamos can be relied upon to work practically without attention, and with little fear of breakdown, the additional responsibility of an extra machine in a large works spreads itself over the whole just as the items of interest and depreciation spread themselves over a larger number of units generated, and logically speaking, the larger the works the less the additional responsibility is felt.

The isolated plant of to-day is quite different from that of a few years ago. Before the introduction of central station supply, we were indebted for a good deal of our early knowledge to isolated plants. Just as doctors must learn their profession and patients must be practised upon, so had the electrical engineer to learn his profession, and the isolated plant owner was often the patient sufferer, the martyr to science. The disappointments and failures of the days referred to were often due to the scant knowledge then possessed by the engineer, and these failures have led to such improvements, that it is difficult to see where further improvements can take place.

The lessons taught were not long in being acted upon, and central stations began to make their appearance at different places some ten years ago, and have gone on increasing year by year, each succeeding year bringing more and more. The primary lesson learned was, that electricity generated in sufficiently large quantities could be generated cheaply and made a commercial commodity. The owners of large works, shops, stores, &c., have also learned this, and following in the footsteps of their former tormentors, are putting down their own plants, some of which rival in capacity many central stations.

Although isolated plants are not adapted for domestic light, except for country residences where current cannot otherwise be obtained, it is obvious from the silent evidence of the increase of isolated plant in business premises, that when a sufficient number of lamps are installed, and when they burn for a considerable time each day, the current can be very cheaply generated.

It points to the fact that sooner or later electricity will have to be supplied at a very much cheaper rate than at present, or the steady commercial lighting will be operated by the isolated plant, and the only customers retained will be the domestic and intermittent commercial work.

The systems of charging for current must be considerably modified to enable the business man to cheaply light his factory if current is to be bought, and he must pay a higher rate for current used for domestic purposes.

COMPARATIVE COST OF STEAM AND ELECTRIC POWER.

I.

Electrical power transmission being as yet in the aggressive stage of development, and called upon to show cause why it should be adopted, it is natural, that from time to time, should appear comparisons of costs with steam power. One of these appear in the *Electrical Engineer* (New York), by Mr. Irving A. Taylor. So far as regards steam power costs in America and here, the probability is that comparisons made in one country will stand good for the other. Mr. Taylor attributes the small attention given to power economy to the idea that power is only thought to be a small item in total costs of manufacturing, and also to the fact that power distributing is a special subject not understood much by manufacturers. There is nothing easier than power distribution, and anyone can get out a plan for doing it, but it is all done by guess work, and the result is often an expensive tangle of belts entirely preventing the use of overhead travellers, as well as being enormous power absorbers. It is not simply the sheer cost of power that is to be counted, often enough it is the incidentals, and this is specially the case where small steam engines are employed.

So much depends on arrangement, and the author cites the case of a shop remodelled to give a four-fold output, which produced as much as seventeen-fold with ease. In this case, arrangement combined with electrical transmission and compressed air for certain duties has been the cause of improvement. Now, air power is costly, but it is extremely useful in the right place, and though giving only 15 per cent. efficiency, being used cold, it saves in labour and increases output. The question is asked, what is the best way to lay out a power plant? The answer is, that where large amounts of machinery are to be driven, certain power centres may be found to which, while power is being used, power may be supplied at a fairly constant rate, and with a high load factor. Such centres may supply simply one machine, or a group of machines, a whole floor or section of a shop, but no large power must be sent far along a line of shafting or a number of belts. There is a tendency to medium sizes of motors, 3 to 15 H.P. They ought to be fairly well loaded, and their efficiency must not be obscured by complicated belt systems. When the load on a machine or a group is nearly constant, the group or unit is to be as directly connected as possible to the motor. Machines absorbing a small but variable power require grouping in considerable numbers on one motor, so as to obtain an even average. Where possible, variable and steady demands should be separated. Thus we want to run a 5-horse blower all day, and a couple of machines consuming from 0 to 10 H.P., and averaging about 2 H.P. The costly part of this load will be the blower. If we use a 15-H.P. motor, the costly load will be run usually on a half loaded motor, through belts and shafts, and will cost double what it would if it were run with a 5-H.P. motor on the blower shaft direct. The group would thus require two motors. But if the maximum load of 10 H.P. on the other machines had never fallen below an average of 7 to 8 H.P., possibly one motor would best have served the group. The author is very severe on a crossed belt. With its two rubbing sides exerting a backward pull of $7\frac{1}{2}$ lbs. at 2,200 feet per minute, the cost of this 1 H.P. of friction will be £20 to £60 a year, a rather expensive price for a crossed belt!! There is no excuse for a crossed main belt, and only necessity should permit any crossed belt to be run. The author saved 50 per cent. of power by uncrossing a main belt. It took half an hour to arrange this. Belts are often the best transmitters for short spans. For spans of 100 feet, a wire rope will be satisfactory where loads do not vary suddenly; but in America wire rope transmission has not been a success—it demands too many conditions; is too curbing. The same applies to compressed air. It is used in Paris, with reheating to 300° or 400°—an essential to economy for large air power. But who wants a fire to make up? People who buy power want it ready cooked, not raw, like compressed air. Electricity has the maximum of convenience and the minimum of waste over any distance, and is bound to win on the score of convenience, if for no other reason. The trouble with electricity is, so far, with those who sell rather than with those who buy. There is so much hesitation in replying to an intended user's questions. It looks as though there were doubts as to success, and so on, and this is not encouraging to users. In Mr. Taylor's further discussion of the question he gives figures to show the advantages of electricity which we propose to reproduce.

(*To be continued.*)

AN ELECTRICAL HYPOTHESIS FOR THE SOLAR AND PLANETARY SYSTEMS, AND SOME OF THEIR ASSOCIATED PHENOMENA.

By DELTA.

(*Continued from page* 74.)

II.

Since the first article was published in the Electrical Review, the solar eclipse of 1898 has been carefully observed, and under favourable conditions, and according to cable information the general shape of the solar corona was generally like that seen in the eclipses of 1867, 1888 and 1896, so that it may be assumed that there is little variation, if any, in

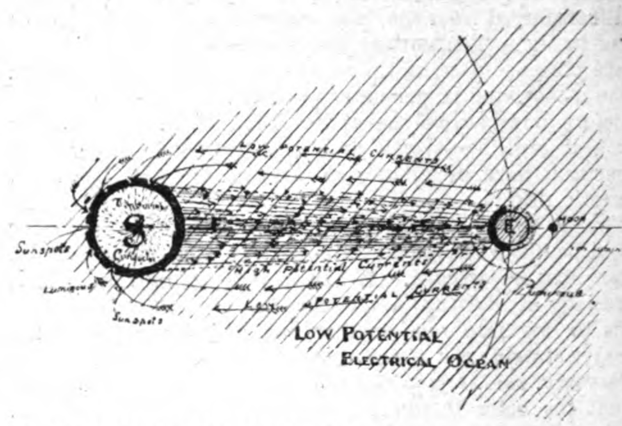


Fig. 1.—Graphic Diagram showing the Cycle of the Conservation of Energy forming the Basis of the Solar Electrical Hypothesis.

the sun's great electrical potential. The varying luminous intensity of the solar triple and concentric envelopes is merely due to the varying degrees of resistance offered to the outward passage of the high intensity electrical energy. The photosphere is probably composed of gas of such high tenuity, as to offer no resistance whatsoever.

The diagram, fig. 1, is intended to graphically explain the author's electrical hypothesis. Fig. 2 gives a rough idea of

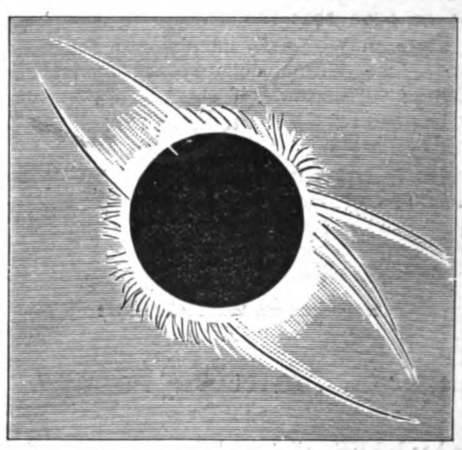


Fig. 2.—Total Solar Eclipse, July 29th, 1878, showing Electrical Streamers.

the appearance of the solar corona. Before proceeding to extend the application of the electrical hypothesis to explain stellar and other phenomena, it may now be an advantage to examine its value, as an explanation of common atmospheric effects.

Cloud Effects.

Aqueous vapour, in the form of clouds (by the well-known attractive influence that water has for electricity), may be said to constitute suspended electrical conductors, that become electrically charged to saturation.* The discharge of these

* An electrically charged cloud induces electricity of an opposite kind to its own.

cloud forms of electrical conductors may be induced by the earth itself, or by a highly electrified wind current, and also by the influence of solar electrical currents that produce the ultra-violet rays.

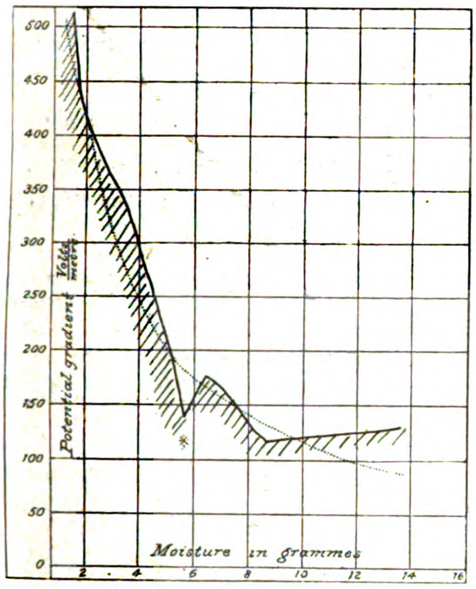
The discharge of the clouds will be induced by contact with any strongly electrical energy absorbing surface.

The strange phenomenon of the water spout, the aqueous column uniting the clouds and the sea, is an example of the powerful and irresistible attractive influence of masses of water, that culminates in the rapid discharge of the clouds' electrical accumulation.*

There are always stronger indications of electrical energy on hills than in valleys.

The Influence of Aqueous Vapour on the Electrical Condition of the Atmosphere.

The influence of the proportion of aqueous vapour in the atmosphere in its effect on the degree of resistance offered to the flow of electric energy is well known.



——— Actual curve. .... Estimated curve.

Taken from Elster & Geitel, *Fitz K. Akad der Wiss, Wien.*

Fig. 3.

The discharge of a rain cloud rapidly clears the atmosphere from an excess of electrical energy. The influence of a highly aqueous vapour condition in altering the electrical potential of the atmosphere is shown by diagram, fig. 3. This diagram 3 is constructed from tabulated results of observations made at Hofner Sonnblick at an elevation of 10,168 feet above sea level, and also at the low level station of Kohn Saiguon. It will be noticed, on referring to the graphic diagram, fig. 3, that the curve of electrical potential runs in a line inversely to that of aqueous vapour pressure.

A casual test made at Massachusetts, by means of a kite connected by wire with a quadrant electrometer, was raised and maintained at some elevation above the summit of Blue Hill, at such a position as to intercept an approaching thunderstorm.

At 7.40 a.m. this thunderstorm, which for some 20 minutes had been approaching from the west, was near enough to cause an incessant stream-like flow of sparks from the kite-string.

If a ground wire was held within a fraction of an inch from the kite string, a spark discharge followed.

After the rainfall, no sparks or any electrical indication could be drawn from the kite-wire.

Cloud disruptive discharges occur when the electrical tension in the atmosphere between the clouds and the surface of the earth exceeds a certain critical value not yet determined.

It would appear that as the voltage increases with the height of elevation from the earth's surface that clouds at various heights will have distinctive electrical characteristics; therefore we should expect that cloudland will be essentially of a stratified character.*

The variation of electrical potential from the inception to the termination of a thunder storm is a striking proof of the masterly factor that electrical energy occupies in terrestrial processes, and is itself evidence of no inconsiderable value in supporting the author's new hypothesis.

Thunder, Hail, and Snow Storms.

Diagram fig. 4 shows the striking variations of electrical potential during thunder storms, at both an upper and a lower placed station.

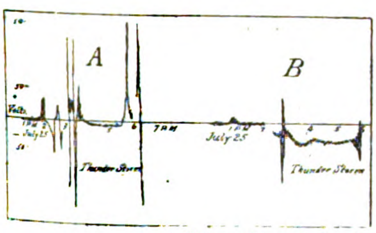
The diagram 5 shows the normal variation of potential characteristic for fine weather. It will be observed that the electrical intensity shows a decided drop from morning until evening.

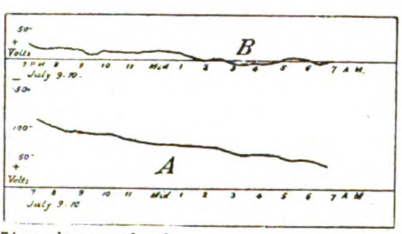
The violent changes of electrical potential of our atmosphere are not only associated with thunder storms. During hail and snow storms we have acute changes of potential. The diagram fig. 6, for which we are indebted to Mr. McAdie, is a very striking exhibition of the great potential fluctuations that exist during a snow storm.

The observations at Sonnblick indicated that cloudless days were associated with an apparently constant and equable fall of potential, maximum (July) between 7 and 9 a.m., followed by a regular reduction of potential to a minimum at the evening.

Observations in a cloud that discharged a small quantity of rain showed the electrical potential to gradually drop to zero value, where it remained for some time.

It has been noticed, as a rule, that in storm clouds the atmospheric electricity usually changes its sign after a lightning discharge, the same change occurs with storms occurring on a plain.





A 194 m. above sea level, and B 74 m. above sea level.

Electrical Potential of the Air Photographically Registered at Two Stations.

Fig. 4. Fig. 5.

The Formation of Hail and Snow Particles.

It is well known that the flow of static electricity between pointed terminals, and through an atmosphere charged with particles of suspended matter, in a condition free from moisture, has a very curious effect. Some of the particles become immediately electrolysed and polarised, and they form nuclei centres of magnetic attraction and aggregation, the small particles rapidly coalesce to form larger ones.

One might attribute the formation of hail, and, in a manner, perhaps, of snow or other forms of frozen vapour, to this action of electrical coalescence.

In hail storms the highly electrical condition of the atmosphere is particularly noticeable. The electrical intensity potential was noticed by the observers at Sonnblick to increase and decrease with the fall of hail.

Diagram, fig. 6, shows the violent electric changes that accompany a snow storm.

Probably the electrical coalescence forming hail takes place at the altitude coincident with that of the Cirrus cloud, at some 5½ miles distance from the earth's surface.

---

* Peletier states that water spouts are accompanied with striking electrical manifestations.

* Hildelrandsson showed that the upper currents move along somewhat parallel to the lower currents, up to a certain height.

According to the law enumerated by Leys:—

Upper clouds have a distinct centrifugal tendency over areas of low pressure, and a centripetal one over those of high.

The Variation of Electrical Potential in Winter and Summer.

The average atmospheric electrical potential is higher in winter than it is in summer—there is less moisture as such in the air, and the absorption by the earth will, it is thought, be slower in winter than in summer.

The moisture in summer months constitutes an excellent

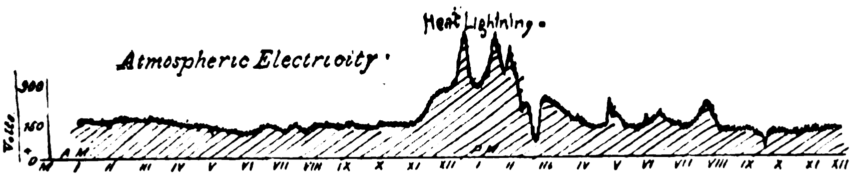


Fig. 6.

conductor for the flow of the electricity to the earth's surface.

Dryness of air, on the other hand, offers a greater resistance to the flow of electrical energy, and hence the tendency to the creation of a highly electrified atmosphere, a prelude to the atmospheric electrical phenomena we know as the magnetic storms.

The Increase of the Electrical Intensity Potential with Increase of Altitude.

If the author's electrical theory is correct, it would mean that the solar electrical intensity potential would be highest at its entrance into the earth's atmospheric envelope, and that by the dispersion of part of its energy in generating heat and light it would become less and less as it approached the earth's surface; or, inversely expressed, *the electrical potential would increase in proportion to the distance from the earth.*

That this is so is shown by diagram fig. 7. The curve shows the rise of electrical potential with height above the surface of the earth.

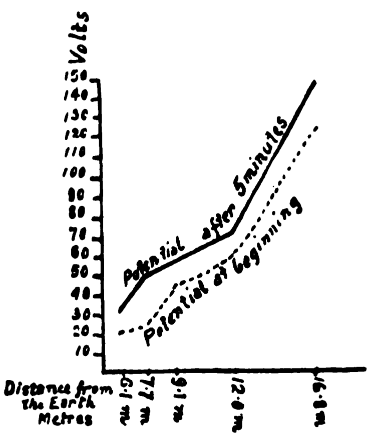


Fig. 7.

Exner's experiments with the water droppers, and made at comparative low levels, showed that whilst the voltage at a height of 17 metres was 100, it increased at a height of 40 metres to 280. He deduces from this that there is a rise of 6—8 volts per metre of elevation.

The Limit of Extent of the Sun's Atmospheric Envelope.

Before enlarging further on this important fact of rise of potential, which in itself clearly shows that the earth cannot be considered to be the primary source of electrical energy, because if it did the electrical intensity would be greatest at the surface, let us attempt to define the limit of the earth's atmospheric envelope. By calculating on the basis of the pressure exerted by the atmosphere upon the earth, equivalent to 30 inches of mercury, the atmosphere only extends some five miles; but this calculation is obviously erroneous, from its neglect to allow for the highly tenuous character of the fringe of the earth's atmosphere.

Meteors having been noticed to evolve gas at a distance of 120 miles from the earth, it is clear that even at this distance extreme atmospheric attenuity cannot have been reached.

That the resistance to the flow of the high tension solar electric currents does not commence to be of sufficient intensity as to produce any luminous or day-light effect until it reaches a distance of 45 miles from the earth is shown y the duration of twilight.*

The all of the electrical potential will vary with the density of the atmosphere, so that Exner's factor of 8 volts increase per metre of distance can only be taken as in any way reliable within a short distance from the earth.

If we take half this factor, or 8, to represent the rise of potential per metre of elevation, we should then have a voltage value, at only five miles distance from the earth, of

$$\frac{†1,609 \times 5 \times 8}{2} = \text{to } 32,180 \text{ volts.}$$

The Zone of Electrical Potential.

If the electrical energy flowing from the sun at high tension and frequency enters the atmosphere, and is absorbed by the atmosphere and the earth, the latter must constitute the zero of potential. The discharge of low intensity electrical energy from the earth into the low potential electrical ocean will not generally illuminate the atmosphere, although there are evidences of such discharges from prominences that have produced luminous effects. Such an example is suggested in the phenomenon of Saint Elmo's fire.‡

Wind and other Currents Electrically Initiated.

Wind currents—particularly those carrying with them suspended particles of hail or snow, are highly electrical, and there is little doubt but that high potential electrical discharges play as important a *rôle* in the production of wind currents as does the more generally accepted explanation of the cause, the effect of heat.

The discharge of a high tension current from one to another, or from a point on to the atmosphere, *sets up a decided flow of air.*

If it is accepted that high tension solar currents flow at their maximum at the equator, then this line will coincide with the initiation of powerful and continuous trade winds. Any chart showing the direction of the prevailing winds will demonstrate that the trade winds are initiated at the equatorial line.

That the discharge of electrical energy into the ocean, will indirectly influence the ocean currents, is probable. The maximum oceanic absorption of electrical solar energy at the equator, may constitute this locality as a locale of initial motion of oceanic currents.§

The wind currents flow from the land to the sea at night, and from the sea to the land at the day time.

The general theory for this change of direction being the alternate influence of the heat of the earth and that of the sea.

The inflow to the earth of the high tension electrical currents in the day, and the outflow of this energy at night, may by repulsive influence on the air have some part in the play of the natural forces, producing the wind currents.

The Relation of Barometric Influence on the Electrical Intensity Potential.

The degree of atmospheric resistance to the flow of elec-

* Slightly luminous clouds have occasionally been seen at night that were calculated to be at a distance of more than 45 miles; it is suggested that their interception of strong solar light intensity electrical currents has produced the strangely luminous effects, silver clouds in an atmosphere of the darkest night.

† Mils reduced to metres.

‡ Buchan records 15 cases of Saint Elmo's fire emitted at night time from the summit of Ben Nevis, between the years 1883 and 1888.

§ The oceanic currents appear to flow from the north, from the south poles, towards the equator, establishing cycles of direction, north and south of the equator.

trical energy being a function of the atmospheric density, it will, therefore, be obvious that a change in the barometric pressure will set up varying resistances, and varying electrical repulsive effects that will cause wind currents. Another cause would be the generation of heat as a *pari passu* effect of the increased resistance to electrical flow, and this heat would tend to expand the air, a common means of producing wind circulation.

It has long been known that some connection exists between the height of the barometric column and the direction of wind currents.

For instance, 10 years' consecutive observations have shown that the least mean barometric height corresponds to the great south winds, and the greatest mean height corresponds to the great north winds. The change of barometer will necessarily mean a change of atmospheric electrical potential, and either an increased or decreased, and corresponding degree of repulsive action, on air.

It has been explained that the dispersion of electric energy of high intensity from a pointed conductor, sets up wind currents by electrical repulsion, it is not, therefore, an improbable suggestion to put this cause as the master one amongst other, and purely physical causes, that set up the flow of air currents. It has been suggested that highly-electrified wind currents may, independently of temperature influence the discharge of highly-aqueous clouds of accumulated electric energy.

Temperature of the Upper Atmospheric Strata.

Let us assume that the temperature of the atmosphere depends upon the resistance offered to, and on the proportion to the electrical energy passing through the atmosphere. The resistance is a function of the atmospheric density, and as the density of the atmosphere decreases, as its distance from the surface of the earth increases, this would necessarily mean that in proportion as the distance from the earth increased, the temperature would decrease; in other words, the temperature would in some measure be inversely proportionate to the distance from the earth's surface.

Aerostatic observers have discovered at the equator, that for each elevation of 187 metres there is a drop in temperature equal to 1° C.

Taking the temperature at the equator to equal 25° C., then at a distance of five miles the temperature will equal

$$25 - \left(\frac{5 \times 1{,}609}{187}\right) = 18^\circ \text{ below zero.}$$

Now, from evidence that has already been adduced relating to the Cirrus clouds and to cometary bodies, it is quite certain that outside the five miles of atmospheric environment the temperature is very many degrees below freezing point. We have nearer evidence in the fact of the mountains being capped with everlasting snow.

If the ordinary theory were correct, these prominences would be the first to meet the assumed rays of light and heat from the sun, and the summit of the mountain would be hotter than the valleys around its base. A somewhat similar objection applies to the ordinary theory of transmission of light from the sun.*

The Zodiacal Light.

The electrical hypothesis provides one speculative explanation for this phenomenon. It is suggested that the apex of the zodiacal light is the outer fringe of the earth's atmosphere, having such a density that by resistance to the flow of electric energy, it is capable of being made luminous. As the atmosphere projects miles beyond the earth's surface when an observer is on the surface of the earth removed some limited distance from the area upon which solar electric energy is acting, he should be able to see the reflection of the earth's luminous atmosphere in the form, say, of part of the frustrum of a sphere.*

* To demonstrate this difficulty one has only to formulate the following argument:—

Axiom.—The intensity of light is inversely as the square of the distance from its source.

Hypothesis.—If the ordinary theory were correct, the maximum intensity of sunlight (which is considered to be four times that of the electric light) would and sequentially be equal at the sun to the determinate quantity, x, given by the equation

$$z \times (93{,}000{,}000)^2 = x,$$

where z equals the photometric and thermal value of the sunlight at the surface of the earth, and this z quantity may be calculated thus: the temperature of an ordinary arc and actinic light has been variously estimated, but if we take it to equal 2,500° C., then the intensity of the light at the sun will be equivalent to a temperature that is beyond the regions of even the wildest fancy, and this figure alone appears to be fatal to existing theories.

The Supreme Importance of the Subject of the Electrical Condition of the Atmosphere—a Suggestion.

Before proceeding to the application, necessarily highly speculative, of the electrical hypothesis to the planetary, stellar, and their associated phenomena, the author wishes to emphasise the urgent, if not supreme importance, of the subject of the electrical condition of the atmosphere. This subject transcends all others, not only in its relation to vegetable organic life, but also to that of human life. The stimulating effect of electrical energy on vegetable life is well known, and this subject alone deserves national recognition.

The author is satisfied that it will be found correct to say that nearly all diseases, and more especially those having a nervous origin,† are in some measure connected with specific electrical atmospheric conditions, and there is little doubt but that the conditions that best secure immunity from any epidemic or other disease, will be found to be coincident with *pari passu* electrical characteristics, but especially with the atmospheric electrical potential.

We must have day by day records of the variation of electrical potential and other electrical changes, along with the barometrical indications from all our meteorological stations. The meteorological stations should be increased at least to double the present number, and be supported by the State.

With this electrical data, we should be able, if not to prevent, at least to counteract the influence of an electrical potential found to be dangerous to satisfactory health conditions of either animal or vegetable existence.

A human sufferer could be removed to positions when the electrical conditions were found to be hygienically beneficial.

By means of the proposed stations the prevalence of electrical changes, magnetic storms, and other electrical phenomena, would soon supply abundance of data of incalculable value to the well-being of the people.

The correlation of the electrical characteristics with hygienic, astronomical, and atmospheric, and other effects could be more exactly determined, and there would then be no necessity to incur blame and displeasure in attempting to formulate speculative theories, however well justified they may be, by correlative and coincident evidence.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

At the last meeting of the Institution of Electrical Engineers, held on Thursday, January 27th, at the Institution of Civil Engineers, Major-General Webber read a paper entitled "Notes on the Electro-Chemical Treatment of Ores Containing the Precious Metals." General Webber prefaced the presentation of the actual paper by explaining that the subject was such a broad one, while his remarks were confined to one or two particular departments thereof, he did not feel justified in describing what he had to say as more than "Notes." The paper, like many others laid before the Institution, is evidently intended to awaken and stimulate thought on particular matters, and is timely as following up the subject matter of the presidential address so recently delivered. We allude to it at length in another column.

On conclusion of the paper, the President called upon M.

* Prof. Bigelow considers the zodiacal light merely as an amassment (in the plane of the sun's equator, and at a place of zero potential) of particles electrically propelled from the sun.

† Every living thing on earth may be rightly considered to be a producer of electrical energy, and each one is more or less highly, if unconsciously, susceptible to the varying electrical conditions of the atmosphere. We have an example of this in the prevalence of neuralgic and similar attacks at certain phases, as yet undefined, of the electrical and atmospheric potential.

Pelatan to open the discussion. This gentleman modestly disclaimed a thorough acquaintance with the English tongue, and stated that he thought the paper gave full particulars of the process in which he was interested, but expressed his willingness to give any further details that might be desired. Later in the evening M. Pelatan had the opportunity of dealing with some of the criticisms, and ably put forward his views in excellent and clear English.

To Dr. Teed fell the part of leader of the attack, and this position he filled with evident relish, and at considerable length. He opened by stating that the paper wanted pulling apart and reconstructing, particularly by setting those processes which are intended for the electrical removal of metals from solvents on one side, and on the other, such as are intended for the making of solvents by electrical treatment. Thus the Siemens & Halske process was one for removing gold from a solvent, while the Pelatan-Clerici had in view the making of a solvent, and dissolving out the gold by this solvent. Molloy, whose name was mentioned in the paper, only attempted to remove gold from a solution, by making a sodium amalgam.

Coming to the Pelatan-Clerici process, Dr. Teed expressed his wish to have explained the meaning of the statement in the paper that certain mixing was done in the treatment tank itself, part of the gold being alleged to be extracted in the vat, and part after the liquor had left the vat. He considered the chemistry of the process involved, while nothing seemed to show that one sort of ore was differentiated from another. Ferritic ore, for example, could not be treated electrolytically, but must be dead roasted first. Then as to cost, the question was, what did it cost to agitate per ton of ore, and how much did the electric current cost per ton? Following this, Dr. Teed cited several processes in which potassium cyanide alone was used to extract the gold from an auriferous ore, the quantity of cyanide employed per ton being less than that mentioned as necessary in the electrolytic process. Warming up to the attack, the Doctor continued that the facts put forward honestly in the paper formed a condemnation of Petalan-Clerici process, and asked, "Could any opponent say anything more virulent? Ridiculous is not a strong enough word for it."

After a few remarks from another speaker—Mr. Herroun, of King's College, on the chemistry of the last-mentioned process—Mr. Sulman, whose name, jointly with that of Dr. Teed, was referred to in the paper in connection with the Sulman-Teed process, rose to wish every success to the process so strongly condemned by his partner, to name certain processes of historical interest which were omitted in the first part of the paper, and finally to pile up a list of theoretical and practical objections to the Pelatan process, particularly questioning the advantages of having to agitate, the improvement in yield due to this process, and the cost of the necessary plant, energy, and solvent. He concluded by stating that it might be that unwittingly an injustice might have been done to the process, but economy is the touchstone of any method of extraction, and by cyanide alone 90 per cent. of the gold can be got from an ore.

Several speakers dealt generally with the subject of the paper; one expressed himself as looking with extreme sympathy upon the attempts to utilise the old Hungarian Mill with the use of electricity to keep the mercury alive.

M. Pelatan then rose to give explanations on some of the detail points referred to by different speakers. He stated that in the mixing vat a quantity of pulp collected, and that the gold was actually got partly in one way and partly in another; the first treatment, lasting two hours, being performed without electrical assistance, a certain quantity of gold was taken up in the mercury.

With regard to the former used in agitation, it was necessary to compare things and processes that were comparable, and the particular use made of agitation in his case, was very different to what was attempted by other inventors. Thus some processes require the cyanide, vat and stuff to be agitated, but he only desired to agitate the pulp undergoing treatment in the vat, and he had found by experience that only half a horse-power was required to stir up five tons of crushed ore.

The consumption of cyanide depended upon the condition of the ore treated, the tailings on the Rand were in a washed condition, the slimes having been taken away already. In any case the figure of 2 lbs. of cyanide per ton, was a very great maximum, and in every-day practice he had not found it necessary to use such a large quantity.

At this point the discussion was adjourned, and the meeting broke up, a general topic of conversation, as the members trooped from the hall, being the extraction of gold, not necessarily, however, from ores, or by electro-chemical means.

LEGAL.

IMPROVED ELECTRIC GLOW LAMP COMPANY *v.* EDISON & SWAN UNITED ELECTRIC LIGHT COMPANY, LIMITED.

This case, which was briefly noticed on page 122 of last week's ELECTRICAL REVIEW, was heard before Mr. Justice Mathew, in the Queen's Bench Division, on Thursday 27th ult.

Counsel for the plaintiffs, Mr. Bousfield, Q.C., M.P., Mr. Wallace, Q.C., and Mr. A. J. Walter. For the defendants, Mr. Fletcher Moulton, Q.C., and Mr. J. C. Graham.

Mr. BOUSFIELD, in opening the case, said the plaintiffs were a company incorporated in March, 1896, their name indicating the nature of the business they were proposing to undertake. The defendants were an old-established and well-known company, having a very high reputation in the electric lighting world, the demand for lamps of their make being very large. That being the state of the case, the plaintiffs being a new company bringing out a new lamp, negotiated with the defendants for its manufacture. The lamp differed from the ordinary type. The ordinary lamp was pear-shaped. The plaintiffs' lamp, on the contrary, endeavoured to get the lower surface as flat as possible, and the upper surface of such a curve that the two together, when part of the glass was silvered, gave the most favourable results as regarded illumination. It was cheaper, gave greater lighting power, and consumed less than the ordinary lamp. The negotiations took place between Mr. Fanta, the managing director of the plaintiff company, and Mr. Jacob, who at that time was the general manager of the defendant company. The basis of all the discussions was, that the defendants should work with the plaintiffs in bringing out the new lamp. The motion was, that the defendants should be the sole manufacturers of the lamp, should supply it to the plaintiffs, and share with the plaintiffs in the profits of the trade resulting from the introduction of the article, which both should push. On the basis of that arrangement, an order was given for the manufacture of 100,000 of these lamps, which was in writing, and was the only contract upon which they were suing in this action. The defendants began to manufacture under this contract, and to make deliveries under it. The date of the contract was the letters of November 3rd and 9th, 1896, and the rest of the arrangement was reduced to writing on November 26th. They could never get the rest of the arrangement confirmed in writing, and it never was. In the meantime, while this arrangement was going on, unknown to plaintiffs, the defendants experimented and introduced a lamp which was nothing more nor less than an absolute copy of the plaintiffs' lamp, the only difference being that instead of the reflecting part of the top being silvered, it was made of opal glass. The defendants had taken out a patent for their lamp on January 10th, 1897, but the plaintiffs did not know this until a later stage. They knew, however, from the delays that were taking place that there must be something wrong. On March 5th, 1897, they learned what was the matter when an advertisement appeared in the ELECTRICAL REVIEW announcing that the defendants had introduced a new orb into the incandescent lamp world. This lamp was called "The Queen of Lamps." It was described as giving a perfect diffusion of light, and as being unquestionably the lamp of the Diamond Jubilee. An action was brought by the plaintiffs against the defendants for infringement, but with that his Lordship was not now concerned. The defendants thus avowedly entered into competition and rivalry with the plaintiffs with a lamp which, as far as bulb was concerned, and everything else except the substitution of opal for silver, was identical with plaintiffs. During the months of April and May, 1897, the total deliveries were under 4,000; that was to say, that during the eight weeks preceding the issue of the writ on May 20th, there was only two weeks' supply delivered. Up to the present time there was still a small number of lamps unfinished under this order. The defendants had alleged that the delays were due to the plaintiffs not giving them instructions as to certain details, such as "capping," but that was not really the case. The capping was a simple question, and could be done at the rate of 800 a day. As a matter of fact the plaintiffs had agreed to pay for the lamps as completed lamps at the stage before they were capped, the defendants to keep a quantity in stock and then "cap" them. It was quite impossible in this trade for the plaintiffs to put the lamps upon the market until they had accumulated a stock, unless they had somebody behind them like the defendants, who had a large output of such articles. If the plaintiffs' arrangement had been carried out when they had got 10,000 or 20,000 accumulated, they could have put the lamps on the market, but without someone behind them like the defendants, who could manufacture at a rapid rate, it would had been necessary for them to have accumulated 30,000 or 40,000 lamps. There were three different voltages and four different candle-powers so that altogether there were to be twelve varieties of lamps from the one shape, namely, the conical. The first specification was for 66,000 lamps, of which 46,000 were to be of the conical and 20,000 of the round type. The plaintiffs had a large Continental trade where foreign lamps were considered as good as English made, but these particular lamps were required for the

English market, and it was essential that they should be of English manufacture. In consequence of the failure of the defendants to fulfil their part of the contract they had to carry out certain English contracts by supplying foreign-made lamps, whilst other orders they had to reject.

Mr. Justice MATHEW suggested that the question of liability should first be considered.

Mr. MOULTON said it would perhaps assist the Court if he stated the defendants' view of the case. It was that no contract had ever been entered into. Unquestionably an arrangement was made that the defendants should supply the plaintiffs with lamps to the extent of 2,000 a week. The letter of November 9th left matters still to be arranged verbally, but the next letter showed it was very much a matter of doubt whether any strict contract was ever entered into. There was a good deal of trouble in making the lamps originally, and hence there was some delay; but the defendants were always supplying the lamps. The plaintiffs, he contended, did not suffer any business damage whatever, and as to the allegation that the defendants put a rival lamp into competition with that of the plaintiffs, there was no foundation for such a statement. The defendants did not receive the specification from the plaintiffs when they ought to have done, and again they were entitled to a reasonable delay for capping. There never was a time when the plaintiffs could not have as many completed lamps as they required.

Evidence was then called for the plaintiffs.

Mr. FANTA, managing director of the plaintiff company, examined by Mr. BOUSFIELD, said the sole object for which the company was formed was to manufacture and sell this improved glow lamp. In 1896 he had several interviews with Mr. Jacob on behalf of the defendant company, and negotiations as to the manufacture by the Edison-Swan for the plaintiff company. Mr. Jacob said he knew if they were to manufacture the lamps the two companies would have to work hand in hand. Altogether there were three or four interviews before the letters of November 3rd and 9th. Ultimately, pending the acceptance of terms, on order was given and accepted for 100,000 lamps to be manufactured by the defendant company. Witness gave evidence as to the nature of the contract, which was disclosed in the letters. He said that the total number of lamps, both of round and conical shape, invoiced by the defendants in accordance with the contract up to April 7th, was 17,279. Of these, 8,904 were conical, and 8,375 round. Between March 31st, the date of the last delivery, and May 20th, the date of the issue of the writ, the total number of lamps delivered was 4,600. Assuming that at that date there should have been delivered 30,000 conical lamps in accordance with the contract, only 8,904 had actually been delivered. Of the 8 or 10 candle-power lamps, 18,000 should have been delivered, but up to the date of the issue of the writ only 597 had been supplied. This failure of delivery had prevented witness's company from placing the lamp on the market from the very beginning. They wanted to put on the market an English-made lamp, which was suitable for the English market, being much more durable than the foreign-made article. The price they were to be paid for a certain lamp to the defendants' company was 1s. 1d. per lamp, but they could get a similar article on the Continent for 6d. It was not so good as the English make, nor was it so durable. As the defendant company did not supply the lamps according to the contract, the plaintiffs could not put the articles on the market because they had no stock. That meant if they had secured orders their small stock would have soon been exhausted, and they could not have continued the supply, which would have been detrimental to the company. Had the defendant company conducted the supply according to their contract the plaintiffs could have put them on the market as they had originally contemplated.

Cross-examined by Mr. GRAHAM: The policy of his board was to have English-made lamps, which were to be manufactured by Edison and Swan, who had offered to do the work. The plaintiffs did not go to another manufacturer when there was delay on the part of the defendants, because the latter were continually promising there should be an improvement in this respect. It was not the appearance of the defendant company's advertisement in the ELECTRICAL REVIEW as to the "Queen of Lamps" that first made his company feel irritation. There was no irritation then and there was not now. His company were not undecided as to the marking of the lamps until January. They were quite decided about the matter from the outset, but the defendants pointed out certain difficulties. The "Queen of Lamps" would have served their purpose when the defendants had failed to supply the other lamps, but the "Queen" would have cost them much more than they had agreed to pay the defendants for the manufacture of the lamp specified for.

Mr. Justice MATHEW expressed the opinion that the real measure of damage would be arrived at by taking the difference between the price in the "Queen of Lamps" and the price of the contract lamp, assuming that the plaintiffs had gone and purchased the former lamp and put it on the market to the extent in which there had been non-delivery.

Mr. GRAHAM submitted that what they were inquiring into was what damages had in fact been sustained, not, theoretically, what damage had been suffered.

Mr. Justice MATHEW: No, indeed, you are not. You are inquiring into what the proper measure of damages is, and I see no better method than the old-fashioned one I have indicated.

In further cross-examination, the WITNESS stated that his company had not as yet contracted with customers for the supply of English-made lamps, because they were not in a position to do so. They required a large stock to do this, and they had not that sufficient stock which would enable them to open a market in the article, and keep up the supply. He denied that his company caused any delay by the failure to give instructions as to the "capping" arrangements.

Mr. L. MANTELL, manager of the National Liberal Club, deposed that an 8 candle-power lamp of the plaintiffs' company gave exactly the same light as the ordinary 16 candle-power lamp. He spoke from experience of the lamps at the Criterion, where the Edison-Swan lamp was superseded by the plaintiffs. The lamps were of German make. It was contemplated changing the lamps at the National Liberal Club in the same way, but as the lamps of the plaintiffs were of foreign make, they were objected to. Mr. Fanta, however, had been told that when he could supply an English-made lamp the change would be carried out.

Mr. ALFRED HENRY WALTON, electrical engineer, agreed with the last witness as to the saving in illuminating power effected by the plaintiffs' lamps, which had been adopted with success at the Empire Theatre. The lamps being foreign made had a shorter life. and witness had told Mr. Fanta he should not give orders for further lamps until the plaintiffs could supply him with the English-made article.

This closed the plaintiffs' case.

Mr. MOULTON, for the defence, said that now, practically, the whole of the lamps contracted for had been delivered. That was to say, the 66,000 for which there had been a specification had been delivered, and of the 34,000 the defendants were prepared to give delivery. There had thus been a carrying out of the contract, and if damages could be recovered, it could only be on the ground of delay. What damages had been incurred here? Soon after they had entered into the contract the defendants commenced to deliver the lamps, and although they delivered slowly, still the plaintiffs, at the very time they brought the action, had in stock 16,000. Surely it could not be said that they had not then a sufficient quantity to enable them to commence the sale. The fact was, that they were not selling the English-made article, but a German lamp. The lamp manufactured for them by the defendants was not a lamp which would be sold in large bulks, and when they had 16,000 in stock they might very well have chosen to commence their sale. They had at the present time 54,000 lamps properly delivered, but notwithstanding this they had not even yet commenced the sale. Why should the defendants be made liable to pay damages to the plaintiffs when the latter had made a determination not to commence to sell until something like 60,000 lamps had been delivered? They never gave the defendants the slightest hint that they had come to this determination. As to the question of prejudice, there was nothing whatever in it. Of the "Queen" lamp, out of 4,000 no fewer than 3,700 were 16-candle-power lamps—that was to say, of the very type of which they kept over-delivering to the plaintiffs. That was, he submitted, a complete answer to the charge that the defendants were keeping back the competitor to the "Queen" lamp. He admitted that there had been delay, and the defendants were quite willing to behave reasonably to the plaintiffs on this account.

Mr. Justice MATHEW thought that the parties might give their counsel authority to settle the case on the basis of assessing what should be paid by the defendants to the plaintiffs in respect of the delay that had occurred in delivery, and he would then discuss the matter with them.

Mr. Bousfield and Mr. Moulton having got the requisite authority from their respective clients, retired to his Lordship's room to discuss the matter with him.

After a brief absence they returned into Court, when it was announced that it had been agreed that there should be judgment for the plaintiffs for £750 and costs.

SALMONY & COMPANY *v.* THE IMPROVED ELECTRIC GLOW LAMP COMPANY, LIMITED.

IN the Queen's Bench Division of the High Court of Justice on Friday, January 28th, the case of Salmony & Co. *v.* the Improved Electric Glow Lamp Company, Limited, came on for hearing before Mr. Justice Kennedy. Mr. Tindal Atkinson, Q.C., and Mr. F. Abrahams were counsel for plaintiffs, and Mr. Rufus Isaacs for the defendant company.

Mr. TINDAL ATKINSON said the action was brought to recover £287 15s. 1d., being balance due for the supply of electrical fittings and lamps. The defendants had paid £138 7s. 4d. into Court, leaving a balance due of £149 odd. There were no pleadings, and there were only two items in the plaintiffs' account, which was sent in to the defendants, in dispute. One was of £156 13s., and another an item of £67 14s. 2d. Those items related to the sale and delivery of certain holders to fix the glow lamps upon. There was a counter-claim. The defendants said that the goods were not delivered at the proper time, and that when they were delivered they were rejected by the defendants, but ultimately taken into their possession on the terms that they were to act as agents for their disposal. That plaintiffs emphatically denied. They said the goods were supplied within a reasonable time and were accepted. Although defendants demurred in the first instance, the goods were ultimately accepted, and they had used a quantity of them. The payment of £138 into Court, he understood, included payments in regard to the items he had last mentioned, and an item of £75 which defendants said was all that was due on a sale of £100 worth of goods, they having deducted 25 per cent. commission. Plaintiffs said that that was all moonshine, and that they never agreed for defendants to act as their agents in any shape or form. All the goods, in fact, had been ordered by them for themselves. Then there was a counter-claim to recover, as he understood, £700 under these circumstances. In 1895, his clients, who were electrical engineers in Charing Cross Street, had control of the agency for the sale of these silvered lamps. They were little electrical lamps which went into a fitting, and which were silvered on the top side so as to reflect and increase the amount of light. That was an agency for the United Kingdom and the colonies, and they were agents for a Mr. Schwarber, of Berlin, who he supposed was the inventor. The plaintiffs under that contract had effected some business, and among other contracts they had disposed of some of these lamps to a Mr. Brown, of Eastbourne, and Mr. McLeod, of Glasgow. The contracts with McLeod and Brown were really contracts of agency; that was to say, that these people had agreed to become the plaintiffs' agents for the disposal of the lamps, and they had also become personally liable to take from them a certain quantity of the lamps, and pay for them, and in addition act as agents in their particular districts. A person of the name of Fanta was the promoter of a particular syndicate which was purposing to take over the sale of these lamps in the United Kingdom, and also to acquire the patent rights. He could not carry out that unless he had been appointed agent, and in the latter part of April, 1895, Fanta negotiated for the transfer to the syndicate of the agency which the plaintiffs held. He was informed of the existence of the contracts with Brown and McLeod, and it was evident that it was intended by Mr. Fanta that he should have some considerable object in view to show that the persons whom he expected were to form the syndicate. The result of those negotiations was contained in an agreement, and it was under that agreement, and an assignment which followed, that the counter-claim was made. The company made an assignment of the contracts on December 16th, 1895. Counsel then went into particulars of the various contracts and their construction, and said that under them the company made various claims, one of which was, that plaintiff, was to take no less than 22,500 lamps from them, whereas he had only agreed to take 4,500. That he regarded as an attempt at imposition. One result of what took place was that Messrs. McLeod & Brown refused to be handed over to the syndicate. The parties met, and there was a long discussion and correspondence, which counsel read. It applied to the orders alleged to have been given and repudiated, and to the delay in the delivery of the various appliances which had to be manufactured in the interior of Germany, and shipped from Hamburg. He contended that all that his client's undertook to do was to have the things made and delivered as quickly as possible, and said it was a fact that 2,200 out of the 2,500 holders were received by the defendants in time to be used at the Jubilee. When plaintiffs sent in their invoices they were returned. Their books had been inspected, and there was no trace of any agency or commission accounts, nor any detecting as to goods not delivered according to contract. He suggested that there was really nothing either in the defence or counter-claim, and called Mr. Henry Max Salmony, the plaintiff; but before he gave his evidence he was recalled from the box, and a consultation took place between him and counsel on both sides with a view to arriving at a settlement. There was, however, no result, and plaintiff then gave evidence in support of his counsel's opening statement. He maintained, as had been admitted by the other side that he had fulfilled his part of the contract entered into, and that was the position he now took up. He and his firm did their best to get the goods delivered from Germany in time for the Jubilee, and many of them arrived soon enough to be so used. He had never admitted that the goods were late in delivery, or that he agreed to allow the defendants to retain them and sell them on a commission of 25 per cent. The usual condition of commission for such a transaction would have been 5 per cent.

The hearing was resumed on Monday, and judgment was given for plaintiffs on the counter-claim, and also on the claim, with costs.

CAWTE *v.* PENNY-IN-THE-SLOT ELECTRIC SYNDICATE.

THIS was a claim brought before the Taunton County Court by a Taunton electrical engineer for £14 for goods, and £25 for breach of warranty. Early last year the Electric Light Extension Syndicate made arrangements with him to do their free wiring at Taunton. After waiting a good time he found that the company, although obtaining orders there, was not carrying out the work, and when he communicated with the company he was informed that a new company would take over all responsibility and arrange with him. Mr. Cawte did certain work, and the Penny-in-the-Slot Syndicate communicated with him. For the defendants, it was claimed that the company had not taken over the Electric Light Syndicate, and had nothing to do with the plaintiff's claim. They had the option to take over, but did not do so. Mr. Bastian, managing director of the Electric Light Extension Syndicate and the Penny-in-the-Slot Syndicate, gave evidence, and said that the Extension Syndicate were prepared to admit the claim of £14 7s. for goods supplied. The claim was amended, and judgment given for the plaintiff for that amount, the question of damages falling through. Defendants' costs were refused.

SALMONY & CO. *v.* THEERMAN & CO.

IN the Westminster County Court, on Wednesday, the part-heard action by Messrs. Salmony & Co., against Messrs. Theerman & Co., electricians, of Manchester, was concluded. The claim was for £8 for a resistance, and the defendants stated that the article supplied was not of the dimensions ordered, and he was only willing to pay £3. The case had been adjourned for the attendance of a witness, Harris Rosenberg, who now gave evidence, that he was one of the plaintiffs, and after the delivery of the machine, he saw the defendant who said he was surprised at its elaborateness, and that it was delivered too late for his purpose, but he would keep it at £3. That he declined to do, and he arranged that he would take it back if he gave them large orders, but the traveller who took the order left them, and being a friend of defendant's, he cancelled all the orders. He only agreed to take it back upon future large orders being paid for, but the orders were all cancelled after the traveller left. The only orders which had been executed were small ones.

Cross-examined by Mr. WOOD: The order was to be from 45 to 50 amperes, not 45 only. Nothing was said as to price. Their catalogue was priced up to 30 amperes. The metal was all right; it was made of galvanised iron wire. If it had been made of silver wire and alloy, it would have been much smaller than this one, and lighter.

On behalf of the defendants, Mr. FREDERICK TAYLOR, a consulting electrical engineer, of 14, Victoria Street, S.W., said the machine could be made much smaller, and equally serviceable. The resistance would work, but was too large. About £3 to £3 10s. would be the price of a German silver or a platinoid one. He could not expect to get a machine like this from looking at the illustration in plaintiffs' catalogue, from which the order was given.

Cross-examined: Crompton's made resistances, but that was not their speciality. Defendant said he had since bought one of the same resistance for £3, and the weight was 2 qrs., whilst the weight of this one was 2 cwt.

For the plaintiffs, Mr. DUNCAN WATSON, A.I.E.E., said that the resistance was a reasonable one. It was a very substantial one.

His HONOUR, after a long and patient hearing, found for the plaintiffs, remarking that, it being an unusual size, the price was higher than was generally the case. He allowed £7 for it, with costs.

CORRESPONDENCE.

Refuse Destructors.

My attention was, a few weeks since, called to the discussion which has for some time occupied a considerable space in your valuable REVIEW, and I further note in your last week's issue that my name, in conjunction with Mr. Laws, of Newcastle, and Mr. Yabbacomb, of Bristol, was introduced by a writer who would like to know our opinion upon the destructor question as now before the public. I do not know, Mr. Editor, what the particular views of the gentlemen named may be with respect to making their opinions known; but I do not think I shall be far wrong when I say that, with the individual experience which we have in the working of the destructor, we neither of us care about entering into a public discussion, through the columns of the press, when the principal writers upon the subject at the present time are manufacturers or those who are interested in the sale of some particular form of furnace—every one, of course, claiming premier position for his particular pet; or may I add another class? I do so with much hesitation, and it is from your correspondence I arrive at the opinion: those who, perhaps too anxious to become great benefactors to their fellow ratepayers, and so earn their everlasting (parochial) gratitude, further some scheme, which may or may not succeed, become anxious about the success of their *protégé*, and, I may say, angry with those who appear, in all good faith, to differ from them.

Some five-and-twenty years ago we used to joke about the "golden dustman." But this gentleman has passed away. The place that knew him once—to wit, say, Paddington—knows him no more, and instead we have the "Golden Dust-bin"—sanitary, of course—in fact, to go through the correspondence which comes to hand daily through the favour of that invaluable institution of modern days, the Newspaper Cutting Agency, it would appear that, thanks to the inventive genius of our destructor makers, the "age of gold" has dawned upon us, and a veritable Klondyke is at our back doors.

So far as my individual opinion is concerned, I was under the impression that that was pretty well known, having erected the first destructor built in the South of England in 1882-3 (the second was Southampton in 1886). I at once utilised it as a steam producer, and have continued to do so up to the present time, and a most valuable adjunct to the sanitary appliance of Ealing it has been during all these years; dealing not only with the house refuse, but with the *sewage sludge* of a continually growing population, and that without the slightest difficulty or nuisance in any way. As is well known, the Ealing destructor is of the "Fryer," or low temperature type, assisted by my "Fume Cremator" of 1885, and which, notwithstanding Mr. Watson's criticism in the lecture at Gloucester, most certainly made the "destructor possible." These words are not my own, but were used by Mr. Laws in the paper he read at the International Congress of Hygiene (London) 1891, and I cannot help saying that it does strike me as somewhat strange that between the years 1885 and 1897 so little has been done by our engineering world in the way of supplying a really useful and economical apparatus for dealing with the question of house refuse. In making this remark I do not for one moment seek to depreciate the high temperature installation, nor suggest that Mr. Watson and others who are advocating their particular furnaces are acting other than in all good faith; on the contrary, I am free to confess that I am always deeply interested in the work being done, and particularly the statements which ever and again find publication from the pen of Mr. Watson, but nothing that I have yet heard, seen, or read has led me to change my opinion that for general use the inexpensive low temperature destructor, such as the "Fryer" of Manlove & Co., or the "Perfectus" of Goddard, Massey, and Warner, are other than the most suitable.

One of your correspondents refers to the statistics in my book on "Refuse Destruction," 1894, making particular reference to Table A., "Towns of England," where, out of a number of towns given as 1,005, 863 were under 25,000 inhabitants, and probably a very large proportion of these have no call for "power," although they may make a valuable asset of a well-burnt clinker and the ash from the hearth for building purposes. No doubt the view I take of them as a municipal officer is primarily the necessity for getting rid of a universal nuisance (house refuse) in a simple and efficient manner; the question of profit is a secondary one, and from this point of view, in my humble opinion, the low temperature furnace is the most likely to accomplish the object and meet the necessities of not the large towns, maybe, such as Leeds, Oldham, and similar centres of very large population, but of the towns which, comparatively insignificant when compared with the above, still just as much require the application of fire to deal with their sanitary nuisances.

Reference has, I know, been made again and again, in the general discussion of this question, to the supposed failure of the Edinburgh destructor. It may appear somewhat venturesome to state that, in my opinion, the Edinburgh destructor was not a failure, and this I do notwithstanding the fact that the Horsfall Company was called in to alter it. I visited Edinburgh twice, at the request of the Corporation, and from exhaustive examination I came to the conclusion that the fault was not in the destructor, but in the mode of working it. A guarantee had been given to destroy a certain number of tons per 24 hours, and the quantity was got through, with the result that the residue was not good hard burnt clinker, but a soft three parts burnt material, certainly unsatisfactory in its result. The experience of Mr. Yabbacomb at Bristol was very much the same; in his paper read at the meeting of the Municipal and County Engineers, September, 1896, referring to the work of the destructor ("Fryers") he says: "That by working all seven days, the amount specified in the contract with the manufacturers could be just reached; but the clinker was of a soft inferior character, through the fires being drawn too rapidly." Subsequently Mr. Yabbacomb applied a steam blast, with the result, a higher temperature, an increased consumption of refuse, $7\frac{1}{3}$ tons per 24 hours, together with an improved clinker, a conclusion I consider in every way satisfactory, and going to prove that, with careful working, an every-day result of a most satisfactory character may be obtained from the comparatively inexpensive low temperature furnace of the "Fryer" class, even when worked in the most moderate "work-a-day" mode.

I am quite aware that from the contractor's and patentee's point of view the low temperature furnace, even when a fan is added, is not a success; there is no special profit to be made out of these, and no patent fees; anyone is at liberty to build them, and for a few hundred pounds an installation equal to the ordinary necessities of a small town population can be erected; in making these remarks, I would again repeat that I am dealing with the smaller towns, and not with the large centres of population. At the same time, having erected the majority of our cells at Ealing without a contract and with our own men, I know the exact cost of construction.

With respect to the Shoreditch destructor, or "universal utiliser," as it has been termed, I can only say that I am content to wait; there is an old saying that "It is never safe to prophecy unless you know," and I cannot help thinking that very much of the feeling engendered in the minds of the Shoreditch chairman and others, has just been the result of "premature prophecy." So far as "thermal storage" is concerned, there is nothing particularly new about that; but its application to destructor purposes is new and interesting. To me, personally, I may say it is especially interesting from the fact that some years since Manlove, Alliott & Co., called my attention to the scheme, and I went into the matter with a view to its application at Ealing, but upon full consideration of the cost to be incurred, with the probable results, I came to the conclusion, to use a common phrase, that the "game was not worth the candle;" but in all fairness let me say that a scheme which might not be suitable for Ealing with its then 25,000 population, might develop results quite different in a district like Shoreditch with its 124,000. Should it succeed I shall be the first to "take off my hat," and acknowledge its merits, indeed, I think I may say that I will do so if it only accomplishes *one half* of the prediction made in its favour at its birth. I do not mean at the banquet, Mr. Editor, that would hardly be fair, you know, but rather between the times when the good Vicar of Shoreditch "read an appropriate dedicatory prayer," and the hour when "the light of other days" was turned down, and amidst the hearty applause of the company the chairman switched on the "light of the future." I am copying from printed account of proceedings.

I have no doubt that ere long a clear and exhaustive account will be forthcoming, showing the Dr. and Cr. state of the whole affair. I should have concluded this somewhat lengthy letter at this point, but for the fact that the morning post brought me in unmistakable print the announcement of another wonderful discovery in the destructor world. *London* informs me and all its readers that "Leyton is again distinguishing itself." In large letters we are informed that "The First Sludge Destructor" has been erected: "A Difficult Problem Solved by the Leyton District Council—A Combined System for Destroying Sewage Sludge as Well as House Refuse," and further, that the council has "proved that the sludge can be burned like ordinary house refuse," and further, that "on the advice of the surveyor, Mr. Wm. Dawson, the District Council made the first attempt *ever tried*, and the result of 15 months' working is sufficient to justify some show of pride." *London Argus* contributes similar information. I read these extracts at first with some amusement, it looked like a monstrous joke on the part of the surveyor to the Leyton District Council, but I took up another cutting and found that Sir Douglas Fox and Francis Fox had reported as follows: "So far as *we* are aware, it is the only form of furnace yet adopted, capable of burning a considerable portion of sewage sludge even when containing as in this case, a high percentage of moisture," and after reading this, I could not but feel ashamed for any professional man, shall I say brother municipal officer, who could allow such absolutely misleading and erroneous statements to go forth to the public, and I am sure that the same feeling will fill the minds of one-half of the municipal engineers of England, when they read them. I was under the impression that I had been burning the sewage sludge of Ealing with the house refuse, ever since 1883, and that most of the municipal engineers of England knew it, I thought that the Ealing works, visited by hundreds of visitors from not only England but from all parts of the world, had one speciality, viz., *burning the sewage sludge*. I was under the impression that the late eminent scientist, Dr. Meymott Tidy, in a lecture at the Society of Arts, April, 1886, said: "To my mind the destructor has reached its highest state of perfection at Ealing from the great thought the surveyor, Mr. Jones, has given to it. The sludge is there mixed with house refuse and burnt. Mr. Jones's view is that every town produces sufficient house refuse to burn the sludge." I thought that in the discussion that ensued upon the reading of Mr. Dibdin's paper on "Disposal of Sewage Sludge," before the Institution of Civil Engineers, as long ago as 1886, the subject of sludge burning was well threshed out, and stranger still, I was under the impression that the surveyor of Leyton—a member of the Incorporated Association of Municipal and County Engineers, of which I have the honour of being a past president—knew the Ealing works well, with all their specialities. All the above only goes to prove how strangely one may be mistaken.

I have upon my recollection the fact that *London*, to which I have referred, among the other items of interest respecting Ealing, says (April, 1895): "It (Ealing) discovered that the proper treatment of its dust and sewage not only gave health advantages such as no neighbouring area possesses, but placed at its disposal what might be called advantages for securing other advantages. *The collected refuse, which is mixed with the sewage sludge and consumed in the destructor cells, and the fume cremators produce tremendous heat, a portion of which had already been used to raise steam for driving the engine of the sewage works, &c.*"

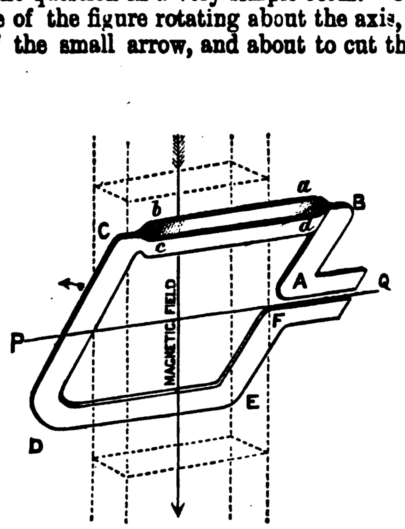
Mr. Editor, I had no intention of so extending my remarks, and I have omitted to touch upon many interesting details, as to residuum, cost, &c.; but reading at the last minute the details concerning Leyton, has led me into a somewhat extensive communication, for which I must apologise.

Charles Jones, M.I.C.E., F.S.I.

Ealing.

Mr. Alfred Still, in your issue of last week, observed that I, not understanding how it is that a buried conductor is free from eddy current heating, had "missed the point." This is perfectly true, and my desire to find it was largely my reason for stating so precisely the mechanism of the action of a slot-wound conductor. But Mr. Still does not assist matters by repeating an unsatisfactory explanation. He says, "surely we are right in assuming that, for a given E.M.F. generated" (I presume in the main dynamo circuit), "the eddy current loss in a conductor depends upon the time which it takes in passing into or out of the uniform magnetic field under the poles." I think we certainly are justified in the assumption, but if the conductor is moved faster into the field the eddy current loss is thereby increased, not diminished. Again, "the explanation given being that whereas in a smooth core armature the conductors enter and leave the magnetic field gradually, taking an appreciable time to do so; in the case of a slotted armature the lines snap across the conductor so quickly that the eddy current losses are necessarily very considerably reduced." He disclaims the form of expression of this explanation, but appears to accept the sense of it. If I understand what is meant, it is certainly wrong. The heat developed in a mass of metal carried across a single line of force, or isolated group of lines, is proportional to the speed, and the quicker it is carried the more it will be heated.

At the risk of again incurring Mr. Still's contempt, I will try to put the question in a very simple form. Consider the metal frame of the figure rotating about the axis, P Q, in the direction of the small arrow, and about to cut the magnetic



field shown by the dotted lines. Current will be generated in the circuit, *a b c d*, analogous to the eddy currents in an armature bar, while current generated in the frame, A B C D E F, is analogous to the main dynamo circuit. The electromotive force in the dynamo circuit due to the movement of the compound bar, B C, is the mean of the forces generated along *a b* and *d c*; and the electromotive force in the circuit, *a b c d*, is the difference of the forces along *a b* and *d c*. For the discussion of eddy currents suppose the main circuit to be open, and consider the passage of the closed circuit, *a b c d*, across the field. If *n* lines of force are threaded through a closed circuit at an uniform rate in a time, *t*, the heat developed is proportional to $\frac{n^2}{t}$, and increases with the speed. In a slot wound armature the bars never enter a strong field at all, and *n* is exceedingly small.

On the other hand, it is not necessarily the case that the bars pass from the interpolar space into the maximum or uniform field more quickly in a slot wound than a surface wound armature. If the two revolve at the same speed, and in fields of the same form, the time occupied in passing into the field will be the same. But in a slot wound armature the gap between the iron surfaces is less than in a surface wound armature, the fringing is less, the bar enters the field more suddenly, and the heating is to that extent increased.

Mr. Still's explanation appears to me to show that slot wound conductors should heat more than surface wound conductors.

The solution of the difficulty lies clearly in the small intensity of the maximum field, not in the rate of speed at which the bars enter that field.

As to my paradox. Mr. Still's case is not parallel at all. A dynamo when running is a seat of electromotive force, not necessarily a source of current; and our conception of its action is not dependent on its always producing current. A magnet, on the other hand, is not a seat of magnetic force, but a source of magnetic flux, and we have no conception of its existence other than as giving rise to magnetic flux. The question is this: Place a permanent magnet, *i.e.*, a body whose sole property, in so far as it differs from a piece of hard steel, is that it is a source of flux, in a position where no flux is possible. What happens? The consideration of a dynamo running, but not generating current, does not bear on the point.

W. A. Price.

Is an Electric Traction Engine Subjected to Shocks, or is it Not?—Raworth v. Emery.

In your issue of October 29th, 1897, you published a letter of mine criticising Dr. Emery's article on "Engines for Electric Railway Power Stations," which appeared in the *Street Railway Journal* of the same month.

With this letter of mine the *Street Railway Journal* was deeply grieved, and in its December number devoted more than a column to the expression of its sorrow that an English engineer should have chosen to write in an ill-natured way about a purely technical subject, and should have attempted to arouse personal or international prejudices.

Of course, nothing was further from my mind, for some of my best friends engaged in the engine trade are Americans, and I regret as much as the *Street Railway Journal* that my letter was open to any such interpretation, and especially do I regret now that we are informed that Dr. Emery is an international authority on the steam engine, that I took the liberty of criticising his literary peculiarities; and I feel sure Dr. Emery, with the usual breadth of mind of an engineer, has already forgiven me.

Dr. Emery has written a letter, in which he endeavours to defend his position, and to destroy mine; I, therefore, propose to submit his arguments to the judgment of your readers.

The original article stated, concerning an engine for electric traction: "Its entire construction must be proportioned to the racking due to continued repetition of shocks," to which I replied: "This oft repeated fallacy would be amusing, were it not for the fact it is too often believed, and worse still, acted upon, whilst all the time the fact remains that *there are no shocks and no excessive strains*."

Now for Dr. Emery's arguments:—

First, he says I "must know that if a dynamo directly connected to an engine be short-circuited, its speed is naturally checked by a load applied with lightning rapidity. Necessarily the fly-wheel tends to twist the engine shaft, and all the moving parts are brought up with a shock, instead of being changed in direction smoothly by a crank motion."

I am sorry to say that the doctor presumes too much on my knowledge. I certainly do not know "that a short circuit tends to twist the engine shaft," although I am quite willing to admit that it tends to twist the dynamo shaft and the coupling.

Further, I do not know "that all the moving parts are brought up with a shock instead of being changed in direction smoothly by a crank motion." No short circuit ever did or ever will bring up an engine in less than half a revolution.

I hope this statement is quite clear. I do not wish to take refuge behind any ambiguities.

Dr. Emery then proceeds with his second argument:

"Again, in releasing a load suddenly, the elasticity of the parts and their weight also produce shocks, as every piece of metal transmitting the load is, within certain limits, a spring."

When the Doctor penned this sentence he evidently forgot that the throwing off of the electrical load does not open the exhaust valve of the engine, and that, therefore, the parts continue under the stress of the steam pressure until the end of the stroke, when they are "smoothly changed in direction by a crank motion."

The above are all the arguments Dr. Emery adduces which are applicable to English electric lighting or traction engines. He concludes, however, with one which applies to some American engines, though not to those which have been sent to this country:—

"Again, if there be any side strains due to overhanging cranks not balanced in one bedplate, the amplitude of the lateral movements caused thereby will be proportioned to the time in which the maximum force is applied; that is, they will be greater for heavy loads than for light ones."

Here again the Doctor is wrong.

It would be a very bad engine that moved laterally $\frac{1}{16}$th of an inch; therefore, with a cut-off of even $\frac{1}{10}$th, there is ample time for the full movement to occur, and, as a matter of fact, anyone with eyes may see the result for himself; at every stroke, on the opening of the admission valve, the cylinder goes over with a snap, there is no appreciable time element.

It is rather unfortunate for the other side that they have got such an honest advocate as Dr. Emery, who has tried to rake up every plausible looking argument in support of their theory, for we now know the nakedness of the land; we also know that the lean kine are eager to eat up the fat kine, and they will do it if we do not bestir ourselves.

The *Street Railway Journal*, in its backing up of its contributor, goes one better than Dr. Emery. It says:—

"It was no unfrequent occurrence to see an engine brought up standing by a heavy load suddenly thrown on with the starting of a number of cars."

Now, what does the phrase "brought up standing" mean? Most electricians are aware that, as the speed falls, the volts fall also, and that the engine will still run at a reduced speed. If the *S.R.J.* means to convey the impression that the engine stops dead, then I say it has been dreaming, if on the other hand it simply desires to indicate that the engine was too small for its job, why does it not reproduce Mr. Philip Dawson's paper for the education of its readers?

John S. Raworth.

Electro-Motors and Fire Office Rules.

The latest rules issued by the Fire Office Committee, a representative and executive body, imposes restrictions upon the construction of electro-motors which, if not modified, will seriously interfere with their use. In fact, the new rules seem to favour one type of electro-motor to the degree of being a broad advertisement for it.

The rule in question enjoins that a "fireproof case which shall form part of the designed construction of the motor itself, and not be an added movable covering," shall in all cases be used. Electro-motors enclosed by a case forming part of the stator are necessarily hampered in construction and of less efficiency than those of ordinary make. It is fair to suppose that the Fire Committee have in view the extreme inflammability of minute particles, especially of organic matter, such, for instance, as flour dust. In a well constructed and carefully tended motor, the ordinary sparking is not sufficient to ignite such particles, and in the case of a short circuit the motor would come to rest long before any part of the burnt-out insulation could be spread by centrifugal force.

Again, in applying electro-motors to the direct driving of machines of small power, the enclosure of the whole in a case not only renders the mechanism more subject to derangement, because a single fault is not observed at the time of occurrence, but also conduces to excessive heating by checking natural ventilation. This is most important in the case of intermittent loads as a free current of air tends to keep the varying temperature within a certain safe limit. A movable box with mica lights may be used in certain cases to enclose the commutator, but in the event of excessive sparking, this method is more dangerous than the ordinary open working, since the confined space would, after some time become filled with infinitely finely-divided metallic particles, the natural result of attrition, finally causing a revolving arc to be formed, quickly destroying the motor, and probably causing a destructive fire.

As small electro-motors are favourably received by manufacturers and the public generally wherever an electric service obtains, it is a pity that the electrical trade should be checked in this direction by the introduction of rules which may be modified without increasing the fire risks.

The Fire Committee, as a representative body so far as the fire offices are alone concerned, do not represent the public, or the electrical trade, and evidently require technical assistance when making their rules.

Fredk. Walker.

February 2nd, 1898.

BUSINESS NOTICES, &c.

Bankruptcy Proceedings.—A receiving order was made last Tuesday, at the London Bankruptcy Court, against John Dewhurst, electrician, &c., 52, North End Road, West Kensington. The debtor presented his own petition, and an order of adjudication was also made by the Registrar. No particulars transpired regarding assets or liabilities.

Electrical Work in Natal.—We understand that Messrs. Mowat & Still, of Pietermaritzburg, Natal, in view of the amount of electrical work now coming on in that city, have opened a branch in their extensive business for electrical engineering, under the management and advice of Mr. Oswald R. Swete, A.I.E.E. (vice-president of the S.A.Soc.E.E.). We understand that the firm are open to receive the latest catalogues of electrical fittings and other appliances.

For Sale.—In an "Official Notice," will be found particulars of two sets of secondhand electric lighting plants, which are offered for sale by the City Electrical Engineer at Liverpool. The plants are suitable for a large and small private house respectively.

Messrs. Montagu Kent & Co., will on the 10th inst., sell by auction, various electric light plants, dynamos, boilers, steam and gas engines, shafting, lathe, planing machines, one electric and three steam launches, at Strand-on-the-Green, Chiswick. See our "Official Notices."

Hospital Lighting.—The Metropolitan Asylums Board have decided on the recommendation of the Northern Hospital Committee to engage an engineer, or a firm of engineers, to prepare a scheme for lighting the hospital, and to draw up specifications, plans, &c. Messrs. Burstall & Monkhouse have already reported upon the cost of electric lighting plant, which they estimate at about £10,350.

Liquidation Notices.—An account of the winding up of the Guattari Power Syndicate will be placed before the shareholders by Mr. A. J. Bale, liquidator, at a meeting to be held at 120 and 122, Newgate Street, E.C., on Tuesday, March 1st, at 2 o'clock.

At meetings of the National Company for the Distribution of Electricity by Secondary Generators, held January 11th and 28th respectively at 2, Warwick Street, Regent Street, W., resolutions were passed winding up voluntarily, and appointing Mr. J. H. Thornton, of Winchester House, E.C., liquidator.

The Affairs of an Electrical Company.—On Wednesday, before Mr. Justice Wright, sitting as an additional judge of the Chancery Division, among the winding-up petitions which appeared in the list was one in the name of Mr. H. O. Ruelle, relating to the National Company for the Distribution of Electricity by Secondary Generators, Limited. On the case being reached, Mr. Rowton said this was a creditor's petition. The matters at issue between the company and the petitioner were the subject of litigation before Mr. Justice Stirling. They were before him on last Saturday week, and on an intimation from his Lordship, certain terms were then arranged, which included that the petitioner should adjourn the hearing of the present petition. He had, therefore, to ask that the matter should stand over generally, with liberty to apply for it to be restored to the list. His Lordship granted the application.

The Electrical Metal Working Syndicate, Limited.—We are informed that Messrs. Scott Anderson & Beit, of Royal Insurance Buildings, Sheffield, have been appointed sole agents for the Voltex process of electric welding, brazing, &c., for the following counties:—Yorkshire (south of a line through Whitby, Northallerton and Richmond to Kirkby Stephen), together with the entire counties of Lancashire, Nottingham, Derbyshire, Staffordshire, Cheshire, Worcestershire and Warwickshire.

Water Power on Tender.—The chief Engineer for Irrigation, Madras, is inviting tenders, by order of the Secretary of State for India, until July 1st, 1898, for the utilisation of water power of the Periyar Lake.

ELECTRIC LIGHTING NOTES.

Bath.—The bill for the quarter's public electric lighting amounted to £516, and when this was before the Surveying Committee last week Alderman Sturges drew attention to the deduction of £27 for 108 failures at 5s. This he said did not mean that there had been 108 distinct failures in the lamps, but that on one occasion through a fault in the machinery a whole line of lamps went out. Was it a righteous thing, he asked, to deduct for 108 failures under those circumstances? The bill was passed without the deduction.

Bedford.—Consumers are agitating for reduced charges for current and lower meter rentals. The Electric Light Committee is to report on the desirability of constructing a refuse destructor at the supply works.

Birkenhead.—The Electrical Committee submitted to the Council, on Wednesday, a report dealing with their department. This report states that in February, 1894, the Council appointed Mr. James N. Shoolbred, M.I.C.E., as electrical engineer and adviser, and the supply of electrical energy commenced in September, 1896. Since, the undertaking has proceeded somewhat slowly, but on the whole satisfactorily. An index of the progress is afforded by a table showing the number of consumers during the quarter ending December 25th, 1896, and the quarter ending December 25th, 1897, the figures being—Consumers, 66; and current in units, 23,543, during the latter quarter, as compared with 23 and 6,635, the figures for the first quarter of the undertaking. A sub-committee has considered the constitution of the present electrical staff and the possibilities of the more rapid development of the undertaking, and the supply of energy for power as well as lighting, especially in connection with the working of tramways, and the result of their consideration is a recommendation to dispense with the services of the consulting engineer on the completion of the various contracts under his supervision, and to appoint a resident electrical engineer, at £300 per annum, to direct the further development of the electrical supply.

Birmingham.—In a recent report the Gas Committee make some remarks regarding the past and prospective effect of electricity supply upon the gas consumption. They consider that there is nothing to suggest that "it will not be necessary" to extend the gas works in order to meet the demand. The total sale of electricity in Birmingham, in 1896, is given at "not more than equivalent to a sale of 60,000,000 cubic feet of gas as ordinarily used for lighting purposes. This would not, even if it had all been used in substitution for gas, displace plant for the production of more than 350,000 cubic feet of gas per diem. The electric lighting of the Market Hall has only diminished the consumption of gas registered in that building from 8,600,000 to 6,900,000 cubic feet per annum. The greatest daily output of gas in Birmingham in 1896 was over 33,000,000 cubic feet, and the total sale in the year was 4,859 million cubic feet. The effect of the competition in Market Hall Ward, where electricity has met with the largest sale, shows a slight decrease in the sale of gas for 1896, as compared with 1892, but an increase in 1897 over 1896 of 3·6 per cent. in the central area, and 13·6 in the rest of the ward. In other large towns and cities where electricity has made progress, an increase has taken place in the gas wanted, this being shown by figures."

Blackpool.—The need for extending the Corporation electric lighting system was before the General Purposes Committee last week. It was stated that the present plant was all taken up. They had no reserve, and the committee could not undertake to supply any more customers, although they had many large applications, including the new Alhambra, the Hotel Metropole, and the arc lighting of several more streets in the town. It was proposed to spend another £40,000, and to put down a new engine of great capacity. Several of the members complained that sufficient time had not been given to carefully consider the matter and the electrical engineer's suggestions. The Committee approved of the expenditure. It was stated that the necessary machinery had been provisionally secured, as engineering firms would not undertake to fulfil further orders in less than two years.

The Town Council on Tuesday adopted the proposed scheme for the extension of the electricity works at a cost of £40,000. Application is to be made to the Local Government Board.

Bradford.—The shops and warehouses comprising Borough Mills, Manchester Road, are now supplied with the electric light from a special plant which has just been put down. There are about 30 tenants on the premises, and provision is made for about 1,000 16-C.P. lamps. The installation, which was put in by Messrs. A. J. Harris & Co., comprises two dynamos, each to supply 350 lamps, and 55 Epstein cells, for 400 lamps. It seems that a company works the concern, each consumer taking a share in it, so that the cost should be very low. The cells are charged by a motor transformer during the day.

Bristol.—A Local Government Board inquiry was held on Tuesday into the application for a £23,000 loan for the extension of street lighting in the city. It was asked that the sanction should be given as speedily as possible, as it is desired to push on with the scheme.

Burnley.—A Local Government Board inquiry was held last week *re* an application by the Corporation to borrow £25,000 for electric lighting. The Town Clerk said that four years ago the electric lighting installation was started, and the loans already sanctioned amounted to £29,756. With the additional borrowing powers they would be able to extend the plant and the mains into the out-districts of the borough.

Cardiff.—A Local Government Board inquiry has been held into the Council's application for a £29,500 loan for electric lighting. Mr. Applebee, the electrical engineer, showed the progress of the undertaking, for which £59,835 had been borrowed, and he explained the extension proposals.

Colombo.—The Indian papers give particulars of the proposal of Messrs. Boustead Bros., which has been accepted by the Colombo Municipal Council, for the electric lighting of Colombo. The firm will replace 548 gas lamps by 548 60-C.P. incandescent electrics, erecting lamp-posts, overhead mains and feeders, &c., &c., for Rs.25,000 (or Rs. 45·62 per lamp), or an annual payment of Rs.2,250. Current will be supplied to the lamps at the rate of 200 hours per month including renewals, maintenance, &c., &c., for Rs.30,000 per annum, which is about 15 cents per unit, or Rs.54·74 per lamp per year. The contract is for five years, after which the municipality can take over the street installation at a valuation. Private consumers will be charged not more than 50 cents per unit (7¾d.). The engineers have a sly dig at the City of London Electric Lighting Company, for they add "In the City of London a company has the monopoly of supplying current at 8d. per Board of Trade unit." Yet even at Colombo it can be profitably done for ¼d. less!

Crieff.—Mr. Yorke's proposals *re* electric lighting were again before the Town Council last week, and there was a discussion on various points, but the matter was delayed until a conference between that gentleman and the Council could be arranged for obtaining further information.

Darfield.—A special meeting of the District Council will be held on March 4th, to decide whether to apply for an electric lighting provisional order.

Dundee.—Panmure Street Congregational Church has been lighted by electricity, the congregation subscribing the money.

Edinburgh.—The street lighting extensions, to which we referred last week, have been agreed to by the Town Council.

Edmonton.—The Board of Guardians' Works Committee is to report on the advisability of supplying the electric light to the Edmonton House and Chase Farm Schools.

Exeter.—In a report to the City Council a Committee state that they have no data on which to estimate the cost of electrically lighting the main streets, but inasmuch as part of the first cost of arc lamps and posts would have to be paid, and the positions of some of the lamps were to be changed, they had allowed for an increased estimated expenditure of £400.

The electric lighting undertaking is going on satisfactorily. The number of lamps has increased from 7,400 to 10,000, and orders are coming in faster than they can be supplied.

Finchley.—Up to the present the Council has refused to support any electric lighting scheme, but they have now informed a correspondent that they will give careful consideration to any proposal he may make.

Hull.—The electrical engineer, Mr. Barnard, has submitted the following estimate of income and expenditure during 1898:—Expenditure: Generation of current, £3,100; distribution of current, £350; repairs, renewals, and maintenance, £1,100; management expenses, £1,175; insurances, £150; rents, rates and taxes, £950; interest on capital, £1,985; payments to sinking fund, £1,470; balance, being profit, £970; total, £11,250. Income: Sale of electricity, £10,830; meter rates, £420; total, £11,250.

Ilford.—The Council is to approach the Great Eastern Railway Company with a view to the purchase of a piece of land adjoining Sylvan Road for an electricity works site.

Kendal.—In December the Council decided to communicate with experts in gas and electric lighting matters on the lighting question, but as nothing has been done there is a feeling that there has been unnecessary delay on the part of the Gas and Water Committee. At the last Council meeting it leaked out that the electric lighting matter had lapsed through inadvertence. Letters had been received from experts, but had been misplaced and could not be found. The Town Clerk is communicating with the experts again.

Leamington.—The Midland Electric Lighting Company, Birmingham, are stated to have unconditionally withdrawn their Bill for power to light the Borough by electricity. Some time ago the Corporation commenced the promotion of a Bill on similar lines, and it is now stated that the Midland Electric Lighting Company have withdrawn in order that they may be the better enabled to oppose the Corporation scheme. The company have large works in Wise Street, but up to now the demand for electricity has not been by any means equal to the supply. It is stated that the cheap rate at which gas is supplied has militated against a general adoption of electricity in the Borough.

London, E.C.—The Court of Common Council has referred it to the Streets' Committee to consider and report forthwith as to the desirability of applying to the Board of Trade for an electric lighting order to enable the Corporation to supply electric light within the City from a station to be established by themselves or otherwise; and also to report as to the practicability of generating electricity from steam raised by burning the City's refuse in specially constructed furnaces in such proposed electric light station.

Merthyr Tydfil.—The Board of Trade has revoked the 1896 electric lighting order, as and from January 24th, 1898.

Penzance.—The Municipal Electric Supply Company has laid a scheme for lighting the town before the Council. The idea is for the undertaking to be "substantially municipal," the entire responsibility of capital expenditure resting on the company until the Council takes it over. The same system as employed at Brighton is suggested. Referred to the Lighting Committee.

Peterborough.—The Board of Trade has sent to the Council for any observations which they may wish to offer, a description of the system in the form in which the Board propose to approve it, subject to their regulations for securing the safety of the public, and for ensuring a proper and efficient supply of energy. The system to be adopted is described as follows: For general purposes. A continuous current direct supply at constant pressure, and the three-wire system, the mains being partly continuously insulated cables drawn into iron pipes or earthenware conduits, and partly bare copper conductors laid in earthenware or concrete conduits. The Lighting Committee has adopted the Board's suggestions. The application of the Peterborough Electric Light and Power Company for a provisional order is being opposed.

The Local Government Board inquiry will be held on Tuesday, February 8th, regarding the £15,000 loan. This is the second inquiry.

Shoreditch.—At the Vestry on Tuesday last Mr. H. E Kershaw, Chairman of the Electric Lighting Committee stated:—"That owing to the unprecedented success of the Vestry's efforts in the combined scheme of the generation of electricity from the steam supplied by the dust destructor, the Committee recommend the Vestry to reduce the charge for electricity from 6d. per unit for the first two hours and 4d. per unit for the surplus, to 6d. per unit for the first hour and a half and 2d. per unit afterwards. This will work out to consumers of electricity using the light for three hours per day at 4d. per unit, four hours per day at 3½d. per unit, six hours per day at 3d. and so on reducing the cost in proportion to the number of hours the light is in use. This, I believe, is a record in municipal electric light undertakings. After existing for six months only, we are supplying electricity, within a little, as cheaply as any municipal installation in the country. During the past quarter we have sold 95,000 units of electricity, and the engineer's estimate for the current quarter is 150,000 units. The Committee feel extremely gratified that their efforts have been attended with such marked success, fully justifying what has been repeatedly termed a most expensive and dangerous experiment, and for the benefit of the many municipalities who are watching this scheme, though we do not feel called upon to issue our statistics until the end of the first financial year (June 30th) we are satisfied that our expectations will be more than realised, and the success of the joint scheme most *thoroughly established*." After discussion the Vestry resolved to defer the Committee's recommendations till after the financial year's statement in March.

St. Albans.—The Herts County Council will oppose the St. Albans Electric Lighting Order, 1898.

Ventnor.—Plans for the electric light station in Newport Road have been passed by the Council.

Walsall.—A Local Government Board inquiry was held on 28th inst. into the Corporation's application for borrowing certain monies, including £7,000 for electric lighting. The Town Clerk, referring to the growth of the electricity undertaking, said that in 1896 there were lamps of 5,704 C.P. connected, but in 1897 there was the equivalent of 8,195 C.P. The increased demand necessitates an increase in the size of the engine room, and to put in one 250-H.P. engine and a dynamo. There will also be two additional transformer stations, mains, &c., and the present capacity will be doubled.

Watford.—In February, 1894, the Local Board gave Mr. F. Downer permission to carry an electric wire from his etching rooms to his private residence. It is understood that Mr. Downer is supplying a neighbour with current, and the Electric Lighting Committee now recommends that he be requested to give an undertaking that he will limit the supply of electric light to his own premises as soon as the Council is prepared to supply the light.

West Hartlepool.—A site has been secured for the electricity works, in the vicinity of the paper works. The low tension continuous current system has been adopted.

Westgate-on-Sea.—The application of the Isle of Thanet authorities for an electric lighting order is being strongly opposed as regards Westgate-on-Sea.

Wigan.—Before proceeding with the electric lighting scheme, the ratepayers within the proposed area are to be canvassed.

Willesden.—The application of an Electric Lighting Committee for a provisional order is opposed by the Council.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Argentine.—The rumour that appeared in some of the London papers to the effect that the directors of the Anglo-Argentine Tramway Company were contemplating the adoption of electric traction, is contradicted by the *Review of the River Plate*, though that journal considers the company will have to move in that direction before many years have passed, or lose their traffic.

Bradford.—On Wednesday the Tramway Committee met to deal with tenders for rails, paving, electric wires, cars and car-sheds and all the other appliances needed for the electric tramways.

Bristol.—On 26th ult., the Bristol Tramways and Carriage Company's Parliamentary Bill authorising the use of electrical power was laid before the shareholders, and unanimously approved. Correspondence which had passed between the Council and the company respecting the former body's proposal to purchase the undertaking was read. Mr. G. H. Low, the chairman, in going into the matter of electric traction and the advisability of employing such on the proposed extensions, said that several of the contemplated extensions were to traverse roads which were so steep as to make them practically inaccessible for horse tramways, but with electricity they could deal with districts hitherto unprovided for. He referred to the company's relations with the Corporation in 1896, *re* the supply of electric power for the tramways, since which date the gentlemen who took a prominent part in endeavouring to force their supply of current upon the company, had been assuring the ratepayers that come what may they must have electric traction. On the point of the overhead trolley system being the most practicable form, there was no difference of opinion between the company and a majority of the Council. The company was not seeking to enter into competition with the Corporation, but, he proceeded, "we, having an established business, are simply asking for authority to carry on our business and for the purposes of running the remainder of our cars by electricity, to generate and apply our own electricity, as we are already doing in connection with the working of seven or eight miles of tramway within the city of Bristol. We are at the present moment generating for our own purposes at a station within the city and county of Bristol more electrical current than the Corporation turn out for the whole of their customers and their street lighting, and we have the plant there already installed to enable us to make a much larger output. In addition, we were only last session authorised by Parliament to convert our extensive depôt at Eastville into a generating station, and we propose to acquire waterside premises at Counterslip also for the purposes of a power station. I do not believe for one moment that a Parliamentary Committee will prevent the citizens of Bristol from securing the advantages of electric traction over the present horse lines simply because another trading concern, namely, the Corporation of Bristol as owners of lighting works, put forth a plea that we should be forced to bolster up their undertaking as a condition to this improved form of traction being given to the public. So far as your directors are concerned, they are as determined as ever in their intention to resist to the uttermost such an attempted interference in the company's business, and no circumstances have occurred since our original decision on this point to weaken us in the slightest degree, but rather to the contrary." Regarding the purchase question, he remarked that the right of purchase by the Corporation arises in connection with the horse lines about 15 years hence, though as to the main portions of the electric lines there is no right for 21 years.

Crewe Light Railway.—The Cheshire County Council and the Crewe Town Council appeared in opposition to certain of the clauses proposed by the British Traction Company in this Bill. The company, however, practically carried their scheme.

Dover.—The electric trams continue to be well patronised. During the week ended January 22nd, 25,890 passengers were carried, and a daily average of £17 19s. 7d. taken in fares. The total fares since the opening has been £2,265.

Electric Power Distribution Scheme.—Last Friday Mr. Devonshire (representing the British Thomson-Houston Company as chief engineer) addressed a number of manufacturers at the Swan Hotel, Mansfield, with respect to the proposed electric power scheme. He gave no quotations or terms for power at present, but could promise that it would be cheaper than steam.

Hastings.—Councillor J. J. Boutwood has been lecturing on "Electric Tramways" here, and his lecture was repeated at the Market Hall, on Wednesday, by request.

Hull.—We understand that, owing to the open specification, there was an enormous divergence in the tenders submitted for the electrical equipment of the Corporation tramways. The power quoted for varied from 466 kilowatts to 1,500 ditto; and the prices, of course, varied in a corresponding degree. Tenders were received from the following firms, viz., Mr. R. W. Blackwell; British Thomson-Houston Company, Limited; Brush Electrical Engineering Company, Limited; Crompton & Co., Limited; Electric Construction Company; John Fowler & Co. and Greenwood & Batley (joint); Laing, Wharton and Down; Lowdon Bros.; Mather & Platt; Thos. Parker, Limited; Siemens Bros. & Co., Limited; Simplex Electric Conduit Company; Westinghouse Electric Company, Limited. As we state elsewhere, Messrs. Siemens' tender has been provisionally accepted by the Works Committee, and their report was to come before the Council yesterday, Thursday, for confirmation.

Kirkcaldy.—The Ratepayers' Association is advising the Council to take up Prof. Kennedy's combined lighting and traction scheme, to which we referred last week. It is said that the present idea is to have 10 cars, five running in each direction.

Liverpool.—Sir Arthur Forwood, the chairman of the Tramways Committee, has prepared a report on the work of the tramways, with special reference to the question of low fares, and he recommends that for the electric tram system penny fares be adopted throughout the city, two-pence being charged for seats in the smoking compartment.

Middlesbrough.—The laying of the tramway rails in connection with the electric tramway from Thornaby to Middlesbrough has been completed, and the Highways Committee has voted £1,200 to the Imperial Tramways Company for wayleave.

New Cross and Waterloo.—We understand that this electric underground railway scheme is not to be proceeded with.

Newcastle-on-Tyne.—The City Council held its adjourned debate on the proposals in reference to the municipalisation of the tramways last week. The following resolution was passed:—"That in the next application to Parliament power be sought for the Corporation to work their own tramways; but that, until the scheme to be prepared by the recently appointed new Tramway Committee for providing the city with tramways has been considered by the Council, it is inexpedient to come to a determination as to whether the working of the tramways should be undertaken by the Corporation."

Ripon.—The Town Clerk is making inquiries as to the best means of providing a tramway—electric or cable—between Ripon Station and the market place.

The Power Distribution Schemes.—The Power Distribution Company has asked the Tipton Council to withdraw its opposition, on condition that the company agrees not to supply the electric light except with the Council's consent. A sub-committee will confer with the company and the other local authorities concerned.

The Ripley and Belper District Councils are among the latest bodies to oppose the scheme of the General Power Distributing Company.

The Darlaston General Purposes Committee recommends the Council to withdraw its opposition to the application of the Midland Electric Corporation for Power Distribution, subject to fair and reasonable conditions to secure economical terms to customers, and protective clauses in favour of the Council being inserted in the provisional order.

The "Underground" and Electric Traction.—In connection with the proposed employment of electric traction on the Metropolitan Underground, Mr. Bell, the chairman and managing director of the company made some important remarks to the shareholders last Friday:—"His anxiety had always been to see the Inner Circle worked first as an experiment by electricity. The departmental committee appointed by the Board of Trade to consider the ventilation question had arrived at certain conclusions, which were stated in the report. Although the committee had recommended various openings as a tentative measure, they had added a rider that if within three years from the passing of the Act authorising the openings, the company had not adopted electric traction, or other mechanical means of ventilation—which practically meant fans—some competent authority, to be stated by Parliament, should order the openings to be closed. That was if they were contumacious, which, however, no one could charge them with being. For the last 10 years the directors had had the idea of electric traction constantly before them. They all desired it, and they hoped they were on the high road to obtain it. Certain proposals were now under consideration, and he hoped that they would shortly be in such a condition that the directors could regard them as practicable. In that case they would immediately ask the shareholders for their approval. To enable them to be prepared for electric traction, Clauses 19 to 28 had been inserted in the Bill. The District Company were in accord with them in regard to electric traction. With respect to the question of ventilation by fans, they had tried fans, and he knew them to be a failure. He had expressed to the departmental committee his belief, after 25 years' experience of their railway, that electric traction was the solution of the problem they had been appointed to consider. The use of electric traction would involve entirely new stock."

Underground Electric for Brighton.—A Bill is to be introduced into Parliament next session, for power to form a company to construct an underground electric railway from a point near the station of the L. B. & S. C. Ry. Company, to a point under King's Road, but with openings under the parade communicating with the beach. The total length of the line will be 5 furlongs 17 25 chains. The capital of the company will be £120,000 with power to borrow £40,000 for equipment purposes. According to a financial daily, the maximum fare proposed to be charged is 2d. for the whole distance. The promoters names are Messrs. S. H. Doubleday, C. F. Webber, and J. W. Kersley.

Wallasey.—The District Council is about to take formally into consideration the desirability of taking over and working the local tramways, and also the question of employing electric power.

TELEGRAPH AND TELEPHONE NOTES.

Bedford Telephones.—A Committee is inquiring into the desirability of applying for a municipal telephone license.

Norwich Telephones.—At the Norwich Town Council last week there was a very lengthy discussion on the telephone system. Sir Harry Bullard, M.P., proposed that a petition be presented to the Postmaster-General to grant a municipal license, to be worked either by the Corporation or by a company approved by it; also that a deputation be appointed to present the said petition. The debate is to be continued at the next meeting.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1898 ...	...
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Cape Haitien-Puerto Plata	Dec. 31st, 1897 ...	Jan. 26th, 1898.
Curaçao-La Guayra ...	Jan. 5th, 1898 ...	...
Paramaribo-Cayenne ...	Jan. 27th, 1898 ...	...
Amason Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	..
Para-Cameta	Jan. 13th, 1898 ...	Jan. 27th, 1898.
Saigon-Hong Kong	Jan. 8th, 1898 ...	...
Para-Maranham	Jan. 22nd, 1898 ...	...
Bolama-Bissao	Jan. 28th, 1898 ...	...
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Cartagena-Barranquilla ...	July 4th, 1896 ...	...
Saigon-Bangkok	Jan. 22nd, 1898 ...	Jan. 24th, 1898.
Majunga-Tananarive	Jan. 26th, 1898 ...	Jan. 27th, 1898.
	Jan. 30th, 1898 ...	Jan. 31st, 1898.

The Direct West India Cable Company, Limited.—This company announces that its cables from Bermuda to Turks Island, and Turks Island to Jamaica, are now open for traffic, and that messages for these islands can now be sent at the rate of 3s. a word. The company draws attention to the fact that this is the only "direct" and all-British cable route to Jamaica and other West India islands (the other alternative routes being *viâ* the United States and Cuba, or the unsettled central American States).

CONTRACTS OPEN AND CLOSED.

OPEN.

Bilbao.—February 28th. The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Consul at Bilbao, reporting that the provisional board appointed in connection with the electric tramway which it is proposed to lay from Zumarraga to Zumaya, in the province of Guipuzcoa, invite plans and tenders, to be received by February 28th, for the construction and equipment of the line. Further particulars of the conditions of the tenders for the above-named tram line and branch, which together measure 30 miles, may be inspected at the Commercial Department of the Foreign Office any day between the hours of 11 and 6.

Belgium.—February 11th. The Provincial Government Authorities in Brussels are inviting tenders for an installation of electric lighting in the offices of the Governor of Brabant in the Rue de Chêne, Brussels. Tenders to be sent to the Gouvernement Provincial, Brussels.

Belgium.—February 16th. Tenders are being invited by the Société Nationale des Chemins de Fer Vicinaux, of Brussels, for the supply of 38 electric tramcars. Tenders to be sent to, and particulars may be obtained from, the offices of the company, Rue de la Science, 26, Brussels.

Berlin.—March 15th. The Municipal Traffic Deputation of the Town Council have opened a competition for the construction of several new electric tramways in that city. Exhaustive details concerning this project are contained in the *Elektrotechnische Zeitschrift* of the 13th inst., which mentions that proposals will be received by the Stadtische Verkehrsdeputation Rathhaus III, Berlin, by March 15th.

Copenhagen.—March 12th. The Frederiksberg Sporveis-og Electricitets Aktieselskab want tenders for steam engines, dynamos, accumulators and switchboards. Offices of the company, Gl. Kongevei, 140, Copenhagen.

Denmark.—March 12th. Tenders are being invited for the supply of the engines, dynamos, accumulators, &c., required in connection with the new central station at Frederiksberg, near Copenhagen. Tenders to be sent to the Frederiksberg Sporveis-og Electricitets Aktieselskab, Gammel Kongerie, 140, Copenhagen V., from whom particulars may be obtained.

Edinburgh.—February 5th. The Corporation want tenders for the wiring of the Police Station, Abbeyhill. See our "Official Notices" January 28th for particulars.

France.—March 31st. Tenders are being invited by the Municipal Authorities of Saint Chamond (Loire) for the concession for the lighting of the public streets of the town, either by gas or electricity. Particulars from, and tenders to be sent to, La Mairie de Saint Chamond (Loire).

L.C.C.—February 16th. The London County Council Asylums Committee want tenders for a great variety of sundries. One of the items is for electric lighting sundries for Claybury. Particulars at the office of the Asylums Committee, 21, Whitehall Place, S.W.

Madrid.—February 22nd. The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Chargé d'Affaires at Madrid, enclosing copy of a Royal decree announcing that a public auction for the contract for repairing the national submarine telegraph cables during the next five years will be held at Madrid on February 22nd. Further particulars as to the cables in question may be inspected at the Commercial Department of the Foreign Office any time between the hours of 11 and 5.

Redditch.—February 14th. The District Council want tenders for the supply of buildings, gas producing plant, gas engines, alternators, cables, transformers, &c., for the electric lighting of the district. Consulting electrical engineer, Mr. J. A. McMullen. See our "Official Notices" January 28th.

Rochdale.—February 19th. The Corporation want tenders for steam dynamos, balancer, and boosters, &c. Engineers, Messrs. Lacey, Clirehugh & Sillar. See our "Official Notices" January 14th.

Roumania.—March 15th. Tenders are being invited by the General Direction of the Roumanian Post and Telegraphs in Bucharest for the supply of 56,000 metres of galvanised iron and steel wire.

Spain.—February 11th. Tenders are being invited by the Municipal Authorities of Valderas (Leon province) for the concession for the electric lighting of the public streets of the town during a period of 17 years. Particulars may be obtained from, and tenders to be sent to, El Secretario del Ayuntamiento de Valderas (Leon).

St. Helens.—February 21st. The Corporation want tenders for various plant and machinery, &c., in connection with the proposed electric tramways. See our "Official Notices" January 28th for particulars. Consulting engineer, Dr. J. Hopkinson.

St. Pancras.—February 22nd. The Vestry want tenders for dry back marine boilers with superheaters and brickwork seatings. See our "Official Notices" this week.

The War Office.—April 27th. The Secretary of State for War is prepared to receive offers, competitive designs and specifications for the supply of portable electric search light apparatus. Particulars from the Director of Army Contracts, War Office, Pall Mall, S.W. See our "Official Notices" for particulars.

Victoria.—March 21st. The Telegraph Department of the Victorian Government Railways are inviting tenders for the supply of alternating current transformers and one main switchboard. Tenders to the Telegraph Superintendent's Office, Spencer Street, Melbourne.

CLOSED.

Bedford.—The Town Council has accepted the tender of Messrs. W. H. Allen, Son & Co., for the supply of a 420-B.H.P. double-acting compound engine for £1,375; also that of Messrs. Easton, Anderson & Goolden, for the supply of a 250-unit alternator for £1,075; that of Messrs. Rootham & Jeakings, for the erection of offices, store rooms, &c., near the electric light station, for £309. 100 electric lamp columns are to be obtained from Mr. W. Bradley, of Rastrick, for £250. A motor and flexible shafting for cleaning boiler tubes are to purchased at an estimated cost of £68.

Hull.—We understand that the Works Committee has given the contract for the electrical equipment of the tramways (including 20 cars) to Messrs. Siemens Bros. & Co. for £42,228.

Sheffield.—The Brush Electrical Engineering Company, Limited, has received an extension order from the Sheffield Electric Light and Power Company for a 600-kw. steam alternator for next winter's load, the plant to consist of an "Inductor" pattern alternator coupled direct to an "Universal" steam engine.

FORTHCOMING EVENTS.

1898.

Friday, February 4th, at 8 p.m.—The Institution of Junior Engineers, at the Westminster Palace Hotel. Paper on "Electro-Magnetic Brakes, and their Capabilities," by Mr. Louis H. Walter, A.I.E.E., of Cambridge.

At 12 noon.—Eastern Telegraph Company, extraordinary general meeting at Winchester House to confirm resolution approving the Company's Bill for capital conversion, &c.

Royal Institution. Mr. A. A. Campbell Swinton on "Some New Studies in Cathode and Röntgen Radiations."

Saturday, February 5th.—Institution of Electrical Engineers. Student's visit to the works of Messrs. Siemens & Co., Woolwich. Train from Fenchurch Street, 10.5 a.m. Applications to join the party, to the Student's Hon. Sec. (Mr. S. Grant, 28, St. Mary Abbot's Terrace, W.)

Monday, February 7th, at 7.30.—Society of Engineers' meeting at the Royal United Service Institution. Presentation of premiums by retiring president, Mr. G. M. Lawford. Presidential address, Mr. W. W. Beaumont.

Tuesday, February 8th.—Liverpool Overhead Railway Company. Meeting at Liverpool.

Ordinary and extraordinary general meetings of the St. James's and Pall Mall Electric Light Company.

Wednesday, February 9th, at 8 0 p.m.—The Institution of Electrical Engineers. "Notes on the Electro-chemical Treatment of Ores containing the Precious Metals," by Major-Gen. Webber, C.B., Past-President (conclusion of discussion). "An Electrolytic Process for the Manufacture of Parabolic Reflectors," by Sherard Cowper-Coles, Member.

At 12 o'clock.—City and Guilds Central Technical College, Exhibition Road. Second of a series of three lectures on "The Design and Testing of Power Cables for Specific Purposes," by Mr. Mervyn O'Gorman.

At 8 p.m.—Society of Arts. "Compensation to Workmen." By A. D. Provand, M.P.

Thursday, February 10th, and Friday, February 11th.—The annual general meeting of the Institution of Mechanical Engineers, at 25, Great George Street. The discussion on Mr. Philip Dawson's paper on "Mechanical Features of Electric Traction," will be resumed. A paper will be read and discussed as follows: "First Report to the Gas Engine Research Committee; Description of Apparatus and Methods, and Preliminary Results," by Prof. Frederic W. Burstall.

Friday, February 11th.—Physical Society (rooms of the Chemical Society, Burlington House). Annual General Meeting at 5 p.m.—Address by the President. After which at an Ordinary meeting: "On Electro-magnetic Induction in Plane, Cylindrical and Spherical Current Sheets, and its Representation by Moving Trails of Images," by G. H. Bryan, M.A., F.R.S.

NOTES.

Institution of Junior Engineers.—The 13th anniversary dinner of the members of this Institution was held at the Westminster Palace Hotel, Victoria Street, on Saturday night. Mr. J. A. F. Aspinall, M.Inst.C.E., the president, occupied the chair. Mr. Alexander Siemens proposed the toast of "British Railways," and Mr. R. Harrison, general manager L. & N. W. Ry., in response, congratulated Mr. Siemens and his fellow-workers on the Employers' Federation on the settlement of the engineers' dispute, which, he said, had been brought about after much labour and much anxiety. It was a settlement which, he thought, would be for the benefit not only of the employers—who did not even claim that it was a victory—but also of the workmen, and, not least of all, of the railway companies and those who had to transport the manufactured articles and the materials necessary for their manufacture. The chairman also responded. The toast of "A Realised Teaching University for London" was proposed by Dr. Perry, F.R.S., and Prof. Silvanus Thompson, F.R.S., in response, referred in eloquent and impassioned terms to the up-hill nature of the task in which the advocates of the reconstruction and enlargement of the University of London had been engaged. It was, he said, an extraordinary thing that in this great capital no opportunity should be offered for a student to take a degree in engineering. The apathy of London members of Parliament on the question was astonishing, seeing how great was the need for the reconstruction of the University. Mr. J. W. Swan, F.R.S., president of the Institution of Electrical Engineers, proposed the toast of the evening, "The Institution of Junior Engineers." He said the extension and greatness of the Empire were mainly due to the genius and enterprise of engineers, with whose future work the interests of the country were bound up. Mr. Vorley, who responded, mentioned that the Institution now comprised 500 members. Before resuming his seat he gave the toast of "The Honorary Members." Mr. Hiram S. Maxim, in reply, spoke of the advantages which electricity possessed over steam, and said it was to the former force that they must look if they wished to have more rapid transit and to double the speed attainable by the locomotive. The evening was a thoroughly enjoyable one; indeed, Mr. W. T. Dunn, the popular and indefatigable secretary, invariably makes the Institution dinner a success in every way, but on this occasion the speeches were specially good, the music, for several years past a feature at these annual gatherings, was highly appreciated, and the cinematographic display of the Queen's Diamond Jubilee procession was admirably handled by the Messrs. Prestwich. We shall hope to see in each succeeding year large accessions to the ranks of the Junior Engineers, for to them we look for the men to carry on the work begun by those, who, one day, must leave the younger members of the profession to bring it to finality. The Junior Engineers may rest assured that nothing will be wanting on the part of the technical press to encourage them in all ways, and to give publicity to the doings of such an important body, youthful though it may be. What it lacks in experience, it makes up for in energy and determination to make its power felt, and we shall always take a pleasure in doing all that lies in our power to foster the further development of the Institution.

Obituary.—The death of Lord Sackville Arthur Cecil took place on Saturday afternoon at Holwood, Beckenham, Kent, the seat of his mother, Mary, Countess of Derby. His lordship had been ill for some eight weeks, but was making progress towards recovery until an attack of pleurisy supervened on pneumonia, which, in his weakened state, he was not able to fight against. He was a son of the second Marquis of Salisbury, and was born in 1848. Educated at Wellington College and Trinity College, Cambridge, he took his B.A. degree in 1869 and his M.A. in 1872. He had considerable scientific attainments, and became very well known in connection with both railways and telegraphs. In 1869 he acted as chief electrician on board the cable steamer *Africa* during the laying of the Marseilles Bona and Malta cable, and in 1870 served on the staff of the late Sir Charles Bright supervising the manufacture of telegraph cable for the Panama and South Pacific Company. Both these cables are to-day in working order between France and Algeria, the destination of the latter having been changed on account of a law suit and the subsequent liquidation of the Panama and South Pacific Company. From 1878 to 1880 he was assistant general manager of the Great Eastern Railway, and from 1880 to 1885 he was general manager of the Metropolitan District Railway. He also became chairman of the Exchange Telegraph Company and director of the Eastern Telegraph Company, the Brazilian Submarine Telegraph Company, the Globe Telegraph and Trust Company, and the Pacific and European Telegraph Company. He was a man of great activity, and was possessed of an enormous capacity for work. Lord Sackville Cecil's rectitude of character won the esteem of all those who were thrown into contact with him, and his loss will be severely felt by his numerous friends, and by the companies with which he was connected. The deceased was one of the original members of the Institution of Electrical Engineers.

On Thursday, the 27th ult., Major Alexander Wood was buried in the Parish Churchyard of Erith, in which district he had lived for some 25 years. The deceased was well known in telegraph circles, through his connection with the Western and Brazilian Telegraph Company, which he piloted through many storms. The loss of his keen perception and his master mind will be deeply felt by his colleagues. To those who served under him will his loss be great, as Major Wood's generous disposition made him continually think of the absent toilers whose work, in sometimes unhealthy climates, contributes so much to the well being of their chiefs and employers at home. While a generous man, the deceased was far from being a weak one, as he dealt severely with things and men when the occasion demanded this treatment. Major Wood was born at sea in 1843, and was the son of Captain Wood, one of the band of pioneer explorers in Central Asia. In early life he belonged to the Bombay Staff Corps, and saw active service in China and Japan. On his retirement from the Indian Army, in 1872, he began the work of his life, and in various capacities was connected with the projected Great Western Telegraph Company, with the Western and Brazilian Telegraph Company, the late Central American Telegraph Company, the Platino-Brazilian Company, and the Amazon Telegraph Company. Until within a year of his death, when his health failed him, he was the active head of the Western and Brazilian, the Platino, and the Amazon Companies. He was also director of the Pacific and European Telegraph Company. Many of our foreign readers may remember the cheery, active personality who attended the International Telegraph Conference of London, Berlin, and Paris. We join with many others in tendering our sympathy to his bereaved family.

We regret to record the death of Mr. C. W. Stronge, C.B., who succumbed to pneumonia at his residence in Whitehall Court on Sunday last. Mr. Stronge was born in 1816, the third son of the late Sir James Mathew Stronge, Bart., of Tynam Abbey, Armagh, and entered the Treasury in 1833. After a service of half a century in that Department, he retired from the post of principal clerk. He had at different periods of his career acted as private secretary to different Ministers, among these the Earl of Derby, during his Premiership. Mr. Stronge was made a Companion of the Bath on the recommendation of Lord Beaconsfield. He had served as official Government Director on the boards of subsidised telegraph and steamship companies, and at the time of his demise, was a director of the Eastern, and of the Eastern and South African Telegraph Companies.

Puzzle—Find the Trolley.—We sometimes get interesting news from across the Atlantic as to what is being done on this side. Occasionally the information is known there sooner than here, and we wonder why it has not been first divulged in England. For a quite new and interesting piece of information we go to the *American Machinist*, which says:—

> On a trolley line in Birmingham, England, the rails are made in Pittsburg, the cars in Philadelphia, the boilers in Erie, the engines in Milwaukee, and the electric fittings in Schenectady.

This paragraph bears a very rosy complexion to the American electrical manufacturers' eyes, which would be quite justifiable if only it were true. What we should like to know is, "How long has there been a trolley line at Birmingham?" This is the first we have heard of it.

Electric Automobiles in France.—The Société des Voitures Electriques, using the Krieger system, the large and well-known Parisian carriage works, which was established in 1895, will probably soon be known by the title of Compagnie des Automobiles Electriques, it being now, says the Paris correspondent of the *Electrical World*, on the point of changing its organisation, and making its capital 5,000,000 francs ($1,000,000). According to some comparative calculations of all the costs of installation and operation required by animal, oil-motor, and electric traction, this company states that all the advantages of economy lie with the electric system. For daily cost of operating cabs they give:—

For animal traction	15.44 francs	($3.10)
For a petroleum automobile ...	13.20 „	($2.65)
For an electric automobile ...	8.13 „	($1.63)

Dust Destructors and Electric Lighting. — The glowing accounts which are given from time to time about the success of the Shoreditch combined plant are having their effect, and municipal authorities in various parts are pursuing inquiries into the subject, in the belief that success is already assured. The Johannesburg Town Council has decided to go in for dust destructors, and the suggestion is now being made there to erect them at the electricity station at the lower end of President Street. In this connection, *Machinery*, a South African paper, urging steps to be taken in this direction, cites the Shoreditch plant as an "unqualified success from all points of view," and well worth imitating. As to the "unqualified success," we will, without referring again to the question of fuel, simply draw attention to some of the points raised on this very interesting subject, by Mr. Robert Hammond, in his remarks to the Gloucester Town Council last week. A brief report appears in another column.

Personal.—Mr. A. E. Worswick, chief electrical engineer of the Cape Town Tramways Company, has left Cape Town for Mexico, to take up a position in connection with the administration of a large electric traction system.

Forthcoming Lectures.—A special course of lectures on "The Design and Testing of Power Cables for Specific Purposes," have been arranged by the City and Guilds Institute to be delivered at the Central Technical College on Wednesdays at 12 o'clock, by Mr. Mervyn O'Gorman, late manager of the Fowler-Waring Cables Company. The first lecture was given on Wednesday, 2nd inst., and the others will take place on 9th and 16th inst.

Professorship Vacant.—Prof. Carey Foster resigns the Quain Professorship of Physics at the University College, London, at the close of the present session. Applications for the chair have to be made to the secretary, Mr. J. M. Horsburgh, M.A., by March 1st.

Our Volunteers.—A daily paper says that it is intended by the War Office to appoint non-commissioned officers of the Royal Engineers for the permanent staff of the new Corps of Electrical Engineer Volunteers, as soon as their services are required for training the Corps.

Toy Science.—This month's issue of *Good Words* has a very interesting illustrated article by Mr. James Swinburne on "Science of Some Toys."

Appointments Vacant.—The Birkenhead Corporation want a resident electrical engineer, at £300 per annum. See our "Official Notices."

The Northwich Electric Supply Company want a resident electrical engineer for their gas-driven electric light works. See our "Official Notices."

Municipal Electrical Association.—We hear that Mr. Alfred H. Gibbings, the city electrical engineer of Bradford, has been elected president of the Municipal Electrical Association, in succession to Mr. C. H. Wordingham, and will preside at the annual covention in London next June.

Lectures on "Electro-Deposition."—Prof. S. P. Thompson commenced on Wednesday at the Finsbury Technical College, a course of laboratory instruction and lectures on "Electro-Deposition." A syllabus of the course has been issued.

Falcon Works Engineering Society.—A very successful meeting of the Falcon Works Engineering Society was held at Loughborough, on Thursday last. Mr. R. P. Sellon presided, and a most interesting paper was read by Mr. J. J. Steinitz, the Borough electrical engineer for West Ham, on "Some Practical Hints on Starting a Municipal Electrical Department."

The American Blizzard.—The American blizzard has played havoc with the telegraph, telephone and trolley wires in Boston. The wires are down in all directions, and some of the accounts in the press say that over 200 horses lie dead in the streets through electrical shocks and extreme cold.

Lectures.—On the 22nd ult., Mr. A. H. Fison, D.Sc., commenced a series of ten lectures on "The Electric Current and its Modern Applications," at the Technical Institute, Wandsworth.

At the Bishopsgate Ward Club, last week, Mr. W. C. C. Hawtayne read a paper on "The Supply of the Electricity from Central Stations," and dealt with the question of municipal *v.* private enterprise. He referred to the error committed by the Commission of Sewers in giving over its electric lighting powers to two companies.

Mr. F. H. Headley read a paper on "Electricity, the Transmitter of Power," before the Mining Association and Institute of Cornwall, on Wednesday last week.

Mr. Wm. Lynd is delivering a series of lectures on "Wireless Telegraphy," in the Free Trade Hall, Manchester.

Presentation to Mr. H. C. Fischer, C.M.G.—It is stated that a movement is on foot among the superintendents and staff of the Central Telegraph Office, for the purpose of making farewell presentations to Mr. H. C. Fischer, C.M.G., who is, as already stated, about to relinquish the office of comptroller.

Personal.—Mr. Mervyn O'Gorman, late of the Fowler-Waring Cables Company, has joined Mr. E. H. Cozens-Hardy, chief assistant to the Brush Company's engineer, in an examination of Continental and American methods, with a view to a subsequent partnership in consulting work.

Telegraph Directors Dead.—The Pacific and European Telegraph Company has, within the last week, lost two members of the Board, in the persons of Lord Sackville Cecil and Major Alexander Wood. In addition to these two names a third has to be registered, Mr. C. W. Stronge, C.B., a director of the Eastern Telegraph Company, who has also died in the same week.

Telegraphists' Grievances.—The Postal Telegraph Clerks' Association have drawn up a circular letter which each postal employé will forward to the member for the constituency in which he lives, urging him to be present at the House of Commons on February 8th, when Mr. Sam Woods is to lay before Parliament the grievances of the service. The circular, says last night's *Pall Mall*, calls attention to the alleged inadequacy of pay and insufficient prospects, and points out that a man must complete 21 years of irreproachable service before he can receive 56s. per week. The association ask for a prospective £200 after 25 years of service, claim the absolute right of combination and free speech, and particularly call attention to the fact that absence through sickness for nine days may lead to compulsory retirement. They desire that this rule should be cancelled.

NEW COMPANIES REGISTERED.

Clench & Co., Limited (55,749).—Registered January 21st, with capital £80,000, in £10 shares, to acquire the business of "Clench & Co.," of Lincoln Works, Chesterfield, and elsewhere, to adopt an agreement with F. and G. M. Clench, and to carry on the business of mining, electrical, mechanical and general engineers, tool and implement makers, boiler makers, metal workers, &c. The subscribers (with one share each) are:—F. Clench, Lincoln Works, Chesterfield, engineer; G. M. Clench, Lincoln Works, Chesterfield, engineer; H. S. Johnstone, Springfield Road, St. Leonard's-on-Sea, solicitor; S. G. McDakin, 15, Esplanade, Dover, retired captain; E. Clements, 74, Southgate, Sleaford, engineer; E. W. Whattan, Rutland Road, Chesterfield, clerk; D. H. Davis, Longlands, Chesterfield, solicitor. The number of directors is not to be less than three, nor more than five; the first are the first five subscribers. Qualification, £500; remuneration as the company may decide. Registered by Devonshire & Co., 1, Frederick's Place, Old Jury, E.C.

Trehearne Electrical Engineering Company, Limited (55,798).—Registered January 26th with capital £2,000 in £1 shares, to carry on the business of electrical engineers, suppliers of electricity, electricians, electrical apparatus manufacturers, &c. The subscribers (with one share each) are:—S. G. Trehearne, 155, Fenchurch Street, E.C., electrician; J. A. England, 118, Abbeville Road, Clapham, stationer; A. J. Jackson, 66, Heaton Road, Peckham, gentleman; R. Bridge, Innellan, Cavendish Road, Sutton, printer; W. H. Hughes, 155, Fenchurch Street, E.C., clerk; F. C. Powell, 248, Haydon's Road, South Wimbledon, clerk; H. C. Clarke, Oakleigh, Merton Hall Road, Wimbledon, assistant. Table "A" mainly applies. Registered by S. G. Trehearne, 155, Fenchurch Street, E.C.

W. J. Jenkins & Co., Limited (55,826).—Registered January 27th, with capital £20,000 in £10 shares, to acquire the business carried on as "W. J. Jenkins & Co.," at the Beehive Works, East Retford, Notts., to adopt an agreement with W. J. Jenkins, and to carry on the business of gas, electrical and mechanical engineers, iron founders, millwrights, metal workers, contractors, &c. The subscribers (with one share each) are:—L. F. Trafford, 2, Sloane Street, S.W., major; Mrs. A. R. Trafford, 7, Sloane Street, S.W.; G. R. Trafford, Oxford and Cambridge Club, S.W., gentleman; J. Goodman, Yorkshire College, Leeds, professor; C. P. Smith, 41, St. Michael's Road, Northampton, traveller; J. W. Durnford, 24, Caledonian Road, East Retford, engineer; W. J. Jenkins, 125, Thrapston Road, East Retford, engineer. The number of directors is not to be less than three nor more than five; the first are:—L. F. Trafford, J. Goodman and W. J. Jenkins; qualification £1,000; remuneration as fixed by the company. W. J. Jenkins is the managing director with £400 per annum. Registered by Jordan & Sons, Limited, 120, Chancery Lane, W.C. Registered Office, Beehive Works, Retford, Notts.

Langdon Davies Electric Motor Company, Limited (55,830).—Registered January 27th, with capital £70,000 in £1 shares, to adopt an agreement with the Davies Motor Company, Limited, for the acquisition of certain agreements relative to alternate current motors, and to carry on the business of electricians, engineers, light and power contractors, and electrical manufacturers. The subscribers (with one share each) are:—E. W. S. Crawley, 44, Castletown Road, West Kensington, engineer; C. E. Cree, 12, Nevern Road, Earl's Court, barrister; A. W. Cree, Brodsworth, Beckenham, solicitor; H. E. Cree, Benenden, Eastbourne, solicitor; W. S. Matingly, 113, Highbury Hill, N., clerk; W. L. Davies, 61, Gwendwr Road, West Kensington, engineer; A. Soames, Walpole Lodge, Bromley, Kent, engineer. The number of directors is not to be less than three nor more than nine. The first are C. E. Cree, A. W. Cree, W. Langdon Davies, A. Soames, and E. W. S. Crawley. Qualification £1,000; remuneration not more than either 10 per cent. of the profits, or a £1,000 per annum dividend. Registered by Cree & Son, 13, Gray's Inn Square, W.C.

United Ordnance and Engineering Company, Limited (55,860).—Registered January 29th with capital £550,000, in £1 shares (275,000 £5½ per cent. cumulative preference), to acquire and turn to account the benefit of a contract with Schneider & Co., of Creuzot, for the manufacture of the Schneider-Canet Artillery, in the United Kingdom and its colonies, to acquire and carry on the business of mechanical, hydraulic, electrical and mining engineers, carried on by Easton, Anderson & Goolden, Limited (registered in 1894), and to adopt an agreement with E. T. Hooley. The subscribers (with one share each) are:—H. F. Nicholson, Cobham, Kent, admiral; C. Cammell, Sheffield, gentleman; H. K. Baynes, 15, Chapel Street, S.W., gentleman; W. T. Marriott, 56, Ennismore Gardens, S.W., Queen's councillor; E. Legge, 7, Albion Street, W., barrister; P. B. Dobson, Zulla Road, Nottingham, gentleman: H. P. King, 36, Savernake Road, South Hampstead, clerk. The number of directors is not to be less than five nor more than eleven; the first are—H. F. Nicholson, K.C.B., F. Elgar, H. McCalmont, E. Cammell, P. Mosley, T. Wilson, and H. K. Baynes. Qualification £1,000; remuneration £300 each per annum (£500 for the chairman), together with £1,000 per annum, divisible, for every 1 per cent. in the ordinary dividend above 5 per cent. Registered by Golding & Hargrove, 93, Cannon Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Railways' Electric Supply Syndicate, Limited (52,812).—This company's statutory return was filed on November 13th, when 7,000 shares were taken up and issued as paid, out of a capital of £10,000 in £1 shares.

Silicon Electric Lamp Syndicate, Limited (47,238).—This company will not be proceeded with, as the patents, for the acquisition of which the undertaking was formed, have been otherwise disposed of and the name of the company will be struck off the register.

Rand Central Electric Works, Limited (43,712).—This company's annual return was filed on January 7th, when the capital of £300,000 in £1 shares was taken up in full. 25,000 shares are considered as paid, and £275,000 has been received.

Single-Wire Multiple Telephone Signal Company, Limited (16,875).—This company's annual return was filed on December 24th, when 374 shares were taken up and paid for in full, out of a capital of £5,000 in £10 shares.

CITY NOTES.

The St. James' and Pall Mall Electric Light Company, Limited.

The ordinary general meeting will be held at Carnaby Street Central Station, Golden Square, W., on Tuesday, February 8th, at 12 o'clock, and the directors' report to be then presented reads as follows:—"The directors submit their report for 1897, with the accounts as certified by the company's auditors. The extension of Carnaby Street Station is on the point of completion, and will soon be equipped with a full plant of 5,000 horse-power. It has been working satisfactorily throughout the year in connection with the station at Mason's Yard. Steady progress has been made in the increase of the company's supply to private consumers, and the principal streets of the district are now lighted by electricity. An agreement, dated December 16th, 1897, has been made with the holders of founders' shares by which, subject to confirmation by the shareholders, they will receive an allotment of 120 ordinary shares at par in exchange for each founders' share, such exchange to take effect as and from January 1st, 1898. In order to carry out this agreement steps are being taken to increase the capital of the company to £300,000 by the creation of 20,000 new ordinary shares of £5 each, of which 12,000 £5 shares are to be issued at par to the holders of the founders' shares. This will give the company £60,000 additional capital at once, and will, in effect, extinguish the founders' shares. The net earnings of the company during the past year have amounted to £29,093 17s. 7d. Of this sum, £6,996 10s. was distributed in August last in payment of an interim dividend at the rate of 7 per cent. per annum for the half-year ending June 30th, 1897, on the ordinary shares, and of 7 per cent. per annum on the preference shares. The balance, £22,097 7s. 7d., together with the undivided profit of £327 15s. 9d. from last year's account, leaves £22,425 3s. 4d. now to be dealt with.

"The directors propose to divide the amount as follows:—

	£	s.	d.
(a) By payment of a dividend at the rate of 7 per cent. per annum on the preference shares for the second half of the year	3,500	0	0
(b) By payment of a dividend on the ordinary shares for the second half-year of 11s. per share, making, with the interim dividend paid on August 2nd last, a total distribution of 14½ per cent. for the year	10,989	0	0
(c) By payment of a dividend of £75 10s. 4d. per share on the founders' shares...	7,551	13	4
(d) Amount to be carried forward to ordinary shareholders' undivided profit account ...	384	10	0
	£22,425	3	4

"Sir John H. Morris, K.C.S.I., and Mr. Bennett Fitch, M.Inst.C.E., are the directors who retire by rotation under clause 79 of the articles of association, and, being eligible, offer themselves for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths & Co., also retire, and, being eligible, offer themselves for re-election."

At the conclusion of the annual ordinary meeting of the company, an extraordinary general meeting will be held for the purpose of confirming the following resolutions passed at the extraordinary general meeting of the company, held on January 18th, 1898, so as to make them special resolutions:—

"1. That the agreement bearing date December 16th, 1897, and made between the company of the first part, the parties whose names are subscribed in the first column of the schedule thereto, being the registered holders of the 100 founders' shares of £1 each in the company of the second part, and Eustace James Anthony Balfour and Josiah Latimer Clark of the third part, be, and the same is hereby approved, and that the directors be, and they are hereby authorised to carry the same into effect.

"2. That the capital of the company be increased to £300,000 by the creation of 20,000 new ordinary shares of £5 each, and that notwithstanding the provisions of article 4 of the articles of association, 12,000 of such 20,000 new ordinary shares of £5 each be issued at par to the registered holders of the 100 founders' shares of £1 each in the company as provided by the said agreement, December 16th, 1897.

"3. That the directors be and they are hereby authorised to issue to any registered holder of a founders' share at any time hereafter, not more than 120 new ordinary shares of £5 each at par upon such founders' shareholder transferring each founders' share, of which he is the registered holder to Eustace James Anthony Balfour and Josiah Latimer Clark as trustees for the company, nothwithstanding that the said agreement of December 16th, 1897, may not have been executed by the holders of the whole of the said 100 founders' shares within the three months provided by Clause 5 thereof."

City and South London Railway Company.

The ordinary general meeting was held last Friday at Winchester House, Mr. Charles G. Mott presiding. In moving the adoption of the report, the chairman regretted that they were not able to recommend an increase in the dividend on that occasion over what they paid for the corresponding period of the previous year. In the December half of 1896 they had what was for them a very large increase in their traffic owing to two very important matches of the Australian cricketers at the Oval, and, moreover, that half-year was favourable for them, the weather having been severe as compared with the mild and dry autumn or early winter they had had this year. It was, he thought, very satisfactory that they were able to show, in the circumstances, an increase in their receipts from passengers and parcels of about £40. He thought it clear that a natural increase was going on in their traffic, apart from what they might derive from exceptional causes. Their line at present had no connections with any other railways, nor did it run through a district which was a very busy one. The extensions were going on very satisfactorily, and considerable progress had been made at Finsbury Pavement. Both tunnels were very nearly completed along Moorgate Street to the Bank. It would take some weeks before one of these tunnels was quite finished up to the Bank, and they would then only have to tunnel a very little further up to the station in Lombard Street. The tunnel on the south side of the river, starting at Denman Street for the London Bridge Station, and going in a southerly direction, was very nearly completed, and would in a few weeks be up to the junction with the old line, where the new line left the existing line. One of the tunnels from that station northwards towards the City was completed to the extent of about one-third under the river. The necessity which they were under of upholding the church of St. Mary Woolnoth, at the corner of Lombard Street, which had given them a great deal of trouble in the past, would probably cause them some delay. In view of this fact and the necessity which had been thrown upon them of upholding the church, they were asking Parliament in a Bill they were promoting this Session to empower them, if there was any consequent delay in completing the line within the time expected, and they therefore had to incur expenditure in dividend on the preference shares they had issued, to charge such dividend in the first instance to capital account. As they were aware, they issued for these extensions £200,000 of preference shares, the dividend on which was deferred, and was not to begin to accrue until January 1st next. The first half-yearly dividend on these shares would not become payable until August, 1899, and he might state that the reserves they now had in hand were equal to one-half of the dividend which they would then have to pay. They had been acquiring property for the station for the Clapham extension, as they thought it very desirable that that line should, if possible, be completed by the time that the other extensions were finished and opened. Most of the property necessary for the two stations in connection with that extension had been acquired. They were negotiating for letting the contract for this extension, in connection with which they were, of course, providing for increased power, &c., at the generating station. The contract time for completing this extension would expire on September 30th next, and they had good hopes for believing that a year hence they might be able to announce that that line was ready for opening. Having referred to the City and Brixton Railway, and to the negotiations which had gone on with certain parties who were willing to construct this line, he stated that their company would work it from their central generating station. They would hold a Wharncliffe meeting on the 17th prox., when they would submit that company's Bill and also their own Bill, when full details would be given and the provisional arrangement with the City and Brixton Company would be set forth. With a view to an interchange of traffic they had entered into an arrangement with the Central London Railway Company, whose line commenced at the Mansion House and went by way of Holborn and Oxford Street to Shepherd's Bush. That company, he believed, would have a very important traffic, and it had been arranged that the platforms of their stations at the Bank and their station below should be connected by a short subway. They believed there would be a very large interchange of traffic in consequence of this arrangement, which would prove of great convenience to a vast number of people. Their Finsbury Pavement station was exactly opposite the booking office of the Moorgate Street station, and there should be a considerable interchange of traffic between the two lines. They would also have an interchange of traffic at London Bridge with the South-Eastern and Brighton companies. When, too, the Clapham extension was completed, they would have a station very near the Clapham Road station of the Chatham and Dover Company, and there also there would be a means of interchange of traffic. In addition, powers had already been obtained for two other lines, which were going to Finsbury Pavement—he referred to the Great Northern and City Railway, which would go from Finsbury Park to Finsbury Pavement, and the Epping Forest and Walthamstow line, the terminus of which would be very close to Finsbury Pavement station. Traffic would be brought to their undertaking by these lines from all parts of London, and an immense interchange of traffic might be looked for with these different railways. They had deposited a Bill for extending the time for constructing that part of the line which it was not at present proposed to build—namely, from Finsbury Pavement to the Angel at Islington.

Mr. Sampson Hanbury seconded the motion, which was adopted.

Buenos Ayres and Belgrano Tramways Company.

An extraordinary general meeting of this company was held on Tuesday, at Winchester House, for the purpose of considering a draft agreement with the Buenos Ayres and Belgrano Electric Tramways Company, Limited, for amalgamation with the latter.

Mr. John Morris, who presided, said the proposed new company would have a larger mileage of lines than the present one, and for horse traction it was intended to substitute electricity. The advantages of electric traction had long been before the public in other countries to a greater extent than in England. In the United States it had almost everywhere superseded animal power, and on the Continent of Europe, especially in Germany, it was well known and highly appreciated both on account of its convenience and economy. With electric traction it was possible to estimate accurately the cost of running cars, as it made companies independent of good or bad harvests, and other temporary causes of that kind. The cost of traction was practically reduced by one-half. He quoted the experiences of Montreal and Hamburg, in both of which the old tramways had fallen upon evil days, but had been resuscitated and made prosperous by the adoption of electricity.

The proposal was carried.

Official Announcements re Companies.

The Registrar of Joint Stock Companies gives notice in the *London Gazette* that the following and many other companies will be struck off the register within three months, unless cause is shown to the contrary:—

Birmingham House-to-House Electricity Company, Limited.
Caustic Soda and Chlorine Syndicate.
Dalziel's Atlantic Telegram Company.
Electrical Accessories Company.
Electric Light and Power Share Trust.
Exeter Electric Light Company.
Irish House-to-House Electricity Company.
Lancashire and Cheshire House-to-House Electricity Company.
Liverpool House-to-House Electricity Company.
Manchester House-to-House Electricity Company.
Midland House-to-House Electricity Company.
Nightingale Automatic Electrical Machine Company.
Northern House-to-House Electricity Company.
Pacific Telegraph Company.
Railway Electric Fog Signal Syndicate.
Railway Electric Reading Lamp Company.
South of England House-to-House Electricity Company.
Western House-to-House Electricity Company.
Wrexham and District Electric Supply Company.

Metropolitan Electric Supply Company.

The following letter from a holder of founders' shares in this company appears in the *Financial News*:—"The proposal of the directors of the Metropolitan Electric Supply Company to offer in exchange for each founders' share an allotment of 140 ordinary shares at par, strikes me (a holder of two of the founders' shares) as a very inadequate proposal considering the present rapidly-increasing revenue of the company. It must be remembered that there are only 100 founders' shares in this company, and that the holders thereof are entitled to one-half of the entire profits after 7 per cent. is paid on the ordinary; this will ultimately mean a very large sum indeed as the capital increases. I venture to think, therefore, that the holders of founders' shares will do well to decline the directors' proposal at the forthcoming meeting.—C. Temple Layton."

Anglo-American Telegraph Company, Limited.

The report of the directors to the ordinary general meeting of the proprietors, to be held at Winchester House to-day, at 2 o'clock p.m., states that the total receipts from July 1st to December 31st, 1897, including the balance of £8,507 5s. 11d. brought forward from the last account, amounted to £187,832 0s. 11d. The traffic receipts show an increase of £6,540 as compared with the half-year ended December 31st, 1896. The total expenses of the half-year, including the repair of cables, &c., as shown by the revenue account, amounted to £58,372 4s. 5d., being an increase of £371 16s. 8d. over the corresponding period of 1896. The directors, under the powers conferred upon them by the articles of association, have, before declaring the net profits, set apart the sum of £12,000 to the renewal fund, leaving a balance of £117,459 16s. 6d. Interim quarterly dividends of 14s. per cent. on the ordinary stock, and £1 8s. per cent. on the preferred stock, were paid on November 1st last, absorbing £49,000, leaving a balance of £68,459 16s. 6d., out of which the directors recommend the proprietors to declare final dividends of 19s. 6d. per cent. on the ordinary stock, and £1 19s. per cent. on the preferred stock, amounting to £68,250, thus making a total distribution for the year ended December 31st, 1897, of £3 per cent. on the ordinary stock, and £6 per cent. on the preferred stock. The balance of £209 16s. 6d. will be carried forward to the next account. The cables and land lines of the company are in good working order. In accordance with the articles of association, two directors of the company, Sir Gerald FitzGerald and Charles Burt, Esq., retire at this meeting, and, being eligible, offer themselves for re-election. Mr. Joshua Dean and Mr. John Gane, F.C.A., the auditors, retire, and offer themselves for re-election.

Central London Railway Company.

The fifth ordinary general meeting was held on Wednesday at 16, Great George Street, S.W., Mr. Henry Tennant presiding.

The Chairman remarked that the number of shareholders had slightly increased during the half-year, and the number now stood at 1,073. In moving the adoption of the report, he said: On reference to the report you will perceive that the expenditure up to the end of the half-year now under review, has been £1,606,948 7s., and that the amount received on shares is £1,407,042. The expenditure, therefore, appears to have been more than the receipts, and the capital account shows a debit balance of £199,906 7s. Now this, in the main, is explained by the fact that £228,000 odd appears as owing to the Electric Traction Company under certificates from the engineers—that is, the engineers have certified that this sum is due to the contractors, and the company have not paid them. If you will look at the accounts, you will see that the Traction Company covenanted to take up a certain number of shares, and they now stand in the accounts as unissued shares. This, the Traction Company are ready to do, and therefore the sum entered as payable to them will be disposed of on the transactions as to the shares being completed, and that will be so completed before very long. The share capital, when that has been done, will stand thus:—The whole of the share capital will stand as issued with no less than £6 per share paid up thereon. I think there is nothing else in the accounts which I need trouble you about at present. What is more important is the question of the progress of the works which is dealt with in the engineers' report. According to that report, good progress has been made during the past six months, and I am glad to say that no serious hindrance to the engineers' operations have occurred during the half-year. You will observe the interesting fact that three-fourths of the ordinary tunnel—that is the main line tunnel, has been completed as well as one-half of the station tunnels—these station tunnels are, of course, a good deal wider than the ordinary tunnels so as to make room for platforms. One-half of these have been completed, and the shafts for the lifts, and staircases, the engineers say in their report, have been constructed. Of course, there may be some finishing work, but the main operation has been completed. I think I have said before that a very difficult work had to be undertaken, viz., the diversion of sewers. They are very difficult things to touch, especially in London, I think, and then gas and water pipes had to be taken up or removed, and all that had to be done under the pavement at the Bank Station. Now, this is proceeding satisfactorily, and part of it is practically complete, and the public subways are well advanced. The operations in connection with access from the Waterloo and City Company to the public subways at the Bank are also, according to the engineers, making satisfactory progress, although great difficulty was encountered in the construction of this part of the work owing to sewers and other obstructions which had to be dealt with. I hope that all these difficulties are now practically surmounted. We have agreed provisionally for the construction of a low level connection between the platforms of the City and

South London Railway and the platforms of the Central London at the Bank station. The terms are to be embodied in an agreement, which the South London Company are preparing, and as we have not yet received it, I am not in a position to say anything further at the present moment respecting it. The arrangements for the supply of electrical equipment have been made, and the works have been commenced. In the present position of the railway, there are no materials for any long speeches. The time will come when the occupant of the chair, whoever he may be, will have plenty to talk about—that is, when the line has been completed for traffic, and is earning a dividend. He moved the adoption of the report, and the payment of interest at the rate of 3 per cent. per annum on the paid-up capital of the company.

Lord Colville of Culross seconded the motion, which was agreed to.

Mr. Tennant was re-elected a director.

The Liverpool Overhead Railway Company.

The directors' report to be presented to the half-yearly meeting of the shareholders, to be held at the Law Association Rooms, 14, Cook Street, Liverpool, on Tuesday, 8th inst., reads as follows:—

"In presenting the half-yearly statement of capital and revenue accounts to December 31st, 1897, the directors have to report that the gross revenue receipts amount to £37,583, and the working expenses to £24,240 4s. 1d.

"The number of passengers carried during the last two years is as follows:—

	Half-year ending June 30th, 1896.	Half-year ending December 31st, 1896.	Half-year ending June 30th, 1897.	Half-year ending December 31st, 1897.
First class ...	455,561	476,817	608,278	621,392
Second class	2,284,823	2,473,828	2,618,844	2,790,768
Workmen (special return tickets) ...	999,191	968,489	1,042,138	1,055,330
Total ...	3,739,575	3,919,134	4,269,260	4,467,490

Revenue Account.

	£	s.	d.
Receipts from passenger traffic amount to ...	£36,994	12	0
Miscellaneous receipts and interest	588	8	0
	£37,583	0	0
Less working expenses	24,240	4	1
	£13,342	15	11
Deduct interest on mortgage debentures ...	3,400	0	0
	£9,942	15	11
Add balance brought forward, June 30th, 1897	3,810	6	0
Leaving available for dividend	£13,753	1	11

"Out of this balance your directors recommend the declaration of dividends at the following rates (less income-tax), payable on and after February 11th next:—

5 per cent. per annum on preference shares	...	£3,000
3½ " " ordinary shares	...	7,875

leaving a balance of £2,878 1s. 11d. to be carried forward to next half-year.

"The directors retiring by rotation at this meeting are Mr. Edward Lawrence and Mr. George Hunter Robertson, who, being eligible, offer themselves for re-election. The auditor retiring by rotation is Mr. George Nicholson, who is also eligible for re-election."

The Yorkshire House-to-House Electricity Company, Limited.

The annual general meeting of the shareholders of the Yorkshire House-to-House Electricity Company, Limited, was held on Tuesday afternoon at the Great Northern Hotel, Leeds, Mr. Grosvenor Talbot presiding.

The Chairman, in moving the adoption of the balance-sheet and report, said that he hoped it would prove satisfactory to all. The amount of capital now raised by shares was £131,932, an increase of £33,372 over last year. The total amount expended on capital account was £161,009, representing an increase of £55,632. The large additional expenditure had been due in the first place to the erection of new buildings. They had added 1,000 horse-power to their engine capacity, the total capacity being now 2,800 horse-power, and had also largely improved the means of supplying the current to the centre of the town. They proposed to pay the same dividend as last year, and for this half-year at the rate of 7 per cent., making 6 per cent. for the year. The depreciation fund now amounted to £6,660, and the reserve fund to £8,000, while the total amount they held in reserve in one form and another was £17,929. During the past year they had increased the number of lamps by 9,754, and the units sold by 131,871. The Chairman then referred to the recent reduction of price, which, he said, had made electricity in Leeds the cheapest illuminant, and then went on to deal with the proposed acquisition of the company by the Corporation. In connection with this matter, he said that the directors knew no more about the subject than the shareholders themselves. He felt sure that they would endeavour to meet the demand in a fair spirit. The Corporation were sending a deputation to meet the directors in a week's time. The company was a flourishing and progressive concern, and he was confident that whatever they would be able to get from the Corporation would not be anything like its value either in the property or the rights which the Corporation would gain and which they would have to surrender.

Mr. A. G. Lupton seconded the resolution, which was carried unanimously.

A number of questions were asked as to the suggested taking over by the Corporation. Mr. Colbeck said that he had heard that some of the founders' shares might come into the market in order that their position might be tested.

The Chairman said that he had not heard of there being any likelihood of anything of the sort taking place. He did not think that anyone really knew what the value of those shares was, though a gentleman had written from London offering £170 each for them. Not a single share of that class had ever changed hands.

In answer to a question as to whether an effort had ever been made to redeem the founders' shares, the chairman said that the directors had inquired into the matter, and discovered that they could not redeem the shares without putting such a burden upon the concern as to render it extremely improbable that the shareholders would consent to the scheme. It would be such an exhaustive process that it would do away with dividends for some time to come.

Mr. A. G. Lupton and Mr. J. T. Pearson were re-elected directors, and the meeting closed with a vote of thanks to the chairman.

National Telephone Company.—The directors last week resolved, subject to final audit, to recommend, at the forthcoming general meeting of shareholders, the following dividends for the half-year ending December 31st, last: At the rate of 6 per cent. per annum, less income-tax, on the amounts paid up on the first and second preference shares; at the rate of 5 per cent. per annum, less income-tax, on the amounts paid up on the third preference shares; at the rate of 6 per cent. per annum, free of income-tax, on the amounts paid up on the ordinary shares, carrying £40,000 to reserve, and about £9,000 forward. The transfer books will be closed from February 4th to the 17th, both days inclusive, and the dividend warrants will be posted on the latter date. With regard to the 130,766 third preference shares issued in June last, the dividends thereon will be calculated from the dates fixed for payment of the various instalments.

Stock Exchange Notices.—The Stock Exchange Committee has appointed Wednesday, February 9th, a special settling day in New General Traction Company, Limited—20,000 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 34,001 to 54,000; and has ordered the undermentioned securities to be quoted in the Official List: City and South London Company—further issue of 832 5 per cent. perpetual preference shares, Nos. 8,420 to 9,251; New General Traction Company, Limited—20,000 6 per cent. cumulative preference shares, Nos. 34,001 to 54,000.

General Electrolytic Parent Company.—The directors of the General Electrolytic Parent Company, Farnworth, near Widnes (owners of the Hargreaves-Bird Electrolytic Alkali process), have issued warrants to the shareholders for the payment of an interim dividend of 50 per cent. on the capital of the company, free of income-tax.

Waterloo and City Railway Company.—The report of the directors and statement of accounts for the half-year ended December 31st, 1897, states that the sum of £113,170 was expended during the half-year. The shares being now fully paid up, the directors recommend that they be converted into a general capital stock.

Cuba Submarine Telegraph Company.—The directors have declared a dividend for the past half-year at the rate of 6 per cent. per annum.

The Electric Light Company.—A private meeting of the above (a new company) was held on Monday last, at Cannon Street Hotel.

London Electrical Cab Company.—The letters of allotment for the new issue of shares, have been posted.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending January 30th, 1898, were £1,059; week ending January 31st, 1897, £1,101; decrease £42; total receipts for half-year, 1898, £5,393; corresponding period, 1897, £5,488; decrease, £95.

The Liverpool Overhead Railway Company. The receipts for the week ending January 30th, 1898, amounted to £1,337; corresponding week last year, £1,227; increase, £110.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending January 28th, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,808.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, Jan. 26th.	Closing Quotation, Feb. 2nd.	Business done during week ended Feb. 2nd, 1898. Highest.	Lowest
137,400*l*	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	...	...	100 —104	100 104	...	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	6 — 7	6 — 7	...	...
125,000	Do. do. 5% Debs. Red.	100	...	...	...	93 — 96	93 — 96	...	...
923,960*l*	Anglo-American Teleg., Ltd.	Stock	£2 9s.	£2 13s.	3 %	61 — 63	62 — 64	62½	...
3,038,020*l*	Do. do. 6 % Pref.	Stock	£4 18s.	£5 6s.	6 %	111 — 112	112½ - 113½	113	111⅝
3,038,020*l*	Do. do. Defd.	Stock	...	...	...	12⅞ - 13¼	13¼ — 13⅝	13⅝	12 13/16
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	...	...	16½ - 17	16¾ — 17¼	...	...
75,000*l*	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	...	...	112 —116	112 —116	...	...
44,000	Chili Teleg., Ltd., Nos. 1 to 44,000	5	4 %	4 %	...	3 — 3½	3 — 3½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	...	187 —192	187 —192	...	...
653,586*l*	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	105 —107	106 —108	107½	106⅝
224,850	Consolidated Teleg. Const. and Main., Ltd.	10/-	1½%	2 %	...	1/16 — 3/16	1/16 — 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	...	8 — 9	8 — 9	8½	...
6,000	Do. 10 % Pref.	10	10 %	10 %	...	18 — 19	18 — 19	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	...	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	...	10 — 11	10 — 11	...	...
30,000*l*	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	...	103 —106%	103 —106%	...	...
60,710	Direct United States Cable, Ltd.	20	2½%	2½%	...	10½ — 11	10½ — 11	11	10 13/16
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	...	18 — 18½	18 — 18½	18 1/16	18 1/16
70,000	Do. 6 % Cum. Pref.	10	6	6%	...	19 — 20	19 — 20	19½	...
89,900*l*	Do. 5 % Debs., repay. August, 1899	100	5 %	5%	...	102 —105	100 — 103 xd	...	...
1,302,615*l*	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4%	...	131 —134	131 —134	133½	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7%	...	18¾ 19¼	18¾ — 19¼	19¼	18⅞
25,200*l*	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5%	...	99 —103	99 —103	...	...
100,500*l*	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5%	...	100 —103	100 —103	...	...
320,000*l*	Do. 4 % Deb. Stock	Stock	4 %	4%	...	132 —135	130 —133 xd	...	...
51,100*l*	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5%	...	99 —103	99 —103	...	...
69,200*l*	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5%	...	100 —103	100 —103	...	...
300,000*l*	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1906	100	4 %	4%	...	104 —107	102 —105 xd	...	...
200,000*l*	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4%	...	108 —111%	108 —111 %	108	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	...	12 — 12½	12 — 12½xd	12 5/16	12
180,042	Do. do. 6 % Pref.	10	6 %	6%	...	17¾ — 18¼	17¾ — 18¼xd	18 1/16	17⅞
150,000	Great Northern Teleg. Company of Copenhagen	10	10 %	10%	...	27 — 28	27 — 28	...	...
160,000*l*	Do. do. do. 5 % Debs.	100	5 %	5%	...	101 —104	101 —104	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10%	...	52 — 55	52 — 55	54¾	54½
100,000*l*	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6%	...	108 — 111	108 —111	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	...	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5½%	5½%	6 %	6⅝ — 6⅞	6¾ — 7	7	6 11/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	16 15/16	16¼
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	14 — 16	14 — 16	16	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6 — 6½	6 — 6½	6 7/16	6 3/16
130,766	Do. do. Nos. 119,235 to 250,000, £5 paid	5	...	...	5 %	6 — 6½	6 — 6½	...	...
329,471*l*	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½ %	104 —109	104 —109	106½	104½
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	⅝ - ¾	⅝ - ¾	...	...
100,000*l*	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	...	105 - 108	105 —108	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	7½ - 8½	8 — 9	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	140 — 145	140 — 145	...	...
58,000	United River Plate Teleph., Ltd.	5	4 %	...	...	4 — 4½	4 — 4½	...	...
146,733*l*	Do. do. 5 % Debs.	Stock	5 %	...	...	101 —106	101 —106	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	nil	...	4 — 5	4 — 5	...	...
213,400*l*	Do. do. do. 5 % Debs.	100	5 %	5 %	...	103 —106	103 —106	...	...
64,268	Western and Brazilian Teleg., Ltd.	15	3 %	2 %	...	9¾ — 10¼	10½ — 11	10 15/16	10⅜
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	...	7½ — 8	7½ — 8	...	...
33,129	Do. do. do. Def. Ord.	7½	1 %	...	...	2¾ — 3¼	3½ — 4	3⅜	3⅛
382,230	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	105 —107	105 —107	106½	...
88,321	West India and Panama Teleg., Ltd.	10	⅜%	1 %	...	⅜ — ⅝	½ — ¾	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	7 — 7½	7¾ — 8¼	8	7½
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	5 — 7	5 — 7	...	...
80,000*l*	Do. do. 5 % Debs. No. 1 to 1,600 ...	100	5 %	5 %	...	105 —108	105 —108	...	...
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7%	...	105 —110	105 —110	...	...
160,100*l*	Do. do. 6 % Ster. Bonds.	100	6 %	6%	...	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share.	1895.	1896.	1897.	Closing Quotation, Jan. 26th.	Closing Quotation, Feb. 2nd.	Highest.	Lowest
30,000	Charing Cross and Strand Electy. Supply	5	5 %	6 %	7 %	14 — 15	14 — 15	15	14⅜
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6¼ - 6¾	6¼ — 6¾	6⅜	...
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 16,277 ...	5	5 %	5 %	...	10¾ — 11¼	11¼ — 11¾	11⅝	11
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	4½%	4½%	...	112 —114	112 —114	...	...
40,000	City of London Elec.Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	7 %	...	30 — 31	29½ — 30½	31	29½
10,000	Do. do. Prov. Certs.	5	...	...	...	29½ — 30½	29 — 30	29½	28½
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	...	17 — 18	17½ — 18½	17¾	17⅝
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	...	129 —134	129 —134	131	...
30,000	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—30,000	10	nil	nil	...	15 — 15½	15¾ — 16¼	16⅛	15⅛
20,000	Do. do. do. 6% Pref., 40,001—60,000 ...	10	6 %	6 %	...	15¾ — 16¼	15¾ — 16¼	16¼	15 1/16
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5	...	...	...	10 — 11	10½ — 11½	11	10¾
10,000	Do. do. 7 % Cum. Pref. ...	5	...	...	...	11¼ — 11¾	11½ — 12	12	11 13/16
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	4 %	5 %	...	19½ — 20½	20 — 21	20⅝	19⅞
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem. ...	10	...	...	...	19 — 20	19½ — 20½	19⅞	19 9/16
220,000*l*	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	117 — 121	117 —121	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	2½%	4 %	...	18 — 19	18 — 19	...	...
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	7½%	10½%	14½ %	18 — 19	18 — 19	18⅞	18⅜
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	10 — 11	10 — 11	...	...
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	4 %	101 —104	101 —104	...	...
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2⅞ — 3⅛	2⅞ — 3⅛	3 1/16	2 15/16
79,900	Westminster Electric Supply Corp., Ord., 101 to 80,000 ...	5	7 %	9 %	12 %	17 — 18	18 — 19	18⅝	18

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred shar° warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first par of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, Jan. 26th.	Closing Quotation Feb. 2nd.	Business done during week ended Feb. 2nd, 1898. Highest.	Lowest.
30,000	British Electric Traction	10	...	...	...	17¼ — 17¾	18½ — 19	18⅞	17½
90,000	Brush Elec. Enging. Co., Ord., 1 to 90,000... ..	4	...	...	...	2⅛ – 2⅜	2⅛ – 2⅜	2 7/16	2 3/16
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	...	...	2⅛ — 2⅜	2⅛ — 2⅜	2⅜	2 5/16
125,000*l*	Do. do. 4½ % Perp. Deb. Stock... ..	Stock	...	...	...	109 — 113	109 – 113	...	...
50,000	Do. do. 4½% 2nd Deb. Stock Red. ..	Stock	...	...	...	102 — 105	102 — 105	...	...
19,126	Central London Railway, Ord. Shares	10	...	...	...	9¾ — 10¼	9¾ — 10¼	10 3/16	10
143,106	Do. do. do. £6 paid	10	...	...	...	5¾ — 6¼	5¾ — 6¼	6 3/16	5 15/16
58,830	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1¼ — 1⅜	1¼ — 1⅜	1⅜	1 7/16
61,777	Do. do. Def. do. £5 pd. ...	...	...	...	...	4¼ — 4¾	4¼ — 4¾	4 9/16	4¼
630,000*l*	City and South London Railway	Stock	1 9/16 %	1 9/16 %	1⅞ %	69 — 71	69 — 71	71	70½
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	nil	...	...	2¼ — 2¾	2¼ 2¾	...	...
99,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 99,261	5	5 %	5½%	...	2½ 3	2½ — 3	2 13/16	...
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5½%	...	4½ — 5½	4½ — 5½	4 13/16	4⅞
118,000	Electric Construction, Ltd., 1 to 118,000	2	5 %	6 %	...	2¾ – 3	2¾ — 3xd	2 15/16	2 13/16
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 ...	2	7 %	7 %	...	3⅛ — 3⅝	3⅛ – 3⅝	3⅝	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	...	...	...	½ – ¾	½ – ¾	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	...	...	...	⅜ — ⅝	½ — ¾	...	...
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	10½%	.	...	9 — 11	9 — 11	..	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	8 %	10 %	...	21 — 22	21½ – 22½	22	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	...	18½ – 19½	19 — 20	19⅜	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	...	110 — 115	110 – 115	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	...	23 — 24	22½ – 23½	23¼	22⅝
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	103 — 107	103 — 107	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	2⅞%	2⅞%	...	11⅜ 11½	11 5/16 – 11 7/16	...	...
18,000	† Do. do. Pref., £10 paid	10	5 %	5 %	...	16 — 16½	16 — 16½	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	15 %	...	39 — 42	39 — 42	40½	39¾
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	...	102 — 105	102 — 105	...	...
54,900*l*	Waterloo and City Railway, Nos. 1 to 54,900	10	...	..	...	12¾ — 13¼	13½ — 14	13⅞	13

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0 %; 1891—7 %; 1890—8 %.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

* Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 11.

Electric Construction Corporation, 6 % Debentures, 105—106.

House-to-House Company, 4½% Debentures of £100, 108—110.

Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 15—15½; 1st Preference Cumulative 6 %, £5 (fully paid), 8¼—8¾. Dividend, 1896, on Ordinary Shares 7 %.

London Electric Supply Corporation, £5 Ordinary, 3—3½.

* T. Parker, Ltd., £10 (fully paid), 12⅜.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares (fully paid, 8¼—8¾. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount 3 per cent. (October 14th, 1897).

THE INSTITUTION OF ELECTRICAL ENGINEERS.

ABSTRACT OF INAUGURAL ADDRESS.

By J. W. Swan, F.R.S., President.

(*Concluded from page* 132.)

Gold Extraction.

Before the introduction of the cyanide process for the treatment of gold ore, various electrolytic methods, chiefly based upon the solvent action of electrolytic *chlorine*, had been proposed and worked; but the purely chemical cyanide process has largely, if not wholly, superseded these electrolytic methods for the primary treatment of gold ore. Messrs. Siemens & Halske, however, have patented and successfully introduced a method for treating the cyanide liquors from the tailings, or waste sludges, produced in cyanide gold extraction, and containing a very small amount of gold. An extremely dilute solution of cyanide is employed to dissolve the gold. This is afterwards subjected to electrolysis, with iron anodes and thin lead cathodes, with a current density of one or two-tenths of an ampere per square foot. This results in an almost complete recovery of the gold in an adherent form upon the lead cathode. When the required amount of gold has been deposited, the cathodes are removed, and the gold separated by cupellation. This process appears to be exactly suited to the clean quartzite ore of the Transvaal. Over 1,000,000 tons a year of tailings, such as were formerly discarded as useless, are now profitable treated by this process.

Zinc Extraction.

The extraction of zinc from its ores by electrolysis is a problem, on the solution of which much ingenuity and a considerable amount of money have been expended. It is a tempting problem, inasmuch as the method in common use of reducing the native sulphide or the carbonate of zinc to the state of oxide by calcination, mixing this with non-bituminous coal, and distilling in clay retorts at an extremely high temperature, is absolutely barbaric in its primitiveness and its wastefulness.

A step has been recently taken towards this object by means of a process (the invention of Dr. Hoepfner) at present being worked by Messrs. Brunner & Mond. In this process zinc chloride is electrolysed; the products are chlorine and zinc. Such zinc is purer than ordinary commercial zinc, and will no doubt be welcomed by the users of zinc in primary batteries.

For the electrolytic treatment of that hitherto intractable class of ore such as the Broken Hill Mine produces—the mixed sulphides of lead and zinc—two processes deserve mention—one, the Ashcroft process, because very extensive preparations have been made for carrying it out on a large scale; and the other, that of Cowper-Coles.

These bold attempts in new directions deserve success.

Aluminium Extraction.

One of the largest, the most important, and in many respects the most interesting of the electro-chemical industries is that of the production of aluminium. In 1855 the price of aluminium was not far from the price of *silver*, when silver was twice its present value. Now, bulk for bulk, it is the price of *copper*. It is no longer bought by the *ounce*, but by the *pound* or *ton*. The full measure of change has been brought about by the employment of electrolytic extraction. It is an instance of an electrolytic method displacing a thoroughly elaborated and established chemical method, and of the enormous increase in demand that has followed a reduction of price. The production at the present time is, I estimate, not less than 2,000 tons a year. At least 10,000 horse-power is absorbed in this industry alone, and power to double that amount is about to be applied to it. There is every probability that new uses will be found for the metal, and that the manufacture will become a much larger one than it is at present.

Although English enterprise was prompt to adopt and improve the original chemical process, the production of aluminium had wholly departed from us until the British Aluminium Company recommenced the manufacture in the electrolytic form, across the Border, attracted there by the advantage of cheap water power.

The process by which aluminium is extracted, in *America*, on the *Continent*, and in *Scotland* to-day, is in principle exactly similar to that by which Davy extracted potassium from potash 92 *years ago*. The electrolyte is kept in a state of fusion by the electrically generated heat. There are nominally two processes in use, but the difference is extremely small—chiefly a slight difference in the composition of the electrolyte. That known as Hall's process has as its distinctive feature an electrolytic bath composed of potassium fluoride in which alumina prepared from bauxite is continuously dissolved; while in

Heroult's process the solvent of the alumina consists of cryolite, the double fluoride of aluminium and sodium. The electrolytic furnace consists of a carbon-lined iron box connected with the negative pole of a dynamo; this contains the electrolytic bath. Massive blocks of carbon are connected with the other terminal of the dynamo, and form the positive pole. These are immersed in the bath of fused material, and nearly reach the bottom.

The carbon used in the manufacture of the anodes and for lining the furnace is required to be of great purity and hardness. The current density employed is very large—about 700 amperes per square foot of cathode surface, about 8,000 amperes per cell. A difference of potential of 5 volts is maintained between the electrodes. In practice, 14 electrical horse-power hours are expended in the production of 1 lb. of aluminium. If a mean pressure of 5 volts is assumed, the theoretical yield should be nearly one-third of a pound more; there is, therefore, some secondary and wasteful action as well as true electrolytic action going on, and room for further economy.

Sodium Extraction.

The experiment by which Davy set free the few minute globules of metallic potassium in the little pool of fused potash has to-day its fruition in the electrolytic process of Castner for the extraction of *sodium*. In the Castner sodium process an electrolyte of fused caustic soda is employed, with an anode of iron and a cathode of copper. The sodium is reduced at a comparatively low temperature, and while in a fused state is run off into moulds. By this process there is produced in one works 260 tons of sodium a year.

Sodium is also extracted electrolytically in Germany, and, I believe, in America. The electrolytic process of sodium extraction is so much more economical than the chemical process as to have almost completely displaced it.

Electrolytic Alkali Production.

I now come to perhaps the most important of all the applications of electro-chemistry at present engaging the attention of chemical and electrical engineers, namely, its application to the alkali manufacture.

There are now several processes in commercial operation for the production of caustic alkali, and chlorine from brine.

In the process of Holland and Richardson brine is electrolysed in a tank divided into anode and cathode compartments by impermeable partitions reaching nearly down to the bottom of the tank. The anode compartment is enclosed, and provided with a flue for conducting the chlorine to bleaching powder chambers. Carbon anodes and iron cathodes are used. During electrolysis the caustic alkali formed at the cathode dissolves, sinks down to the bottom of the tank, and is drawn off; this alkaline solution is subsequently evaporated and fused.

A somewhat similar process has been introduced by Messrs. Hargreaves and Bird for the manufacture of bleaching powder and alkaline carbonates.

In the process of Hulin—in which brine is electrolysed for the process of soda and chlorine—the anode and cathode are both of carbon, but the carbon cathode is in the form of a thin porous partition. The peculiarity of the process is the percolation through the cathode partition of the stratum of the electrolyte in contact with it. This portion of the electrolyte is most strongly charged with alkali, and is forced slowly through the diaphragm by slight pressure on the surface of the bath, caused by restraining the escape of chlorine.

In the processes described, considerable loss and many disadvantages arise from imperfect separation of the products of the electrolytic action at the anode and cathode. There have been a number of inventions with a view to avoid this defect. The apparatus of Castner and Kellner is one that grapples with the difficulty in a most ingenious and effective manner, and it is especially entitled to notice because it is already in extensive commercial use. 10,000 tons of caustic soda and over 20,000 tons of bleaching powder will be produced by it this year.

The elementary apparatus consists of a shallow rectangular slate trough, divided into three compartments by two partitions. These cross the trough from side to side, but do not quite reach the bottom, which is grooved to form a shallow gutter under each partition. The partitions dip into the gutters sufficiently deeply to ensure complete isolation of the three compartments when the gutters are filled to the level of the bottom of the trough with mercury. During operation the mercury not only fills the gutters, but extends in a thin stratum over the bottom of the trough. The trough is so mounted that a slow and extremely slight oscillatory movement is given to it. This results, when one end is tilted up, in the stratum of mercury on the bottom running out of the upper end compartment into the middle compartment. The alternate rise and fall of the ends of the trough is so small that the movement is almost imperceptible, but it is sufficient to cause the mercury in the compartment at the raised end to run into the middle compartment, and that from the middle compartment into the lower end compartment; that is to say, there is an alternate flow of mercury from end to end, which alternately leaves the raised end compartments denuded of mercury, but the floor of the middle compartment and of one of the end compartments are always covered with mercury. The grooves into which the partitions dip always contain mercury, and completely prevent the mixing of the electrolyte in the three compartments. The two end compartments contain brine and carbon anodes, and the centre compartment an iron cathode and water. The anode compartments are covered with glass, and provided with pipes for the conveyance away of chlorine to bleaching powder chambers. During the working of the process, sodium is deposited upon the mercury, with which it instantly amalgamates; the tank is then tilted until the mercury in an anode compartment runs into the cathode compartment, where the sodium is oxidised and dissolved by the water. The current generated by the oxidation and solution of the sodium helps to reduce the power required for electrolysis; for it will be seen that the sheet of mercury lying on the floor of the trough and divided by the partition is always negative in the end compartments and positive in the middle compartment relatively to the opposed electrodes.

The chlorine evolved at the anode is, so far, entirely used for the manufacture of bleaching powder. The caustic soda produced by this process is of great purity.

Closely resembling the Castner-Kellner apparatus is that lately invented by Rhodin, in which the mercury-sealed anode compartments are capable of being rotated, and the construction is such that external heating may be applied, a higher current density employed, and such temperature conditions maintained as are necessary for obtaining the best result.

Electrolytic chlorine is also extensively applied to the production of chlorate of potash. The manufacture of chlorate of potash by electrolysis is performed in a tank divided by a porous partition, with very thin iridio-platinum anodes and iron cathodes. The electrolyte in the anode compartment is usually a solution of chloride of potassium maintained at a temperature of 45° to 50° C. The solution from the cathode compartment containing caustic potash is continuously supplied to the anode compartment, where the potash absorbs the chlorine, with the production of hypochlorite, which is almost immediately decomposed, with the formation of chloride and chlorate of potassium. The chlorate is removed from the electrolyte in crystals. The yield of chlorate of potash is about 1 lb. per 5 electrical horse-power-hours—nearly 45 per cent. of the theoretical amount. In Switzerland and in Sweden chlorate of potash is now largely produced electrolytically by water power. I am informed on very good authority that preparations are in progress for a large increase of production, and that there is no question as to the electrolytic method entirely superseding the purely chemical method.

Electro-thermal Processes.

The electro-chemical processes I have so far described or referred to are all of them of the electrolytic kind. There are other electro-chemical processes which are not electrolytic, but which are important, and deserve mention. I refer, in the first place, to a group of processes and effects which depend on the principle of dissociation and combination at extremely high temperatures, and which involve the employment of the electric furnace, first suggested and applied experimentally by Sir William Siemens.

In this class is included the electro-thermal manufacture of phosphorus; also that most useful and interesting polishing and cutting material next in hardness to the diamond, carborundum—the invention of Mr. Acheson.

Mr. Acheson has developed the size of the electric furnace to enormous proportions, and made it yield results of great industrial value. Amongst these I must mention incidentally—for it is not a chemical, but a physical action—the complete transformation of amorphous carbon into graphitic carbon. It is not new to produce this transformation on a small scale, but to completely convert large masses of carbon into graphite is both new and of great importance.

It is well known that blocks of carbon as ordinarily manufactured, when used as anodes in an electrolytic cell, rapidly disintegrate; and until now this has been a serious difficulty in the construction of electrolytic apparatus like that of Castner-Kellner. This difficulty is completely met by the use of graphite anodes, into which ordinary amorphous carbon anodes are now being transformed by the electric furnace.

Some idea of the scale of these electric-furnace operations may be formed when it is realised that 1,000 electrical horse-power for 36 hours is expended in one heating.

To the same class of electro-thermal products belong carbide of calcium and a great number of analogous products, first obtained by M. Moissan by means of the electric furnace, employed with the most admirable skill, guided by thorough scientific knowledge, and the exercise of that kind of imagination which apprehends and realises far-off possibilities. I am informed by Mr. Worth, of the Acetylene Company, that carbide of calcium is now being manufactured at the rate of probably 20,000 tons per annum. Considering the value of this substance as a means of easily generating the highly illuminating gas, acetylene, and other products, there appears to be great probability of this manufacture becoming much larger.

Ozone Manufacture.

I must not omit to mention a quite different order of electro-chemical effects, in which alternate or intermittent currents of high tension are employed to induce the formation of ozone. By means of ozone, secondary chemical effects of great value are obtained; among these I may mention the manufacture of vanillin and heliotropine, now established manufactures.

Ozone has also been applied to wax bleaching, and to the thickening and bleaching of oils, and to a number of other important uses.

Prospects of the Electro-Chemical Industry.

Although I have but touched the fringe of this matter, I will not weary you with further examples of the value and extent of the applications of electricity to chemical manufactures. I have shown that already there is a large amount of valuable electro-chemical work being done, and that there is a limitless prospect of expansion.

Looking at the immediate future, many interesting questions present themselves, which must be considered, even though we may not be able to completely answer them. Amongst these are the questions, To what extent, and in what cases, are electro-chemical methods likely to supplant old-established chemical methods? And it is not too soon to ask where, and by what means, will the new electrolytic manufactures be ultimately carried on?

Will the introduction of electro-chemical methods of manufacture uproot the old manufactures from their ancient habitat?

In the time that has passed, Britain has enjoyed in chemical manufactures a great advantage in the possession of an abundance of coal.

We are about, in some measure, to lose the benefit of this advantage through the innovations of electro-chemistry.

Whether we profit or lose by the change, largely depends on our readiness or unreadiness to adapt ourselves to the new order of things.

Whatever happens, nothing can be more certain than this—that the electrical engineer who adds to the ordinary knowledge of his profession a competent knowledge of the principles of electro-chemical practice in manufacturing operations, is thereby making broader and surer his path to success.

Addendum—Ratio of Cost of Power to Production in Electrolytic Manufactures.

Material.	Electrical Horse-Power-Hours consumed in the Production of 1 Lb.	Cost of Power to produce 1 Lb. with 1 E.H.P. at £5 and £10 a Year.	
		At £5	At £10
		Pence.	Pence.
Aluminium	14	1·75	3 5
Nickel	1	0·13	0·26
Sodium	3·33	0 41	0·82
Caustic soda + 2⅓ lbs. bleaching powder	2·7	0·33	0·66
Chlorate of potash	5	0·62	1·24
Zinc extraction	1	0 13	0 26
Copper „	0 5	0 065	0·13
Copper refining	0 25	0·032	0 064

PHYSICAL SOCIETY.

Ordinary Meeting, January 21st, 1898.

Mr. Shelford Bidwell, President, in the chair.

Prof. Fitzgerald exhibited some photographs by Mr. Preston in illustration of the Zeeman effect for various cases, including those of iron, cadmium, zinc, and sodium. These photographs, and the method of obtaining them, have already been described. The cause of doubling is now attributed by Prof. Fitzgerald to absorption by the surrounding vapour. In a particular case he examined a double line that exists in one of the photographs. Under the polariser the two lines are at first distinctly seen; but when the polariser is turned, a thin line appears in the middle, and this central line is therefore circularly polarised in a direction opposite to that of the outer pair of lines. The reason for the appearance of doubling in the first position of the polariser is that the central line is there completely absorbed out by the surrounding vapour.

Prof. Oliver Lodge then gave a communication concerning his work on "Electric Signalling Without Connecting Wires."

From the nature of the oscillatory disturbances emanating from any of the customary forms of Hertz vibrator, syntony has hitherto been only very partially available as a means for discriminating between receivers. There is, in fact, so rapid a decrease in the amplitude of the vibrations that almost any receiver can respond to some extent. Discrimination by syntony is possible with magnetic systems of space telegraphy where the magnetic energy much exceeds the electric, *i.e.*, as between two separated inductive coils; and by the use of such coils, appropriately applied, the author has been able to attain fair syntony even with true Hertz waves—*i.e.*, he has constructed spark-gap oscillators, with sufficient persistence of vibration, and syntonised resonators. The "coherer" principle can be applied to either a purely magnetic or to the Hertzian system. It was first used by Prof. Lodge in devising lightning guards, and afterwards in his magnetic system of telegraphy by inductive circuits, each in series with a Leyden jar; a pair of knobs in near contact, or other overflow gap, being provided in the receiving apparatus. This was the first meaning of a "coherer" in the electrical sense, as used by Prof. Lodge. It referred to a *single* contact between two metal knobs. The term has since been extended by others to the filings-tube of M. Branly, and some confusion has arisen, for M. Branly does not consider that simple coherence and break explains fully the behaviour of his instrument. Prof. Lodge is disposed to agree, for he finds that the resistance of almost any form of coherer varies in rough proportion to the received impulses, and that there are other peculiarities (to be mentioned later); he is, therefore, inclined to think that the action cannot, after all, be entirely explained as due to mere "welding," but that there is something more to be learnt about it. The sensitiveness of a coherer depends upon the number of loose contacts; it is a maximum for a single contact, *i.e.*, for a needle-point lightly touching a steel spring. With this sensitive coherer, hardly any "tapping-back" is required for decoherence, but it wants delicate treatment when properly adjusted, and the greatest current through it should not approach a milliampere. On the other hand, a Branly tube rather improves under rough treatment; in such a tube the author prefers to use iron filings in the best possible vacuum; brass too is very good, but rather less easy to manage. Aluminium is thoroughly bad, and gold, for the opposite reason, will not work, its surface is too clean. Points, or small surfaces for making contact with the filings, are better than large surfaces. The usual method of connecting the coherer across the gap of an ordinary Hertz receiver, in parallel with the telegraph instrument and battery, has the unavoidable objection that they shunt away part of the received oscillations. In the syntonic receiver of Prof. Lodge, which contains no gap but a closed wire coil instead, the difficulty no longer exists; for the coherer can now be in series with the detecting instrument, and in so far as these obstruct the oscillations, they may be shunted out in various ways, as the author describes. The main feature of his new systonised vibrators is this self-inductance coil, whose function it is to prolong the duration of the oscillations, and thereby to render syntony possible. Although such a coil acts disadvantageously, in so far as it possesses resistance, the resistance does not increase so fast as the self-induction. The coil should consist of thick copper of highest conductivity, and it should have maximum inductance for given resistance. For similar reasons, the capacity-areas should also be of highest conductivity, their dimensions should increase outwards from the spark-gap as triangles. The receiver must have no gap, it should be accurately bridged over when a transmitter is used as receiver. The limit of speed of response depends upon the telegraphic instrument. Dr. Muirhead adapted a siphon-recorder to the purpose, because it is one of the quickest responders; he arranged it so that it could be used with intermittent currents, direct. Under these intermittent impulses the siphon trembles; and instead of the ordinary siphon-signals, the slip is marked with dots and dashes. Constant mechanical tremor is usually employed for decoherence, but the author finds that decoherence can be brought about by electrical means, without any mechanical tremor, by connecting the coherer momentarily to a circuit less effective as a collector than that of the proper capacity-areas of the syntonised receiver. The battery and galvanometer detector-circuit may be used for this purpose; the coherer being momentarily connected to it, and while so connected letting it experience an impulse from a distance. Prof. Lodge has designed a revolving commutator, by means of which the coherer can be rapidly changed over from the resonating circuit to the instrument circuit, and finally to the "tapping back" apparatus. A coherer is more sensitive when thus isolated and exposed to the full influence of the received oscillations; the subsequent detection of the effect by altered connections is very convenient for laboratory measurements. A diagram of a series of plotted measurements showed that the resistance of an undisturbed filings tube is approximately a direct function of the intensity of the received stimulus, whether successive stimuli increased or decreased in strength. This electrical process of "tapping back" is to be depended upon, but the process long continued fatigues the tube until a mechanical shake is employed to restore it. Large size apparatus made by Dr. Muirhead for actual distant syntonic work was exhibited, and means were shown for protecting and isolating the coherer when its receiving areas were being used as emitters; also a switch used for changing at one moment all the connections from "sending" to "receiving."

Prof. Threlfall said he had come to the same conclusion as Prof. Lodge as to the advisability of diminishing the number of contact points in the coherer. He had endeavoured to produce longer and more persistent waves, and thus to set afield greater effective energy. It was desirable to keep the waves as parallel as possible. He thought there was some probability that the wave-fronts could be altered and rendered more conformable by a process of diffraction.

Mr. Rutherford also had found it best to work with long waves. He fully appreciated the advantage of increasing the capacity of the oscillator by extending the surface of the metallic plates.

Mr. Campbell Swinton asked whether experiments had been made to verify Hertz results as to the influence of reflectors behind oscillators and receivers. He had found them disadvantageous. A single wire behind either apparatus seemed partially to annul the effect. He also asked whether Prof. Lodge had observed the extraordinary sensitiveness of coherers to small changes of current in neighbouring circuits.

Prof. Lodge, in reply, said he had observed the sensitiveness to slight, sudden variations of current referred to by Mr. Campbell Swinton, for instance, when electric lamps were switched on or off. The effect of mirrors had been studied by Prof. Fitzgerald. They required to be of large dimensions as compared to the oscillator and receiver, otherwise the true reflections were not obtained.

Dr. Silvanus Thompson afterwards exhibited a Tesla oscillator. This apparatus is intended to replace the two induction coils and spark-gap arrangements used by Mr. Tesla for high frequency experiments. It consists of an induction coil with a separate self-inductance coil in the primary circuit. This self-inductance coil is also used as an electro-magnet for the separate interrupter of the primary circuit. A condenser is connected between one end of the primary coil and one terminal of the interrupter, so as to include both of them between its terminals. The primary is a single turn of copper strip, six inches wide. The secondary is one layer of thick wire; each turn separated from the next by an air space. The supply current, about half an ampere, may be taken from the electric light mains at almost any voltage from 50 to 200, direct or alternating.

Prof. Lodge said it would work quite well at 10 volts. He pointed out, also, that if the straight discharge rods at the spark-gap were free to slide, the discharge drove them back into their sockets.

Prof. Fitzgerald said it was stated at Toronto that the spark was broken at the interrupter when the condenser was charged, and that by the time the condenser was ready to discharge, the contact at the interrupter had been made again. It seemed to him that the condenser discharges and surgings must take place at a rate far higher than the period of the mechanical movement of the interrupter. The condenser charges and discharges were very rapid. It was not what is ordinarily called the "time constant" that was involved, for that only referred to constant voltage. Here the voltage was changing very rapidly indeed.

Prof. Herschel asked if such an apparatus was suitable for work with Röntgen rays.

Dr. Thompson, in reply, congratulated Mr. Tesla upon the perfect working and compactness of his invention. The present form was not suited for Röntgen ray experiments, but Mr. Tesla had designed a special coil that was excellent for that purpose.

The President proposed votes of thanks, and the meeting was adjourned until February 11th.

NOTES ON THE ELECTRO-CHEMICAL TREATMENT OF AURIFEROUS ORES.

The object of the gold mining industry is to obtain the precious metal from its ores in the simplest, cheapest, and most efficient manner. First, the ores are pulverised, then the gold which they contain has to be absorbed by mercury, or dissolved by chlorine, bromine, cyanide, or their compounds, or by other solvents; then comes the operation for the recovery of gold by distillation of amalgams, precipitation by chemicals, or by electro-deposition.

Is the *rôle* of electricity confined to the precipitation of the metal or does it assist in dissolving gold?

Major-General C. E. Webber, read on the 28th ult., at the Institution of Electrical Engineers, a paper on "Notes on the Electro-chemical Treatment of Ores containing the Precious Metals," in which he says that "the precipitation of gold and silver with the aid of the electric current has a history which may help his audience to appreciate the present situation of a question which cannot be devoid of interest to the members of the Institution of Electrical Engineers."

This preamble sounded well and looked very promising for electro-metallurgists, who expected that some light would be thrown on the influence of electrolysis on auriferous ores in a dissolving liquid containing either chlorine, bromine, cyanide of potassium, chloro or bromo-cyanogen.

Major-General Webber passed in review a legion of patents, and went back to Becquerel (1835), Crosse (1837), Prince Bagration (1844), who "described in the *Bulletin de l'Académie des Sciences de Saint Pétersbourg*, some experiments with finely divided gold dissolved in an aqueous solution of potassium cyanide under the influence of the galvanic current, by which means he precipitated the precious metal on a copper cathode."

With all due respect to the gallant Major-General, this is a little error. Bagration noticed that gold was soluble in an aqueous solution of cyanide of potassium *without*, and not *under the influence* of the galvanic current.

Next comes Rae, whose process is incorrectly described by Major-General Webber, who confines himself to the mechanical details of the electrolytical apparatus, while the only important electro-chemical question is the statement made by Rae, that he made use of the combined action of the current of electricity and of suitable liquids, such as cyanide, so that by the action of cyanide the metal is *reduced*, and can then be collected. What Rae says is that "under the influence of the current, the action of the chemicals is *materially facilitated*, and from the solutions, the precious metals are precipitated on the cathode."

Here we have the whole thing in a nutshell! Does the current aid the cyanide of potassium in dissolving the gold, or is it the cyanide of potassium alone, which dissolves the gold without any aid from the electric current, the action of which is simply to deposit the gold dissolved by the cyanide of potassium on the cathodes?

If the electric current does not accelerate the dissolving action of the cyanide of potassium or other similar chemical agents, we shall have done at once with all the processes in which a gold dissolving bath is supposed to accelerate the exhaustion of the auriferous ores when in conjunction with the electric current. The author has not ventilated this question, and we do not hesitate to say that this is to be regretted.

He tells us, and this we accept as a fact, that the Breakwell and Haycraft electro-amalgamator is a copy of the Rae system, except that they "use *no solvent* of the precious metals present in the mixture under treatment."

There is, however, a little mistake in this statement, since if the cyanide of potassium in Rae's apparatus dissolves the gold, the electric current is merely an agent for precipitation, and it would be much more practical to dissolve the gold in one tank and to precipitate it in another. In an electro-amalgamator, on the contrary, the current helps immensely the absorption by a mercurial cathode of the fine and coarse gold.

It may be that in 1888 "MacArthur and Forrest neglected or discarded the assistance of electricity in combination with a weak solution of cyanide of potassium because of the great expenditure of chemicals which they alleged to be the result," but they know better now, and there are already several MacArthur patents for the electro-deposition of gold from its cyanide solutions.

What is the use of the very dry abridgments of the Body and Hannay specifications?

Major-General Webber states that the Breakwell and Haycraft apparatus is the first example in which the bottom of the vessel, described as of basin shape containing mercury, as in the case of the ordinary amalgamating pan, is also the cathode. Here again he is misinformed; has he never heard of the electro-amalgamator, invented by the French engineer Bazin who died a fortnight ago?

At all events, he ought to know Nolf and Pioche, and also Partz, who, in their well-known electrolysers, used mercury as a cathode at the same time as Rae invented his electro-amalgamator between 1868 and 1869.

Here is a more serious blunder:—Major-General Webber modifies and distorts the text of the Molloy specification and states that "he dissolves gold by means of bromine, chlorine, cyanogen or *other compounds*." Bromine, chlorine, iodine, are not compounds, and the characteristic feature of the Molloy process is the employment of bromine, chlorine, iodine *and cyanogen* or THEIR *compounds* as solvents of gold. Accuracy is as much indispensable as impartiality for critics. If the version of the Past-President of the Institution of Electrical Engineers is correct, how could Molloy maintain that he was the first to think of the bromo-cyanogen as a solvent of gold?

We still fail to see where we are driven by the lecturer, who goes on quoting patents such as that of Kendall, who added barium per-oxide to a cyanide of potassium solution, or to use the *ipsissima verba* of Major-General Webber, who "treated pulverised ores with peroxide of barium and a suitable cyanide in a *water solution!!*"

Then comes Pielsticker, who treats the ores with a solution of cyanide of potassium in conjunction with an electric current of low tension, and with circulation of the liquid through the space between the electrodes which are fixed respectively, the anode to the bottom, and the cathode to the top, of the tank. This time, we were, so to speak, entitled to have the opinion of Major-General Webber on this claim, identical with the theory of J. Rae, viz.: that the precious metals are attacked more energetically by a cyanide solution in connection with a current of electricity than without. But this question appears to be immaterial to the learned author, who simply says:

"To recapitulate: This process has, in common with Rae and his successors, the combination of a solution of potassium cyanide with an electric current, by which it assists solution and effects precipitation on a cathode; and, in common with Molloy, it effects the treatment in more than one stage, and by means of 'circulation.' In this latter respect Molloy and Pielsticker are at one with the process of Siemens & Halske, in contradistinction to the processes in which 'agitation' is essential. With reference to my observations further on as to 'agitation,' it may be here observed that in such processes the density of the sludge at various points in the system of circulation must depend on its rate of motion."

What is the resemblance to be found between the arrangement of Pielsticker, who has a mass of ore between his electrodes, and that of Molloy, who has a layer of mercury over which the gold solution passes, or the large Siemens vats where a large volume of weak gold solution passes between numerous electrodes close to each other, and circulates at a rate of more than 5,000 gallons per hour?

We must congratulate Major-General Webber upon the chivalrous generosity which made him spare us the tedious detailed description of all the existing patents for the use of the electric current in combination with mercury, cyanide of potassium, and halogens. Those processes and their theories are not new things for electricians, and the Institution of Electrical Engineers is not quite the proper place for their discussion. This is not a paper on electro-chemical treatment of ores; it looks more like a report on a mongrel patent with a view to prove that, although there are many breeds in it, as a whole it is not similar to any of them. We can only compare this paper to the "Notes on the Treatment of Gold Ores," a book in which, about 10 years ago, Florence O'Driscoll depicted all the patents for the chlorination of auriferous ores, which he said were superseded by the Newbery-Vautin system, with this difference, however, that the book was extremely interesting, while we cannot say the same of the paper on the electro-chemical treatment of ores, the sole object of which seems to be to enable the author to speak highly of the Pelatan-Clerici process.

"In this we have, I believe, for the first time, a process and apparatus which effectively combines, in a way that can be constructed and worked by a workman of average intelligence, the following:—

"(1) A vat made of a material, dielectric in its nature; (2) an agitating apparatus of various specific forms, each form calculated to carry out one and the same process—being the result of considerable experience—having an agitator, part of which constitutes the anode in an electrolytic circuit, which is carried so that it can by no means make contact with the bottom or sides of the vat; (3) the presence of a cathode, which covers the whole of the bottom of the vat, made of a metal (preferably copper) plate or sheet, and suitably contained and fixed so as to carry on it a layer of mercury; (4) the use of a graduated current from an electrical generator, having large quantity and low potential; (5) the mixture or sludge under treatment being composed of water in given proportions, ore finely pulverised, potassium cyanide or other solvent of gold and silver, and common salt, with the addition as required during the process of alkalies or organic acids as may be required."

We would welcome a paper depicting the progress and the actual state of the electro-metallurgy of gold, or describing a new, simple, and original process for the extraction of the precious metals from their ores, but this lengthy panegyric of an electro-cyano-chloro-mercurial method does not contain much beyond the ancient history of patents which have been dead, buried and forgotten for a long time, to which are added the descriptions of the Molloy, Hayward, Danckwardt, Clark, Keith and other apparatus, and finally of the

Pelatan-Clerici installation. Here and there are a few chemical equations with which every electro-chemist is acquainted and which are to be found in specifications or in books on electrolysis, and also a little dissertation on the fouling of mercury.

This evidently is the electro-chemical budget of the report, and it strikes us at almost every paragraph that we have already read it somewhere. With regard to the Pelatan-Clerici process itself, nothing can be said in favour of a combination of ores, kept agitated over a mercury cathode in a solution of cyanide of potassium and chloride of sodium.

It is a complication more than an improvement; Major-General Webber has valiantly made great efforts to prove that his favourite system is different from the others which he has described, and we do not pretend that he has not succeeded in doing it, but he has altogether failed in his attempt to show that, from the technical point of view, the Pelatan-Clerici apparatus is constructed according to the canons of electro-metallurgy. We sincerely regret to have to perform the unpleasant duty of criticising this lecture, but we do not see how we could have acted differently: silence would be interpreted as the recognition of the excellence of a process which no competent man will recommend as a sound application of the electric current to the extraction of gold. We do not, in any way, say that the Pelatan-Clerici system is not an effi ient one, that it does not extract the maximum of the precious metals contained in the ores; we vaguely know that it has been worked about two years at the Delamar mine; its merits or demerits as a gold extractor have nothing to do with us, we simply look on it as an electro-chemical apparatus, and it strikes us as being a very faulty one, almost as bad, and perhaps worse, than those in which carbon anodes are used as stirrers of the ore. In the present case we have a metallic agitator which acts as an anode, and the sole fact of using a metallic anode in hard and constant contact with the ores in a solution which consists of chlorine and cyanide of potassium, is a breach of the laws of commercial electrolysis, especially when currents, such as those stated by Major-General Webber, pass through the electrolyte. He finds it quite natural that the potential must be between 5 and 14 volts for a vat of 9 feet interior diameter, capable of treating 2½ tons of ore per shift of 12 hours, total 5 tons per day of 24 hours, and he informs us that the potential must be governed by resistances "fixed" in the circuit of each vat.

He further makes this remark that "the quantity is regulated by the resistance in that part of the external circuit which lies between the electrodes. Provision is made for a minimum quantity of 1½ amperes per square foot, being half the sum of the cathode and anode together in square feet," thus, if that area is equal to 52 square feet, the current should not be less, and not much more, than 39 amperes.

When the voltage is high and the current heavy, there is no economic extraction of gold and there is no good deposition of gold.

Evidently there is something wrong in such an arrangement; a rather large proportion of cyanide of potassium is used; then some specific oxidising agents and chloride of sodium are added to increase the conductivity: and, nevertheless, this electro-chemical process requires 14 volts and 1½ amperes per square foot. This is preposterous! And, leaving aside the question of the enormous consumption of cyanide of potassium, no man who understands the application of electricity to the extraction of precious metals, would, for a moment, entertain the extravagant idea of adopting such an electrolytic apparatus, in which the expenditure for the electric current is considerable, and, besides, necessitates a costly installation of motive power for stirring the ore in the vats.

We do not insist on the drawback of the agitation of the ores; we do not even ask whether or not the quicksilver is broken up by the sand with which it mixes, with subsequent loss of mercury and gold; but it does not seem that Major-General Webber has gone very deeply into the investigation of the electro-chemistry of the process. We do not even discuss the value of the following theory:

"The expressions I have used—namely, 'reduction of resistance' and 'increase of conductivity'—are useful because they are easily understood; but, be it remembered, they are not correct as applied to the solvent, *i.e.*, water. Indeed, these descriptions of the effect of the mixture of sodium chloride in a solution, and then placing that solution between an anode and a cathode, is scientifically inaccurate. What happens to the sodium chloride in solution in the water is, that it is disintegrated and re-formed, and thus it becomes the intermediary by which, at the instant that chlorine gas and sodium are set free, the current is enabled to 'communicate' between the electrodes."

Each one of those who listened to the paper know what takes place in the electrolysis of a chloride of sodium solution in presence of mercury cathode. We also know, as Major-General Webber says, that: "In the first place, one might expect the nascent chlorine to attack some of the baser metallic ores present in a finely divided state. For instance, sulphides, selenides, arsenides, &c., often attached to particles of gold or silver, would be so attacked; the chlorine uniting with the metallic base iron (Fe) or copper (Cu)." But what we are certain takes place at the same time, is the corrosion, disintegration and destruction of the metallic anode. With such a powerful current as the one used by Pelatan-Clerici, the anode cannot last long.

There would have been a really startling actuality in the "Notes on the Electro-chemical Treatment of Ores" if Major-General Webber had introduced in his memoir the subject of the two electrolytic methods for which their respective promoters claim at present the most marvellous properties. One is the Electro-bromine process which would have evidently called for some instructive comments, the other one is the Chloro-cyanide method, which would suggest many interesting remarks. As they are, the "Notes on the Electro-chemical Treatment of Ores" do not seem to present an essential character of utility for the electrical profession.

A SURVEY OF THE POSSIBILITIES OF ELECTRIC HEATING AND COOKING.*

By W. P. ADAMS, A.K.C., A.I.E.E.

My desire this evening is, if possible, to pave the way to a better understanding of the possibilities of electric heating so that engineers may be able to assume that confidence as to its merits which is necessary before any real progress can be attained, and which is at present lacking in many a professional mind. The feeling is general that the cost is, and will be to the end of the chapter, so great that its adoption can only be hoped for by those of more than ample means, but I hope to show that, while it undoubtedly deserves to rank as a luxury, it will be well within the means of those with average incomes when the cost of current is somewhat modified. The reason why electric heating, more especially in the direction of cooking, is able to compare favourably with other methods, is, that the heat can be applied just where it is required, and there is remarkably little waste.

Heating appliances do absorb what appears to be a large amount of electricity, and many electricians, especially those more closely connected with electric lighting, are surprised at the large amount of current which is necessary for cooking purposes, and mentally compare what might be done with the same current if devoted to the production of electric light.

As it is in the direction of electric cooking that I anticipate the largest development in the near future, I shall confine myself at first to a consideration of this subject.

In a kitchen suitable for supplying the needs of a family of from 8 to 10 persons the following apparatus would be necessary: Oven, absorbing 2,500 watts when heating up for about 15 minutes, and on the average about 1,200 watts afterwards. Breakfast cooker, wound for two circuits, each absorbing 600 watts. Two grillers, each wound for 500 watts. Two frying-pans, also wound for 500 watts, and several hot plates for warming ordinary saucepans, or in place of these several self-contained electric saucepans. These plates or saucepans would probably absorb 1,500 watts together. The household supplied from such a kitchen would probably have a maximum demand for not more than 2,500 watts for lighting purposes. The total watts which could be absorbed by the cooking apparatus is 7,200. It must, however, be borne in mind that these various appliances are used at different times, and never altogether.

We shall now consider the difficulties in the way of the adoption of electric cooking. First and foremost is the question of the cost of current. This is all important. In addition to this the first outlay cannot be overlooked, owing to the rather high cost of the apparatus.

The largest field for the development of electric cooking is undoubtedly in private houses supplied from central stations, and if there is to be any large extension in this direction the central stations must be prepared to supply current at a more moderate price than is now charged for lighting. It is generally recognised that electric cooking will eventually prove to be the means of solving the much-vexed question of securing a day load for central stations; and, in view of this fact, many of the central stations offer special terms for supplying electric currents for heating. A number of the central station engineers are, however, still doubtful as to the advantage of adopting electric heating, partly owing to the question of the load overlapping the lighting load. This question I shall touch on later, but I would venture to point out that, if the demand is spread over a sufficient number of hours, electric heating is worthy of consideration quite apart from electric lighting, and it would therefore pay to put down extra plant to meet the additional demand. In fact, I do not think the day is far removed when the demand for current for electric heating will vastly exceed that for lighting purposes; and I submit that the solution of the question lies mainly in the hands of the present suppliers of electricity. If they are prepared to adopt a liberal policy of supplying electricity for heating purposes, perhaps at little more than the actual bare cost, they will very soon find that the improved conditions under which they run their plant will begin to repay them handsomely.

The price to be charged is of the greatest importance, and I will, therefore, make a few comments upon the methods of charging now in vogue. It is becoming usual to make the charge for heating and power about half that made for light. A very usual figure is 3d. per unit, while some supplies have brought the price down to an even lower figure. I may say at once that the ideal to be aimed at for heating and power purposes is a charge of 1d. per unit, and although it is only possible at present for one or two companies to charge such a figure and cover the bare cost of production, I think the figure is well within the range of practicability, and with a rapidly growing load on supply stations, I think it will soon become general. It is noticeable that the local authorities are moving more rapidly in this direction than supply companies. I would commend this to the attention of the supply companies. Their policy of making high charges is, to say the least of it, unprogressive. Only about four are charging so little as 3d., while 26 of the local authorities supply at 3d. or less, 13 of these charge 2½d. and less.

The Wright system of charging for electricity appears to be securing considerable support amongst central station engineers, and the maximum demand system seems to have been receiving even greater favour. With both of these systems I can foresee a trouble in connection with the supply of electricity for heating purposes.

Under the Wright system it is conceivable that the demand meter

* Abstract of paper read before the Northern Society of Electrical Engineers.

may run up to a most unusual height, through the inconsiderate switching on of a number of the heating appliances together, the indicator therefore furnishing quite an abnormal record upon which the charges are to be based. Again, with the maximum demand system, if the charges are to be made upon the usual understanding that the whole apparatus is to be run for an hour at the maximum charge before any reduction is made, the charge cannot come down to anything like a reasonable figure. It is, of course, obvious that the whole of the appliances will not be in use together, and I think this point is worthy of close consideration.

In a certain kitchen it was found that the various cooking appliances were in use for from five to seven hours a day, during which time the highest point reached was 1·5 kilowatts. The average consumption during the day was from 8 units. It will thus be seen that if generating plant to the capacity of 2 kilowatts was installed for supplying these cooking appliances, it would have an earning capacity of about 1,400 units per kilowatt installed per annum.

I find that the number of units sold per annum per kilowatt of plant installed varies considerably among the different stations in country towns where the load is almost exclusively a lighting one and the supply is very small during the day time; about 400 or 500 units represent the work done during a year by one kilowatt of plant installed. In the larger towns, where there is probably a small day supply for power as well as one for lighting in dark offices and basements, the demand is larger. In Brighton, 840; Edinburgh, 640; Glasgow, 696; Manchester, 700. It will be seen that Brighton, which might also be termed a country town, as there are no factories there to absorb power in the day, shows the best results of those named. This, I think, is traceable to the moderate nature of the charge for current.

As a load for summer time, cooking should prove invaluable to supply stations, and the question of overlapping during this period does not arise.

In winter, however, the conditions will be different. A certain amount of overlapping will occur owing to the prevailing fashion of late dinners, but I submit that the load for electric heating is likely to be of sufficient importance to warrant putting down additional plant to meet this.

Much, of course, depends upon the acuteness of the peak as to how this question is to be met. If it can be arranged, it will be desirable to utilise for heating during the day the plant installed for lighting purposes, but if the demand for heating grows to such an extent as to greatly surpass the lighting load, the question becomes of less importance. It is not, perhaps, within my province at this moment to suggest how this difficulty is to be met, but with some stations in this country the question does not arise at the present time, as ample plant has been installed to meet the lighting requirements and still leave a balance in hand to allow for the overlapping. A number of stations appear to be provided with twice the amount of plant required to meet the maximum demand. Of course, some portion of this is reserve plant, but there still remains a good balance in hand to meet this contingency.

I am inclined to think that a secondary battery would prove of great value in meeting the peak difficulty, as there are several depressions on the day load curve which could be filled up if the generating plant were employed during these times of light load for charging the accumulators. How far it is possible to economically utilise accumulators for this purpose in alternating supply stations is an open question.

While considering the charges made by the various supply companies it is noticeable that several have adopted the enlightened policy of charging for power and heating purposes, a price which is actually less than the total works' cost. Putting on one side for one moment the question of overlapping, it is obvious that this is a right policy to adopt, as, assuming that the plant used for lighting is employed for supplying heating appliances, the charge for rent, management, &c., will remain practically the same.

I have the misfortune to be situated in a district served by the City of London Company, which company holds a monopoly and takes advantage of this to maintain a charge which is worthy of the very early days of electric supply. Although their works' cost compares anything but favourably with other large towns, having in many cases a much smaller output, I think you will agree with me that the charge of 8d. is somewhat extravagant, and I may say that such a charge absolutely prohibits any demand for current for power and heating purposes. It is true that a rebate is made if more than a stated quantity of electricity is used, but this is fixed so that it is of little value in the way of reducing the price.

It seems almost incredible that, in these enlightened days, the foremost city in the world should be one of the worst supplied in the matter of electricity.

I have so far made no comparison between the cost of cooking by electricity and that by other means. I shall not deal with this question much in detail, as I think it more practical at the present time if a general idea is given as to what the actual consumption of electricity will be, for the cost by other means varies largely under different circumstances. I have, however, some figures to hand obtained in a kitchen where both gas and electricity could be used at will. The household was a small one, consisting of about five persons, and the consumption of electricity was approximately 30 units per week when cooking was done solely by this agency. When gas was employed exclusively, 1,240 cubic feet of gas were used during a week. The cost, then, of electricity at 2d. per unit is 5s. a week, and of the equivalent amount of gas at 3s. per 1,000 cubic feet is 3s. 9d.

The figures of consumption which I have given above are the most complete at my disposal, and this is my reason for bringing them before your notice, but I have other results to hand which indicate that the consumption of current may be reduced below the figures given when the appliances are used intelligently and with care. For small installations such as we have considered one may assume roughly that a unit per head per diem will suffice for all cooking purposes. These figures will naturally be reduced in larger establishments and experience seems to point to about 1s. 2d. a unit as a sufficient allowance in kitchens where more than 30 or 40 persons have to be provided for. The best results will be obtained where there is a hot water supply. Many of you are probably aware that heating water by electricity is a most uneconomical proceeding, at any rate at the present prices, and where an establishment is sufficiently large it is always recommended that a slow combustion stove is fitted to supply all the hot water for the household. In many houses such a stove is already fitted.

(*To be continued.*)

THE PACIFIC CABLE.

LETTER TO THE RIGHT HONOURABLE SIR WILFRED LAURIER.
BY SIR SANDFORD FLEMING.

Ottawa, *December 28th*, 1897.

The Right Honourable Sir Wilfred Laurier, Premier.

Sir,—For some months past I have frequently been asked by writers of the press to furnish information respecting the Pacific cable. I have been so applied to, as it is well known that I have long felt the deepest interest in the project, having been appointed by the Canadian Government to take part in the Colonial Conferences of 1887 and 1894, and in the Imperial Committee of 1896. I have invariably declined to comply with the request from the feeling that it was distinctly understood that the proceedings of the investigation by the Imperial Committee should be treated as confidential until made public by Her Majesty's Government. I have, in consequence, felt debarred from alluding either to the evidence obtained by the Committee or to the conclusions submitted in their report, or in the special reports presented to the Canadian Government by the Canadian Commissioners and by myself.

These several documents were presented nearly 12 months ago; since then questions have arisen, which were not considered by the Imperial Committee, and many important facts are also obtainable from other sources, explanations respecting all of which should, I conceive, be communicated to the public.

Since the Imperial Committee closed its investigations, the Conference of Colonial Premiers has been held in London. Among other matters, the Pacific cable was brought before this Conference, and from what has transpired the subject was complicated by a new proposition having been submitted by the Eastern Extension Telegraph Company. Consequently, the consideration of the project was deferred. Six months has since elapsed, and I feel called upon to make known some facts and explanations bearing on the questions which, in my humble judgment, the public should understand. I trust you will approve of the information being given to the public in the form I have now to submit to you.

I have the honour to be,
Your obedient servant,
SANDFORD FLEMING.

THE PACIFIC CABLE.

Everywhere it is apparent that the British Empire is being formed by a process of growth and development, and there are many forces actively in operation, all tending to give it shape and strength and distinctive character. Lofty ideals are entertained by men of thought, experience and patriotism; but the future is veiled from us, and we cannot foretell the precise form of relationship which will eventually be assumed by members of the British family of nations in so many meridians of longitude.

If the form of the development to be attained is not clearly foreseen, it can at least be said that the entire British people in all parts of the globe are inspired by a unity of sentiment, and that they are simultaneously moving onwards in one general direction. Progress is the watchword in all quarters. It is impossible not to recognise the advancement perceptible in the colonies of the southern seas, and equally the amazing vitality in British Africa. The Dominion of Canada plays an important part in moulding the destiny of her own people, and in promoting more intimate relationships between the motherland and the colonies.

It is but 30 years since the scattered provinces of British North America became federated in one government. The Dominion thus created inherited many remarkable advantages. It can lay claim to the most important geographical position, owing to its extension between the two great oceans; a position which confers the only means of establishing under the British flag communications between the eastern and western territories of the globe. It enjoys the possession of vast fields of the richest virgin soil, with still unexplored mineral regions of immense extent, and presumably of immense value. The population retains the high qualities of the foremost nations of western Europe, from which it has sprung, and the wide expanse of unoccupied areas leaves ample room for a large accession to its number. These rich possessions of the Dominion give promise, under wise guidance, of a splendid future.

It soon became evident that the development of a country continental in its extent exacted public works of corresponding magnitude. Lines of railway and telegraph were projected from ocean to ocean, and immediately after Confederation, both were proceeded with. In 1874 the policy of establishing the telegraph in advance of the railway was determined upon, and as a corollary to the trans-continental telegraph the proposal to extend the electric wire across the Pacific naturally followed. It can be said that ever since the telegraph reached the coast of British Columbia the Pacific cable has engaged public attention, and that the necessity of this undertaking has been repeatedly affirmed. It received recognition in the Conference of Representative Colonial Statesmen in London in 1887, in that of Ottawa in 1894, at telegraph and postal conferences in Australasia almost annually, and at various times by Chambers of Commerce at home and abroad.

The dominant idea with those who have most strongly advocated the establishment of a Pacific cable has been the unity of the Empire. They foresaw the difficulty of effecting any practical union between communities separated by distance, so long as they remained without the means of direct and cheap communication. At the same time it was plain to them that a telegraph across the ocean would foster trade and commerce—the life of an Empire such as ours.

Among the memorable gatherings of representative men, not the least important was the Conference of Premiers in London on the occasion of Her Majesty's Diamond Jubilee. Before these statesmen met, hopes had been entertained that some definite action would be determined for the inauguration of the scheme. Preparations had long been made for joint action. It was one of the chief objects set apart for special consideration at the conference of the Imperial and Australasian Governments held at Ottawa in 1894. With this view, the Canadian Government, agreeably to a resolution of the Conference, obtained much information on the subject, and transmitted it to all the governments interested in the projected work. Soon afterwards the Secretary of State for the Colonies (Mr. Chamberlain) invited the Canadian and Australasian Governments to send representatives to London for the purpose of taking part in an Imperial Committee to be appointed specially to receive evidence and consider the project in every detail. The Committee first met on June 5th, 1896, and on January 5th, 1897, they reported the results of an exhaustive inquiry.

The proceedings of the Committee and the conclusions which have been formed have not been made public. They have been repeatedly asked for, but as nothing transpired respecting the labours of the Committee up to the Jubilee week, the opinion gained ground that when the Conference was concluded full information would be given to the public with the decision arrived at by the imperial authorities and the Colonial Premiers. In many quarters it was expected that action would on that occasion be taken, and that the inauguration of the cable would result as a practical outcome of the Queen's Jubilee.

The old proverb tells us that it is often the unexpected which comes to pass. The proceedings of the Conference of Premiers were first made known to the public by an article purporting to be published by authority in the London *Standard* of July 25th, and the subject of the Pacific cable is thus alluded to:—

"The Conference left the Pacific cable scheme in mid-air, and it is very unlikely that anything more will be heard of it for a considerable time. The position was entirely changed by a proposal by the Eastern Extension Telegraph Company to lay an all-British line from Western Australia across the Indian Ocean to Mauritius, thence connecting with the Cape and St. Helena and Ascension. . . . . The Eastern Extension Company, it is understood, does not ask for a direct subsidy for the new lines, but seeks other concessions from the Australasian Governments which, if made, will justify them in proceeding with the work."

In the account of the Conference of Premiers laid before the British Parliament, there is a reference, in two sentences, to the cable, no mention, however, is made of any proposal having been submitted by the Eastern Extension Company. But the Premier of New South Wales (Mr. Reid) returned home from England through Canada, and being interviewed by reporters in Montreal, Toronto, and Vancouver, confirmed the statement with respect to the proposal of the Eastern Extension Company. The character of the concessions asked by the company has not been made public, but it has been stated that they desire to obtain exclusive rights for Australia on condition that they connect the colonies with the Cape and lay a new cable from the Cape to England *via* St. Helena, Ascension Island, Sierra Leone or Bathurst and Gibraltar. This scheme is put forward by the company as a substitute for the Pacific cable.

Owing to the fact that telegraphic connection with the Cape is at present extremely defective, the proposal of the company is undoubtedly of great importance to South Africa.

There are two telegraphic routes from England to Cape Colony. Both have landing stations at Lisbon, one passes through the Mediterranean to Alexandria, through Egypt to Suez, through the Red Sea to Aden, and from Aden the cable follows the east coast of Africa, touching among other points at Mozambique and Delagoa Bay in foreign territory. The other route leaves the first at Lisbon, and follows the west coast of Africa, touching at some 14 points; eight of which are under foreign flags, those of Portugal, France, and Spain.

Interruptions are frequent on both routes. There is evidence to establish that during the past four years communication between England and the Cape has been broken many times, and that the aggregate interruptions have averaged in each year 75 days on the west coast route and 87 days on the east coast route, showing that each cable is unavailable from six to seven days per month. While this refers to the average period that the cables have been thrown out of use, the durations of single interruptions have varied from one to 30 or 40 days. As both lines are liable to be broken at the same time serious inconveniences have not seldom resulted. Everyone will remember this contingency occurring when the Transvaal difficulty was at its height. Intense anxiety was then caused during the cable interruption of 11 days, when South Africa was passing through an acute crisis in her history.

Obviously a new cable to the Cape is much required, and as the frequent interruptions to traffic by the two present routes is to a large extent owing to the fact that the cables are laid in the shallow water which prevails along the African coasts, they are in consequence exposed to accidents to which cables in deep waters are not subjected. That part of the proposal, to touch at St. Helena and Ascension, where the water is of ample depth, would give to the cable the necessary security and avoid the difficulties experienced on the present routes. It is, however, not so clear that the northern half of the new cable would be so fortunate. By landing at Sierra Leone or Bathurst and Gibraltar, and terminating in Cornwall, the cable of necessity would be laid for some distance in shallow seas, where it would be exposed to injury from various causes, and where, too, the agent of an unfriendly nation, or, indeed, an evil-disposed fisherman, would have it in his power to destroy the cable with ease, totally unobserved. For hundreds of miles it would be exposed to such risks.

The question may be asked, would not this proposed new cable from England to the Cape, with an extension to Australia, be of general advantage? To such a question there is but one answer. It certainly would be of general as well as special advantage, for the reason that we cannot have too many lines of communication. They are needed in the every-day business of trade and shipping, and moreover, we must come to recognise that a complete telegraph system, ramifying wherever Her Majesty's wide domain extends, is an essential condition of the life and integrity of the British Empire. It is on this, and on other grounds, impossible to admit the claim of the Eastern Extension Company, that the proposal submitted by them is preferable to a trans-Pacific cable, and that it will render it unnecessary.

At the Colonial Conference of 1894, the outline of a telegraph system for the Empire was submitted. It was not confined to one side of the globe; the system projected, embraced, and encircled its whole extent. The scheme was illustrated by a map of the world, with the chief cable lines laid down upon it. If the proceedings of the Conference be referred to, it will be seen that a trunk line of telegraph was projected from London through Canada to Australasia, with extensions to South Africa, India and China. It was shown that by the Canadian route all the chief British possessions on the four continents would be brought into electric touch with each other, and with the Imperial centre in London. It was demonstrated, moreover, that this result could be accomplished without touching a single acre of foreign soil, and without traversing shallow seas, where cables are most liable to injury from ship's anchors and other causes, and where they can be so easily fished up and destroyed. No fact can with greater confidence be affirmed than that the cables by the Canadian route would be far less vulnerable than the existing cables, or those now projected by the Eastern Extension Company. But even if no advantage in this respect could be claimed, it requires no argument to prove that telegraphic connection between England and Australasia would be infinitely less subject to interruption from accident or wilful injury, by having the Canadian line established, in addition to the Eastern Extension lines, especially as the former would be on the opposite side of the globe, and far removed from the immediate theatre of European complications.

It is not possible to believe that anyone disassociated from, and uninfluenced by, the Eastern Extension Company, can view the proposed Canadian Pacific cable with disfavour. If it be important to strengthening the connection between the United Kingdom and the out-lying portions of the Empire, no one can question its necessity. But the Eastern Extension Company has never taken a friendly view of the Pacific cable. From the first it has been its determined opponent. The proceedings of the Colonial Conferences of 1887 and of 1894 give evidence of this fact. The report on the mission to Australia by the Canadian delegates gives some indication of the intense and persistent antagonism displayed by the company, and the manner in which its powerful influence has been employed to thwart the enterprise. It may not be an unwarranted surmise that the immediate purpose of the company in submitting to the Conference of Premiers their new proposal was to divert attention from the Pacific cable.

(*To be continued.*)

ELECTRIC LIGHTING AND DUST DESTRUCTORS FOR GLOUCESTER.

The vexed question of the selection of site for the proposed electric light works for Gloucester came before a meeting of the City Council again last week. The matter has been under the consideration of the Council for many months, and even now an essential and governing factor, viz., as to whether electric light works and dust destructor shall be erected in combination, or otherwise, has not been determined. Mr. Hammond, the consulting electrical engineer, attended the Council meeting, and stated that he had, at the suggestion of the Mayor, inspected the sites which had been pointed out to him. With regard to some of them, they were confronted by the question as to the advisability of separating the two projects. At the present time the Council appeared to have made up their minds that the electricity works and the dust destructor should be combined, and it was useless for him to go on viewing sites which were condemned if the decision of the Council were adhered to. If he might venture to say a word on the point, he would recommend them to avoid going past the best site, or what was approximately the best site, for the electricity works, for the sake of the dust destructor, and, although, as he had already pointed out, there were advantages in the combination, yet they might run that combination too far. Personally he would rather not have the dust destructor next door to his electricity works, for the one reason that the dirt and dust made it more difficult to carry the electricity works on with a dust destructor in the immediate vicinity. Besides they could not keep the machinery and building so smart and tidy as they could if the dust destructor was half a mile away.—The ex-Mayor said Mr. Hammond had stated in committee that the combination of dust destructor and electric light works would mean a saving of £250 per annum. Would the presence of a dust destructor be any danger, or did Mr. Hammond object to it simply because without it the works could be kept cleaner?—Mr. Hammond replied that at Shoreditch the dust considerably interfered with the machinery. The works there were ill designed, and if he were asked to draw up a scheme of combination he should take care that the dust destructor portion was entirely closed up from the electricity works, instead of being connected by windows and doors as at Shoreditch. Of course, he would rather not run the risk of having his smart machinery interfered with, but still he believed those difficulties might be got over, and the saving undoubtedly would be what had been stated.—Mr. C. G. Clark asked if there was any possibility of the dust interfering or damaging the machinery providing the works were properly constructed.—Mr. Hammond replied that an engineer liked to speak from experience, and he must say that the nearest approach to the works not being interfered with was at Cheltenham. There the destructor was separated from the electricity works by a promenade. They had plenty of room there, more than they wanted to take in Gloucester. He knew of no place where a certain amount of dust did not come in. When he recommended the combination he had, of course, considered the *pros* and *cons*, and if they had it they must put up with the disadvantage of some amount of dust, and that would require greater care in cleaning the machinery, because there was nothing so dangerous to electric plant as dust. At Shoreditch some of the machinery was disabled from that cause, but as to whether he could keep it out he would be able to tell them better when he had erected the Gloucester works.

Mr. Clutterbuck, Chairman of the Committee, withdrew the recommendation that the old gasworks site be purchased, after hearing Mr. Hammond's wish to further investigate the question.

The Mayor stated it was useless to discuss the matter further at present. A special meeting of the Council could be called when Mr. Hammond had completed his further investigations.

THE LEYTON DESTRUCTORS.

In last week's "Notes" we briefly alluded to the public inspection of the Leyton sludge and dust destructors, erected at the sewage works by the Beaman and Deas Syndicate, of London and Warrington. In this issue we deal in another place with the general aspects of the destructor question, and here we will just quote sufficient from a paper read by Mr. Liversedge, engineer and director of the syndicate, before the Gloucester Engineering Society on the 18th ult., to enable our readers to understand the construction of the Beaman and Deas plant.

"In the Beaman and Deas destructor each cell of a pair acts alternately as a fume cremator to the other; when the one cell is comparatively green the gases from the other are at their hottest, and with ordinary refuse a minimum temperature of 2,000° F. is maintained in the common combustion chamber where the gases unite, provided only that a reasonable supply of refuse be maintained. It is difficult in working this destructor to avoid one or the other of the pair of cells being in a sufficiently vigorous state of combustion to completely consume, by the gases it throws into the fume combustion chamber, anything whatever of an objectionable character which may happen to be proceeding from its companion. The Beaman and Deas destructor is avowedly, purposely, and openly a quick combustion and high temperature furnace. I submit to you a brick recently, at my request, cut out of the crown of a Beaman and Deas cell which has now been at work for four years, burning rarely less than 15 tons of refuse per day, working continuously day and night for every working day, but allowed to cool down at the end of every week during the whole of that period. It is almost impossible to say by measurement whether the brick has really undergone any wear at all. What happens in this cell appears to be this. As soon as combustion is commenced, particles of siliceous matter, at a very high temperature, are projected against and adhere to the brickwork of the cell. They enter to a certain extent into combination with the material of the bricks, but in doing so they at once form a coating on the surface of the brick, which effectually stops any further action of a corrosive nature. That is to say, there is formed upon the bricks what would doubtless become with a little higher temperature a fine protective enamel, though it actually presents itself as a kind of coke. In practice this crude enamel grows so much more or less in the form of tentacles, that it is necessary from time to time to remove it. It fulfils in my opinion two other useful purposes—it helps to prevent the escape of particles of half charred paper, and assists to mix the gases arising from the drying hearth with those from the fire proper. I submit to you some pieces of this 'enamel.' The temperature by which this effect is produced is necessarily high, doubtless over 3,000° F. The quantity of house refuse which may be effectually destroyed in a pair of Beaman and Deas cells, has been demonstrated to be over 50 tons per day of 24 hours. The normal duty for which the standard pair of cells is supplied is 30 tons, though this amount is often enough exceeded. You will naturally wish to know by what means so large a quantity of refuse can be treated in one of these cells and such high temperature regularly attained. The explanation lies partly in the fact that the combustion is aided by forced draught supplied by fans."

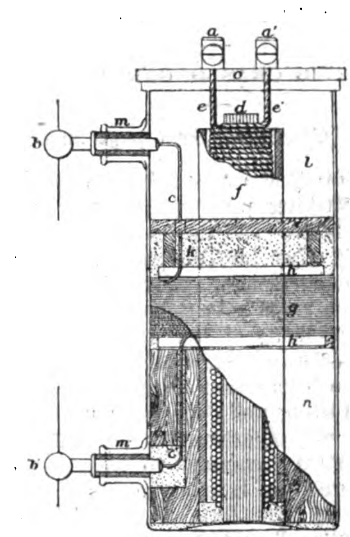
A NEW INDUCTION COIL.

Since the discovery of the Röntgen rays induction coils have acquired a much greater importance. Ruhmkorff's is still the only one in common use. The defects of this coil may be summarised as follows: low efficiency, which hardly amounts to 20 per cent.; high cost of construction both on account of the great weight and cost of the materials employed, and the labour required to wind the enormous length of secondary wire; the delicacy of the apparatus, which is easily damaged by perforation of the insulator or burning of the secondary wire; the great weight of the apparatus which renders transport difficult.

M. De Rochefort-Lucay has studied this question with M. Wydts, and finds that most of these defects are due to imperfect insulation of the secondary wire.*

At the high tensions which are generated in the coil, and which amount, often to as much as 400,000 volts, solid insulators such as glass are in the course of time, very much modified in their molecular constitution, so that in the end they usually break down. In liquid insulators a kind of electric convection takes place.

Viscous or pasty insulators, however, which have neither the porosity of solids, nor the molecular mobility of liquids, offer great advantages. Such insulators are generally hydro-carbons, which decompose slowly under the action of internal electric forces, depositing particles of carbon in suspension which, to a certain extent, reduce the insulating



properties of the material. MM. Rochefort and Wydts have been able, by a special arrangement, to use a viscous insulator without permitting the deposition of carbon.

In their coil, fig. 1, the primary coil is the same as in the ordinary Ruhmkorff coil. It consists of a core of soft iron, *d*, about which a double layer of thick copper wire, *e e'*, which ends at the two terminals, *a* and *a'*, of the external circuit supplying the current. The primary coil, *f*, is surrounded by an insulating tube.

The secondary coil consists of a single bobbin, *g*, containing 600 grammes of copper wire, 0·16 mm. in diameter.

This secondary bobbin is placed round the centre of the primary, and rests upon two tubes of glass, *h'*, supported by a block of wood. A stopper of wood, *i*, furnished with two brackets, rests on the secondary bobbin, from which, however, it is separated by two tubes of glass, *h'*.

The two ends of the secondary wire are connected to the two secondary terminals, *b b'*, in the stoppers of two necks, *m m'*, of the glass vessel in which the whole coil is contained.

The glass vessel is filled with the pasty hydro-carbon insulator.

The apparatus, thus constructed, gives sparks of 20 to 22 cm. in length, with 6 volts and 3·3 amperes (about 20 watts) applied to the primary circuit.

The primary circuit of a Rhumkorff coil giving the same length of spark, would consist of 50 to 60 flat bobbins

* Société des Ingenieurs Civils de France, November 5th, 1897.

coupled in series and separated by partitions of solid insulator. The weight of the secondary wire would be 5 to 6 kg. The number of watts required to work such a coil would be about 120.

In the new apparatus the strength of the current is greater than in the Ruhmkorff, on account of the lower resistance of the secondary. This is a very important characteristic for the production of Röntgen rays, since the time of exposure of a photographic plate necessary in any given case is inversely proportional to the strength of the current used to excite the tube.

There is nothing special about the condenser or the interrupter used in the primary circuit. Those which have been found most suitable for the Ruhmkorff coil are employed with the new apparatus.

MM. Rochefort and Wydts have shown their coil at work in comparison with a Ruhmkorff, before the Société des Ingenieurs Civils de France. The tension obtained was about double that of the Ruhmkorff, and the remarkable density of the spark showed that the strength of the current in the secondary must have been very high.

THE TELEGRAPH TROUBLES.

The Clerks' Point of View.

By CHAS. H. GARLAND.

(*Continued from page* 96.)

More than a century ago Adam Smith wrote in his "Wealth of Nations" a striking passage upon the nature of wages. "The wages of labour are the encouragement of industry, which, like every other human quality, improves in proportion to the encouragement it receives." Although it is only recently that such views have triumphed over the time-worn doctrine of the economy of low wages, the trend of modern thought and modern industrial progress is more and more in the direction of a recognition of the economy of high wages. "If you want a thing well done you must expect to pay for it" is a popular way of expressing the traditional belief in the efficacy of good treatment to ensure good work. All the best authority in labour matters leans towards the view expressed by Mr. John A. Hobson in his work on "Modern Capitalism." "Every rise in wages, leisure, and in general standard of comfort, will increase the efficiency of labour." Without pushing this view to the point of absurdity, it is easily demonstrable that a well paid contented body of servants is the source of the highest efficiency, and turns out the largest quantity of work. Towards obtaining such a body of servants it is surely the duty of administrative officers in large public departments to strive. The value of willing, efficient work cannot be over-rated in a service so important as the telegraph service. Unless the highest speed and the utmost accuracy are assured the main object of a telegram is lost sight of. The greatest value can be extracted from the expensive trunk lines by placing willing, efficient operators at either end.

When so much depends on the goodwill of the men it is surely to the advantage of the Department—to place it on no higher basis—to secure that goodwill. Yet we find a tendency rather to parsimony, and irritating refusal to listen to all appeals against anomalies. In a matter that so nearly affects the daily life of the men as the supply of their refreshments, complaints seem powerless to produce an effect upon the red-tapish system, and meals have to be taken under conditions which are a source of constant annoyance and indignation. Yet an inexpensive measure of reform would remove the ill-feeling. So with pay and prospects, whatever may be the view of the administrative officers, to the clerks it seems as though always the least generous view is taken of all schemes and scales in the matter of interpretation, and King Red Tape sits enthroned upon a mountain of anomalies with ears quite deaf to all the clamours for sympathy.

The history of the £190 maximum is an illustration of this attitude. Prior to 1881, the scales of pay for telegraph clerks were as follows:—

Senior telegraphists...	...	£140 by £5 to £160
1st class " ...	...	£100 " £5 " £160
2nd class " ...	...	£70 " £5 " £90
3rd class " ...	...	12s., 14s., 16s., a week, then £45 by £5 to £65 per year.

Complaints of "stagnation of promotion and inadequacy of pay" led Mr. Fawcett, who was Postmaster-General at the time, to make a full investigation of the matter and he found these complaints to be justified. He recommended to the Treasury a scale which was subsequently adopted and which abolished some of the classes and left the pay as follows:—

Senior telegraphists...	...	£150 by £8 to £190
1st class " ...	...	£110 " £6 " £140
2nd class " ...	...	12s., 14s., 16s., a week, then £45 by £5 to £100 a year.

This revision came into operation in 1881, and it will be seen that the most important change was the raising of the maximum from £160 to £190. This was the improvement which was to meet the "inadequacy of pay." It must also be noted that the whole of the scale was a scale for telegraphists, that is, for operators. No special qualifications were demanded for promotion to the Senior Class, men were advanced into it in the ordinary course as telegraph operators and no one doubted that if he arrived at the maximum of the first class with a good character he would pass automatically into the Senior Class. Long waits at the maxima of the classes, now so common, were not then known. Mr. H. C. Fisher, C.M.G., the Controller of the Central Telegraph Office, who was then, and is now, the chief officer who deals with the advancement of clerks, in a memorandum dated January 10th, 1896, and published as an appendix to the "Minutes of Evidence taken by the Committee on Post Office Establishments," said "Ordinary manipulative ability, combined with regular attendance and good conduct were considered sufficient qualifications for promotion to the Senior Class." This statement of the Controller is important, because it clearly demonstrates the point upon which the whole controversy hinges. Was the whole scale up to £190 a scale for telegraph operators in Mr. Fawcett's intention? As soon as the scheme was applied, and during Mr. Fawcett's administration, it was so regarded. Everybody, clerks and administrative officers alike, believed it to be so. From 1881 to 1892 the scale was so applied by officers who were familiar with Mr. Fawcett and presumably knew and carried out his intentions. Concerning this scale Mr. Fawcett said, in writing to the Treasury, "The rates of pay which I propose are not more than sufficient to afford just and reasonable remuneration to those on whose efficiency and contented service so much of the interests and the convenience of the community depend."

So we had a scale of pay established for telegraph clerks which led, with no great obstacles intervening, from 12s. per week by a slow progress to £190 per year. In a memorandum attached to the papers issued by the Civil Service Commissioners to intending candidates for the post of telegraphist, it was stated that the scale of pay offered "a prospect of obtaining £190." This memorandum was issued with the authorisation of the Postmaster-General. Surely one would have thought that with such a weight of authority and practice behind it, the "prospect of £190" for telegraphists was sufficiently secure. But in 1892 a change came over the scene. Mr. Raikes had previously, by an obvious slip of the tongue, described the Senior Class of Telegraphists as a "moribund class," and had sedulously denied having said it. Suddenly, and without notice, a special qualification was demanded over and above "manipulative ability" for promotion to the Senior Class. A technical examination requiring considerable study in leisure time was set and made, not qualifying, but in a limited degree competitive. At the same time the trend of departmental utterances was to the effect that the Senior Class was a "superior appointment," requiring special qualifications. And in 1894, in a Return prepared for Mr. Provand, M.P., we find them wrested from the place which they had hitherto so honourably filled among the "general body" in all official returns. Now they were treated and classed as "supervisors." So at last the Senior Class as a class of telegraphists had passed the moribund stage, and from its ashes has sprung, phœnix-like, a new class of supervisors who performed no supervising duties. Protests and petitions were useless. It was represented that to ask of a man well advanced in years and well up in all the duties he was required to perform, to set about theoretical study in order to secure promotion, was a terrible and unjustifiable hardship. Throughout the Tweedmouth Commission's sittings the protest was pressed, but to no purpose, and £160 per year, which Mr. Fawcett had found inadequate in 1881, was declared to be a sufficient reward for the duties of a telegraphist.

Simultaneously with this change in the definition of the Senior Class, an alteration occurred in the ratio it bore to the general body. As a class of telegraphists it had maintained a relation of 1 to about 7·5 to the classes below. But upon the new definition the basis of calculation was altered and the ratio became and has been maintained at about 1 to 10·5. The following table will illustrate the alteration of ratio :—

Date.	No. of seniors.	No. of 1st and 2nd Class.	Proportion of general staff to each senior appointment.
1881	126	966	7·66
1886	161	1,224	6 60
1888	175	1,321	7·54
1890	219	1,590	7·26
1892	170	1,740	10 23
1897	172	1,870	10 87

It will thus be seen that quite apart from the difficulty of the technical examination there was, and is, a lesser chance of advancement to the Senior Class than existed from 1881 to 1892.

The fight against the change in the Senior Class appellation, qualifications and duties was waged throughout last year, and at last, at the conference between the Postmaster-General (the Duke of Norfolk), Mr. Hanbury (Secretary to the Treasury) and a number of M.P.'s, which was held in August, 1897, at the House of Commons, I was able, with the aid of Sir Albert Rollitt, M.P., to argue the matter upon the basis of a "breach of contract." This was the sole basis then taken up. As a result the technical examination was abolished, but the words in which this act of reparation was couched are instructive and typical, "The Postmaster-General and Mr. Hanbury are struck with the consideration that it (the technical examination) may in certain cases operate to bar the advancement of an officer who—though in other respects a skilled operator and efficient servant of the department—may not possess the requisite technical knowledge required for an examination on purely technical subjects. They have therefore decided to abolish this rule, &c., &c."—*Post Office Circular*, *No.* 1,216, *August* 10*th*, 1897.

So the technical examination was abolished, but the proportion of seniors to the lower classes is still less than before 1892.

With the fall of the technical examination, our contention that the scale to £190 was an operators' scale was in effect conceded. What is now our position on the matter? This is not the place to discuss the admitted evils of classification. Suffice it to say that we had contended before the Tweedmouth Committee for the abolition of classification, on the ground that it was a system full of evils, and this contention had been admitted by the Committee, in its report, to be justified. Sir S. Walpole was one of the five members of that committee. The words of the report run thus :—

"*Promotion and Classification.*—The complaints under this head are threefold. (*a*) The uncertainty and stagnation of promotion within the classes into which the rank and file of the various grades of Post Office servants are divided. (*b*) The slowness and uncertainty of promotion from these classes to the supervising classes; and (*c*) the delay in filling up vacancies.

"We think that on entering the service it is most desirable that a man should be under no uncertainty as to his future career and prospects of promotion. While the present system of classification prevails, the realisation of this ideal must be difficult. For instance, the sorting or telegraph staff consists, as a rule, of so many second class sorters, or sorting clerks, and telegraphists. The duties of the two classes are largely similar, and in those duties many members of each class are equally proficient; yet it is only as vacancies occur in the first class that there is a chance of promotion for men in the second.

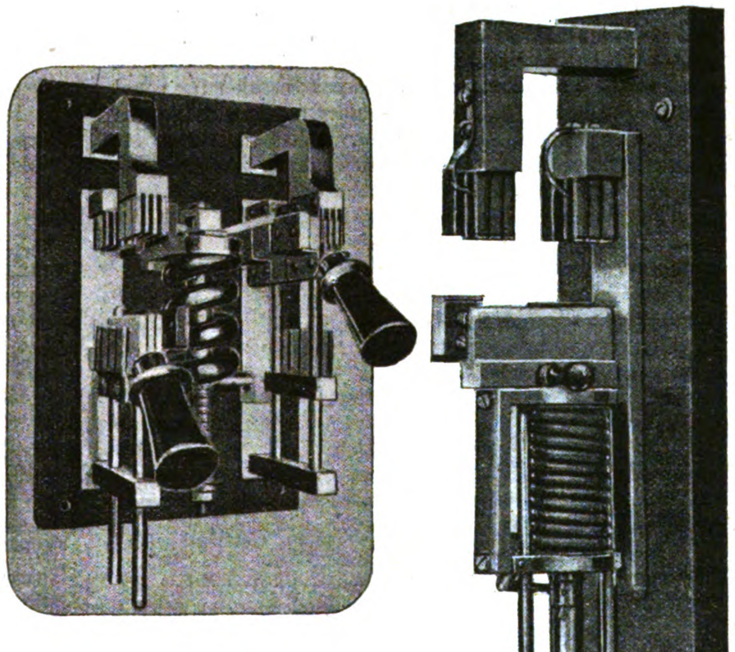
"We therefore recommend that wherever in the case of officers not performing work of supervision such classification exists, it should be abolished, and the officers under certain conditions hereafter to be specified when we deal with the cases of particular classes, should proceed by annual increments from the minimum wage of their class to its maximum."

Telegraph clerks, then, claim that the scale of their class is from a minimum of 12s. weekly to a maximum of £190 per year; that the scale was so intended by Mr. Fawcett, that it was so administered by his officers, and that the demand for any other qualifications than those of manipulative ability and good conduct have been proved to be a violation of their vested rights in this scale. All the evils of classification which led to its condemnation by Lord Tweedmouth's Committee exist in the retained classification now in force, and they demand its abolition. Unless this is done the actual maximum obtainable is only £160, a sum adjudged inadequate by Mr. Fawcett in 1881, and a sum which, under the changed conditions of to-day, is ridiculously insufficient. The prospect of a telegraphist obtaining £190 is less than it was 16 years ago, and so my contention is justified that during a period of progress a large section of public servants have slipped back and have now a lower prospect than in 1881.

(*To be continued.*)

IDEAL CIRCUIT BREAKER.*

A NOVEL circuit breaker has been put on the market by the Ideal Electric Corporation, of New York, the apparatus differing somewhat from anything yet offered to the public. The movements of the blades, or contact bars, are in a



FIGS. 1 AND 3.

* New York *Electrical World.*

vertical position, having a reciprocating motion up and down.

The illustration (fig. 1) shows a circuit breaker of the double-pole type, each pole working independently of the other, so that if an overload or short circuit should occur, both blades drop simultaneously. After closing one side of the switch, if the overload or short circuit still exists, in attempting to close the other side, the side already closed will instantly and automatically open. By this arrangement it is practically impossible to close the circuit breaker as long as an abnormal amount of current is passing. The most commanding feature of this switch is that at no time during the entire action of opening or closing, does any part protrude more than 6 inches from the face of the switchboard, thereby avoiding the danger of striking the operator, and very often injuring him. A man of ordinary strength can with rapidity and ease close circuit breakers of this type up to 5,000 amperes capacity. All conducting parts are made of hard-drawn copper, and all parts not made of copper are heavily copper plated, the entire switch being highly polished and lacquered.

The switch is self-contained and can be easily mounted on the switchboard, no lining up being necessary.

Fig. 2 shows the template and all the drilling necessary for

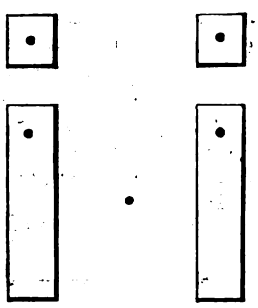


Fig. 2.

a 500-ampere breaker. In the operation of other circuit breakers two large compression springs are commonly used, but in the Ideal there is only one small one, gravity doing the rest. These breakers are also provided with an evenly divided scale, and can be adjusted from 40 per cent. to 50 per cent. overload.

Fig. 3 shows a self-contained single-pole breaker for panel and switchboard work. Only three holes need be drilled in the switchboard to mount the breaker. With the Ideal independent circuit breaker no auxiliary switch is necessary, on account of its independent action.

NEW PATENTS.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents*, 322, *High Holborn, London, W.C., to whom all inquiries should be addressed.*]

1,258. "An improved cord grip ceiling rose for electrical work." F. W. Heaton and H. Smith. Dated January 17th.

1,290. "Means for augmenting lifting-power by electricity." H. Wolff and W. Brase. Dated January 17th. (*Complete.*)

1,294. "An improved coin-operated telephone instrument for public call." F. J. Clendinnen and G. A. P. Weymouth. Dated January 27th. (*Complete.*)

1,301. "Electric signalling apparatus." F. B. Herzog. Dated January 17th. (*Complete.*)

1,303. "Improvements in magnetic ore separators." G. J. Cream. Dated January 17th.

1,379. "Improvements in electrical insulating conduits and in the method of and apparatus for making same." P. M. Justice. (The Lithosite Manufacturing Company, United States.) Dated January 18th. (*Complete.*)

1,380. "Improvements in the regulation of dynamo-electric machines and motors." F. A. Johnson. Dated January 18th. (*Complete.*)

1,391. "Improvements in electro-magnetic brakes for cars." E. Peckham. Dated January 18th. (*Complete.*)

1,416. "Improvements in telegraphic transmitters." S. Price, W. P. Phillips and R. H. Weeny. Dated January 18th. (*Complete.*)

1,464. "Improvements in and relating to holders for incandescent electric lamps." W. McGeoch. Dated January 19th.

1,465. "Improvements in and relating to moulds for shaping glass globes for gas or electric lights, or like articles." J. Buchanan, Jun. Dated January 19th.

1,489. "An automatic interchangeable electric and mechanical advertiser." H. W. Cox and C. T. Taylor. Dated January 19th.

1,511. "Improvements in terminal fuses." J. G. Dixon. Dated January 19th.

1,535. "Improvements in incandescence electric lamps, and processes for the production thereof." C. A. R. von Welsbach. Dated January 19th.

1,557. "Improved clockwork-operated mechanism for switching electrical current." A. S. Scull. Dated January 20th.

1,564. "Electric striking mechanism for clocks and the like." H. Whidbourne. Dated January 20th.

1,628. "Improvements in and relating to secondary batteries." W. A. Crowdus. Dated January 20th.

1,678. "Improvements in, and connected with, dynamos and electric motors." F. O. Prince. Dated January 21st.

1,686. "Improvements in secondary batteries and in means for combining electric lamps therewith." W. A. Crowdus. Dated January 21st.

1,687. "Improvements in electric signalling apparatus." S. P. Thompson. Dated January 21st.

1,691. "Improvements in electric switches." J. G. Dixon. Dated January 21st.

1,697. "Apparatus for the electrolytic treatment of bleaching liquids." M. Haas. Dated January 21st. (*Complete.*)

1,702. "Improvements in electric batteries." M. Reynard. Dated January 21st.

1,706. "Code telegraphing and circuit-testing apparatus for fire-alarm and other purposes." R. Pearson. Dated January 21st.

1,742. "Improvements in, and relating to, electro-magnetic engines or motors." C. McCallum. Dated January 22nd.

1,787. "Improvements in tools and appliances for bonding the rails of electrical railways, tramways, and the like." P. U. Askham and R. Herd. Dated January 22nd.

1,803. "Improvements in, and relating to, electric arc lamps." L. B. Codd and J. A. Codd. Dated January 22nd.

1,809. "Automatic time switch." E. A. Claremont (c/o Messrs. F. H. Royce & Co., Limited). Dated January 22nd.

1,826. "Improvements in rheostats." H. B. Cutter. Dated January 22nd. (*Complete.*)

1,828. "Improvements relating to the transmission of drawings, hand-writing, and the like by telegraph and telephone." J. Walter. Dated January 22nd.

ELECTRICAL PATENTS OF 1884, EXPIRING IN FEBRUARY, 1898.

We are informed by Messrs. W. P. Thompson & Co. that about 95 applications for electrical patents were filed in the month of February, 1884. Of these some were never completed, and those that were only three have been maintained to run their full length of term, viz., 14 years, and being of some interest we give short abstracts of them below:—

2,858. "Improvements in means for producing and utilising electric currents in secondary circuits." L. Gaulard. Dated February 6th, 1884. The induction coils consist of a round or flat primary conductor surrounded by a number of conductors connected in parallel forming the secondary conductor. The compound conductor thus formed is wound upon a bobbin which may have an iron core. The secondary coils may be grouped in various ways by suitable switches according to the requirements of the system. 5 claims.

3,034. "An improvement in apparatus for electrically controlling railway signals." C. Hodgson. Dated February 9th, 1884. Relates to electrically controlled railway signals and consists of interposing between a signal and its motor, a sway beam or its equivalent, one end of which is worked by the motor, the middle of which is connected to the signal, and the other end of which is either held stationary or is left free as determined by an electro-magnet excited by a current transmitted or brought into action from a distance. 2 claims.

4,025. "Improvements in the manufacture of electrical conductors for telephonic or other purposes." E. T. Trueman. Dated February 27th, 1884. Two or more wires are wound spirally round a hard core (of insulated wire, hemp, India-rubber, &c.). The whole is then passed through a gutta-percha covering machine. The core or the wires of the core may be first taped with insulating tape. After leaving the machine the cable may be passed into water containing plumbago finely powdered, which impregnates the surface forming a double surface. 4 claims.

THE

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CONTENTS:

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THE RELATIONS BETWEEN CUSTOMER, ENGINEER, AND MANUFACTURER.

THE above is the title of a recent paper presented before the New York Electrical Society by Mr. S. W. Greene. There is some sound sense in this paper. We read that "many consulting engineers, especially those who have recently commenced practice, seem to think that it is improper for them to consult with the manufacturer, or to examine his plant or to ask him for information or advice." The inevitable result is, that specifications often contain provisions which are a source of annoyance and expense to the manufacturer and purchaser alike, and which have no compensating advantages from either the engineering or the commercial standpoint. "Some of the provisions are impossible or impracticable, and the contractor has the awkward task of asking for this modification." These remarks apply to all trades, and to none more than to trades of special character. There are many contractors who, if they pay proper attention to their business, must inevitably become the best experts, and if they be also engineers, it is difficult for any outside consulting engineer to draw up a specification that will meet the views of the experts, unless the consulting engineer has taken the trouble to first place himself in communication with them.

Some of the worst faults in the drawing up of a specification with the form of tender and schedule of prices, are the adherence to old and abandoned methods, the specifying of materials, to make which or obtain from foundries, &c., will require more time than is given for the completion of the contract, whereas better goods of modern commercial sizes are, perhaps, to be had direct from stock for less money. Then the schedule of prices is often drawn up in what is evidently absolute ignorance of the conditions and necessities of carrying out work, and as a fixed printed form is insisted upon, the contractor cannot place his corrections upon it, and the result is, that what should be a good job proves to be dear and bad. We might take the majority of specifications issued within rifle shot of Westminster Hall, and none of them would pass the judgment of a sound practical builder, contractor, engine manufacturer, or other experienced man in each particular kind of work specified. Now all this is decidedly unfair to purchasers. Why should a man who wishes to have certain work done for him pay a 5 per cent. commission to some engineer to specify things which will cost 50 per cent. more, and be twice as difficult to repair as the plant that he could have bought direct from some good firm of contractors. It is because there are shoddy firms that consulting engineers are needful as go betweens, but this is no reason for the too prevailing egotism that disfigures so much of our English work. Mr. Greene finds the same to prevail largely in America, where special apparatus or methods are called for to the exclusion of standard apparatus of equal efficiency. His idea of the consulting engineer is, that his place is to see that his client selects the best system, and purchases good materials, and the engineer's business is to see he gets them, and he should, therefore, consult with manufacturers, should visit their establishments, and keep himself up to their practice. This, he thinks, no manufacturer would refuse. We should think manufacturers would be glad to keep engineers posted up in view of the chance of having to fill the specifications of these same men at any time, and there is now no mystery in manufacturing that need demand closed doors. On the question of standardising, there is too little done in England. Many things are standardised in America, and great benefit results, especially in railway work. English engineers are perhaps too desirous of making some special mark. Thus, if a railway has worked for years on certain patterns of locomotives, and is working as economically as any other railway, is it not a gross injustice to all concerned that a new locomotive superintendent should hastily alter everything, so as to be able to put his mark on the engines until the rolling stock has as many patterns as there have been superintendents? There must be progress, but a large amount of specified work we constantly meet has not even the merit of being a step forward. It is too often a step backwards into methods properly abandoned by better informed men. Naturally, in the early days of the electrical industry, the types of apparatus have been legion, but then we had not got out of the area of experimentation. Yet there are men in practice who will get up a drawing and a specification for a 20-H.P. steam engine, or for a Lancashire boiler, about which he knows less than the office boy in the boiler-maker's works. Our author points out that some specifications not only specify the conditions of service, the apparatus required, and the tests which will be applied, all which is quite proper, but they specify how the contractor shall make it, which is another.

We all know that he is right. Only a few days ago we saw some general work specified for, which went so far as to specify and show a drawing of certain plummer blocks which were inferior to what any manufacturer of shafting and mill-gearing specialties supplies in his ordinary run of standard work at half the cost these particular new designs would involve.

Many consulting engineers seem to think they ought to supply designs for their clients throughout. Never was a greater mistake made. It is their business to avoid this as much as possible, because the fewer the drawings the cheaper the cost—standard articles being purchased. It is unfortunate there should be so much payment of engineers by commission on cost. The better the engineer does his duty the less he is paid by that system, which we have heard more than once stated to be responsible for the outlay of thousands of pounds where hundreds would suffice. Manufacturers are themselves responsible for much evil. Pick up a manufacturer's catalogues, and how much information will they afford?

Take the above-named item for plummer blocks, and there is found the diameter of the bore and the price, but not a figure as to the length of bearing, the bolt centres, sole length, or breadth, or height of centre. The catalogue is useless, as compared with a German book before us, which gives every detail, so that, by its aid, a scheme of machinery becomes merely the suitable arrangement of certain standards. The truth is, we are to-day, in the commonest articles of engineers' use, in much the same condition as we were before Whitworth standardised the screw thread. The only difference is the screw thread. Everything else is much as it was. English manufacturers ought to look to this. They pay far too little attention to either standardising, as between each other, or making their own goods interchangeable. Pipe makers are grievous sinners in this respect, and of all people, they ought to follow standard sizes and interchangeableness. It is the same with makers of rolled girders, who again fall lamentably behind the American mills, in not providing suitable catalogues, with weights and all other properties of their sections.

Finally, the powers taken by engineers in their specifications to harass contractors ought to be more limited. Every contractor knows the constant trouble which arises, no matter how good his work, because of some busybody of an underling who is continually finding fault and hindering progress, too often for the sake of really spoiling what he is professing to improve. When the engineer is devoid of practical knowledge he is sure to take the part of his man, who is, perhaps, acting as clerk of works, against the word of the more experienced contractor, who is, of course, tainted because he is supposed to be making money out of his work, and must be prevented doing so at all costs.

We take it that the principal duty of a consulting engineer is, or should be, to use a practical knowledge, acquired in a contractor's works, in advising his non-technical client what to purchase from contractors. In the end, it is the contractors who make and employ their own special experts to design. Can a consulting engineer get out plans from steam boilers to incandescent lamps that can compare in any one item with the work of the dozen engineer experts who devote themselves the one to boilers, the other to engines, the third to the dynamo, and so on? Yet this is what we seem to find is the motive underlying most specifications. The system cannot even be claimed good for trade, for it runs up expense and chokes off progress, and the engineer himself is worse off, for he gets his commission probably on a single job costing, say £2,000, where otherwise he might have drawn on two or more jobs at £1,500 each, had an easier time of it, and given better satisfaction.

A Difficulty in Electric Traction.—If one pair of wheels in an electric locomotive combined in series should happen, from any cause, to slip, its high speed of rotation will set up so much counter E.M.F. that the current will be checked and torque reduced, and this will happen to every wheel in a series combination. Coupling rods to check the tendency of one wheel to slip are undesirable additions to an electric as to any other locomotive. As series working is very usual at times of starting, a single greasy spot on the rail might destroy the tractive force of the whole machine. One of the most promising systems of control is stated by the *Electrical World* to be the Leonard system, using separately excited motors with fully-saturated fields in starting, and with armatures supplied from a motor generator with adjustable secondary voltage. If, then, any one wheel slips its torque will be reduced and slipping will stop, but the remainder of the wheels will be unaffected, and as electrical locomotives are not overweighted for tractive purposes, the additional mechanism will be an advantage than otherwise. For yard purposes the electrical locomotive is extolled. It can be run into sheds without risk of dirt, smoke, or fire. It is also quieter and not so alarming to horses.

EXPERIMENTS ON INDUCTION AT LONG DISTANCES WITH HIGH FREQUENCY CURRENTS.

In an article in the *Electrical World*, N.Y., by Messrs. Northrup, Pierce and Reichmann, a series of experiments are described in which several novel instruments and methods were made use of.

The receiver employed was a kind of galvanometer for high frequency currents, and indicated approximately the maximum value of the current in the receiving circuit by the deflection of a copper disc suspended by a quartz fibre inside a coil. The copper or silver disc is set at an angle of 45° to the plane of the coil, and when an alternating current is sent through the latter, currents are induced in the disc which tend to twist it into the plane of the coil.

Considering the importance which the study of high frequency currents has recently acquired, some details as to the construction of this detector may be worth giving, and we therefore quote the description given by the authors:

"The delicacy of these instruments was due to the use of fine quartz fibres for suspension, and rapid damping was obtained by placing the disc between the poles of a permanent magnet. Any motion of the disc generated currents in it which brought it back to rest. Some details regarding the construction of these instruments are worthy of note, since care and experience in these details can alone make the instrument delicate and serviceable. The deflections were read by means of a telescope and scale. The complete period of the first instrument was 16 seconds, and that of the second was 13½ seconds. In the first instrument the system consisted of a ring of pure silver, with an external diameter of 12 mm. and an internal diameter of 7 mm., mounted upon a fine glass rod, which carried a thin, small mirror just above the coil. In the second instrument a silver disc 6 mm. in diameter was used instead of a ring. The mirror in this instrument was 4 mm. × 7 mm. Such mirrors can readily be made by silvering ordinary microscopic cover glass. They may be given the desired shape by breaking them in the following manner: The mirror is laid face down upon a hard smooth surface; the edge of a steel rule is placed upon the silvered surface and pressure exerted, when the mirror breaks along the edge of the rule. Since cover glass is extremely thin, using varnish upon the back of the mirror, or mounting it directly with any kind of cement, will distort the glass and give a confused image of the scale. The mounting is best accomplished by first fastening with hot sealing wax a small strip of cover glass to the rod. The surface of this should then be touched with shellac, and the extreme upper edge only of the mirror laid upon it. The greater portion of the mirror is thus unstrained, and a clear scale can be obtained from an extremely light mirror. The coil of the instrument shown in fig. 1 was wound in several layers upon a hard rubber bobbin with very thin walls. Waxed paper was placed between the layers, and the whole coil was soaked in hot beeswax and rosin. This precaution is required to prevent short circuits between the layers. At the top of the coil all the wires made a semi-circular turn, so as to leave a slot in one side of the coil, through which the glass rod bearing the silver ring could pass, thus bringing the axis of rotation of the ring in the centre of the coil. This made the coils detachable. Various coils with different numbers of turns were tried. One which gave satisfactory results, when the frequency of the induced current was comparatively low, contained 104 turns of No. 36 B. & S. wire. The axial depth of the coil may be as great as, but not greater than, the axial distance from one edge to the other of the silver ring or disc, when placed in the coil at an angle of 45°. The ends of the quartz fibre were attached with hot sealing wax.

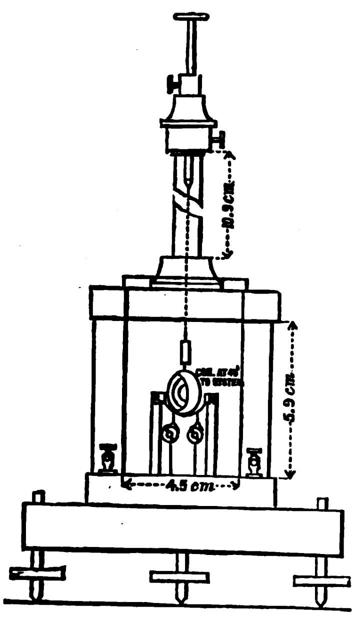


Fig. 1.

"It is essential that the silver ring should not come in contact with iron, for since the ring is suspended between the poles of a magnet the attraction upon the ring due to the presence of iron may greatly decrease the sensitiveness of the instrument. On the other hand, the silver may be found dia-magnetic, in which case the system, when brought by the torsion of the fibre into the right position, may be found to be unstable. This difficulty may be overcome by brushing the silver disc with a weak solution of iron sulphate. A few trials will serve to nullify the action of the magnet on the system."

Using this indicating instrument, the authors made a number of experiments to show the importance of resonance in the two circuits between which the electric waves are being transmitted. In one series of experiments, the inducing circuit A, fig. 2, consisted of a rectangular loop of bell wire, the dimensions of which could be varied. A condenser, *a*, of small and variable capacity, and a spark gap, *b*, were inserted in series in the loop. The receiving circuit, B, consisted of a similar loop with a condenser and the indicating instrument in series. The condensers in both circuits were built up of tinfoil and glass plates 18 × 20 inches. Fractional values of the capacity of one pair of plates were obtained by folding back the upper tinfoil sheet a known amount. The spark gap consisted of two brass balls, about 2 cm. in diameter, their separation being effected by means of a micrometer screw.

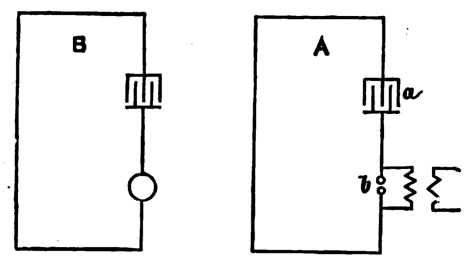


Fig. 2.

In experiments on the production of electric waves, it is important that energy should be supplied to the radiator continuously during the period when the indicating instrument in the receiving instrument is deflecting. Since an induction coil or an influence machine supplies energy only for a time, which is short compared with the intervals between each discharge, it is evident that the maximum amount of radiation cannot be obtained by the use of such sources of current. To obtain the best effects a source of current should be employed which will give a continuous discharge across the spark gap. It is further necessary, in order that oscillations may occur in the circuit, that the discharge across the spark gap should not be of the nature of an arc.

The following simple and effective method of generating a continuous stream of high frequency currents was employed by the authors. The E.M.F. of the alternating 100-volt city circuit was raised to the required amount by means of a high potential transformer. The terminals of the secondary were directly connected to the opposite sides of the spark gap, *b*, fig. 2, and the primary to the city circuit terminals, through a variable inductive resistance. Arcing was prevented at the spark gap by a strong blast of air supplied by a foot bellows. Without this air blast to blow out the arc only very feeble oscillations occur, and practically no induction effects could be obtained; but, with it the oscillations are strong and continuous. It is unnecessary with this arrangement to keep the balls bright and polished. Moreover, the effects obtained can be made extremely uniform if we insert in series with the secondary of the coil a condenser of such capacity that the arc between the balls ceases to have a flaming character.

The experiments with the above described apparatus verified, in a very striking and simple manner, the importance of resonance and high frequency in the effective transmission of inductive effects. The authors deduce by an elaborate mathematical investigation, a formula for the deflection of their high frequency galvanometer. This formula is somewhat complicated and contains many factors. It indicates that the deflection is inversely proportional to the sixth power of the distance between the radiator and receiver, so that this style of apparatus is not very suitable for wireless telegraphy to long distances. Indeed, the authors estimate that signals could not be transmitted over a greater distance than 1,600 feet with the best arrangements of their wire loop apparatus. These experiments are, however, of considerable scientific interest, and the methods described of generating and detecting electrical oscillations appear to possess some novelty, and to have considerable practical value.

COMPARATIVE COST OF STEAM AND ELECTRIC POWER.

II.

THOUGH perhaps less convenient than electric transmission, mechanical methods may, if well designed, be more economical where the load factor throughout the year is high. But a large class of power users make such variable demands for power that the ratio of average to maximum is very small. Such conditions favour electricity both as a power transmitter and as a prime mover in that particular place. Illustrative of the first case is taken an engine of 1,000 H.P., delivering 750 H.P. to machinery and 250 H.P. to power transmitters. But if the load factor be 35 per cent. only—not a specially small factor—the useful work will be only 28·6 per cent. But electrical transmission would give the same total efficiency of 75 per cent. from engine pulley to machinery, and for a load factor of 35 per cent. the total efficiency would be 50 to 60 per cent., or double that for mechanical transmission. Thus, while the total power would be the same and the 1,000 H.P. engine would be retained, coal would be saved to the extent of 30 to 40 per cent., which with coal at 12s. would mean £400 to £600 per year in a non-condensing plant.

In particular cases the main plant could be reduced by at least a fourth with all that this implies of saving.

If at full load the constant charges are £1,000 a year, and the same figure stand also for the variable charges, the variable charges will remain about constant per H.P.-hour. If the load factor becomes 50 per cent., the constant charges remain the same, and the variable charges become halved.

At half a million H.P.-hours annually, the constant charges will be 1 cent per hour, and the variable charges also 1 cent. With only a quarter million H.P.-hours annually, the constant charges will become 2 cents per H.P.-hour, the variable charges being, as before, 1 cent. The total full load cost is thus 2 cents, as against 3 cents when the load factor is 50 per cent.

Hence the total costs must, for economy, be chiefly a summation of variable costs. Constant charges on plant become higher, out of all proportion, as steam engines become smaller. This is a well recognised fact. One man can attend to a 200-H.P. plant. In smaller shops either one man must attend to the small boiler and engine of 2 H.P., or they must be left to anyone, and there is an enormous but not directly visible waste. Central station working has the advantage of a better average load than any individual consumer, but there is the disadvantage of the costly system of mains, and these have proved fatal to central station power distribution, except for small consumers who have been willing to pay as high as 20 cents per H.P. hour. This, of course, applies to steam distribution. Electricity steps in here, and proves capable of transmitting power economically to scattered consumers, and this apart from its higher efficiency for distribution. Much of this arises from the ability of distributing two energies over one main, viz., lighting energy and power energy, both generated by the same machinery. As in a large station the variable charges are small on all loads which do not "peak," a small charge for power brings in a handsome return. With special bids thus possible for consumers of electrical power, it would seem impossible for small isolated steam powers to compete with electrical. This is Mr. Taylor's conclusion, and it should be the province of our English companies to look for customers among the small shops. We have some knowledge of the power consumed by small shops, and we are convinced there is a huge opening. We are also convinced that makers of small motors should lay themselves out to answer a few plain questions as to cost and power. At present the fashion seems to be to tell nothing. Surely there has by this time accumulated sufficient data as to the use of current by a lathe, a drill, or a fan to enable a rough estimate to be given.

The power absorption by machinery has always been a little known subject, but this is largely because the absorption by the machine has been complicated by the question of shafting. With electricity, it would be so very easy to know just how much a 9-inch lathe consumes idle, or cutting, that we wonder no one who has the opportunity has found this out and made a list of a few sizes of tools and their various power absorption. Such a table would, we feel sure, greatly facilitate business.

(*To be continued.*)

SOME NOTES ON SINGLE-PHASE MOTORS.

BY A. C. EBORALL.

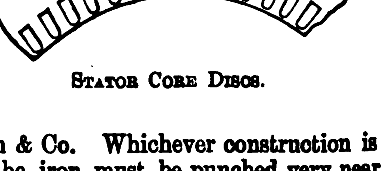
(*Continued from page* 137.)

The Stator.—The stator of modern motors is always built up of lightly insulated soft iron core discs, these, as shown in fig. 7 (A, B, C), being either slotted, or pierced with rectangular or semi-rectangular holes for the reception of the windings. Fig. 7A is Messrs. Brown, Boveri & Co.'s construction, fig. 7B that of the Oerlikon Company, and fig. 7C that of

FIG. 7A.

FIG. 7B.

FIG. 7C.



STATOR CORE DISCS.

Messrs. Kolben & Co. Whichever construction is used, the apertures in the iron must be punched very near the inner edge, or else there may be considerable leakage across the small iron bridges or air-gap. In practice, the distance of the hole from the internal periphery of the stator is rarely more than 3 millimetres in the largest motors, and is a mere shred of iron in the small ones. If the stator is of large size, the core discs are punched out in sections, these sections being afterwards bolted up together, the joints in one layer being covered up by the next.

The depth of the hole or slot varies in practice from $1\frac{1}{2}$ to 3 times its width; it should be as small as possible, as leakage increases with the depth of winding. The distance between each hole or slot is a little more than the width, there being preferably many small slots or holes rather than fewer large ones, as these would tend to destroy the evenness of the field, and might cause heating of the rotor.

The advantages of thus imbedding the windings (first introduced by Mr. C. E. L. Brown) are several. For example, the weight output is increased, the magnetic resistance is reduced to a minimum (and hence a smaller magnetising current is required, and larger power factor results), and all eddy currents in the stator windings are prevented. Further, if the motor windings are also embedded, as in practice is the case, the air-gap need only be large enough to give the necessary mechanical clearance, the strain comes on the iron, not on the windings, and both rotor and stator are smooth all round.

As to which is the better, the hole or slot, probably, taking them all round, there is not much to choose between them. The pole produced by hole winding is more even than that produced by slots, but owing to the absence of the small iron bridges, there is probably a little less leakage with the latter. Messrs. Kolben's semi-rectangular hole has more winding space than either of the other two, and gives a very even pole.

The next thing to consider is the winding. The speed of the motor, and the frequency of supply being known, the number of poles is given by

$$p = \frac{120 \times \text{frequency}}{\text{revolutions per minute}}$$

as already pointed out. They may be produced by either a ring or drum winding; but some form of the latter is invariably used, and is far the best. Ring winding has several disadvantages—its magnetic leakage is greater; it requires more wire for the same effect, and, moreover, precludes the use of an iron case for holding up the stator core discs on account of the leakage that would be produced through it. The bad effect of leakage on the starting and power factor of a single-phaser have already been pointed out.

Fig. 8 shows diagrammatically the form of drum winding introduced by Messrs. Brown, Boveri & Co., and now

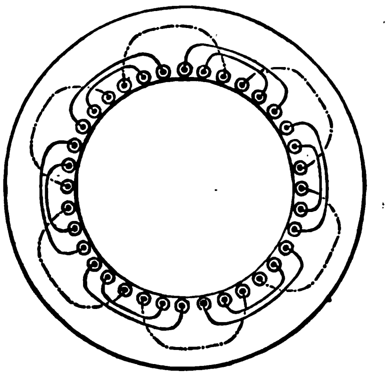


Fig. 8.—Stator Drum Winding.

invariably used on the Continent for all kinds of induction motors. The dotted lines indicate the starting winding. In practice, each coil of the working winding is wound quite straight, its shape being a simple rectangle, while the coils of the starting winding are bent up and over the others. It is usual to wind about two-thirds of the holes with the coils of the working winding, the starting winding consisting of equal ampere-turns of thinner wire, as it is only in use for a short time. The number of turns on the starting winding depends, however, on the nature of the starting device employed, as will be seen later.

The Rotor.—Rotors for single-phase motors may be of two kinds: a simple short-circuited bar winding, or a three-phase bar winding, whose ends are joined to slip-rings on the shaft and between which may be inserted resistances, used as a rule only during the starting of the motor, and whose function will be discussed later.

If the rotor is of the first form, it is built up of core discs of the shape shown in fig. 9A, each stamping being lightly insu-

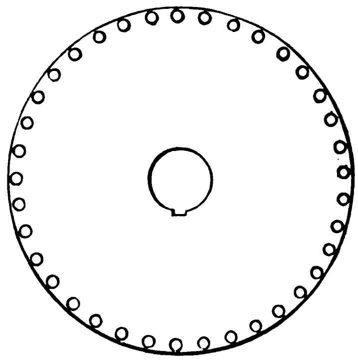


Fig. 9A.—Rotor Core Disc.

lated from its neighbour, and the two end plates being made considerably stouter than the rest for the sake of stiffening the rotor. Three or more bolts are generally passed through from end to end, and parallel to the shaft, for the same purpose. Through the holes in the core discs copper bars are passed through, the bars being insulated by paper or other material from the iron. The copper bars are short-circuited at each end by means of copper rings, the section of these rings, for a reason presently to be explained, being considerably less than the total section of the bars.

The reason for insulating the rotor bars at all is simply to fulfil one of the conditions previously enumerated as to confining the rotor currents to proper paths. The reason

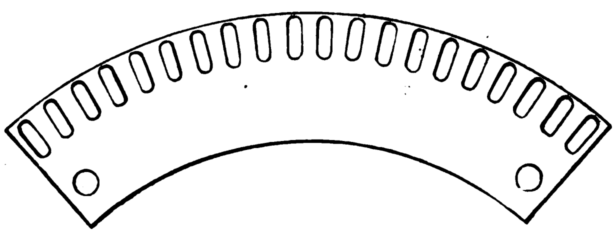


Fig. 9B.—Rotor Core Disc.

for using rings for short-circuiting the bars is partly because they offer a good cooling surface, and partly because by their use over-wrapping at the ends and the use of connectors is avoided, the whole forming a sound mechanical job.

If the rotor has to be of the second form mentioned above, with its windings connected to slip-rings, its construction is somewhat different. As such a rotor is generally of large size, the core discs are built up in sections, as shown in fig. 9B, and owing to the fact that the centre of the iron part of large rotors is inactive, these sections are built up either on a spider, or else on the rim of a fly-wheel, according to the size of the motor.

The number of holes or tunnels is determined by reference to those in the stator, they being always more numerous than those in the latter, and an uneven multiple of them when possible. It follows from this that the rotor holes or tunnels will be longer and narrower than those in the stator.

(*To be continued.*)

LEGAL.

Salmony & Co. v. Improved Electric Glow Lamp Company.

The hearing of the case, the verdict in which was briefly recorded in our last issue, was resumed on Monday last week.

Mr. Max Salmony was cross-examined at considerable length by Mr. Rufus Isaacs, but on the whole bore out his counsel's opening statement as to the agreement arrived at with the defendant company.

Mr. Ernest Rosenberg, also a member of the firm, called by Mr. Tindal Atkinson, gave evidence. He said that at the interview of September 16th, 1887, the defendants accepted their conditions, and an agreement was completed. Mr. Snell, the solicitor, and Mr. Fanta wanted them to guarantee that Mr. Brown, of Eastbourne, and Mr. McLeod, of Glasgow, would accept an assignment of their agencies, but they refused to give it. The invoices were returned by the defendants, but they ultimately agreed to take the goods.

Mr. Rubenstein said there was a discussion as to the £700 alleged profit from the agencies, at a meeting at the Hotel Metropole, but no guarantee, such as was suggested, was given. There was only an offer from Mr. McLeod, but no acceptance of any contract.

His Lordship said the questions seemed to be whether the defendants were entitled to rely on the special agreement which they set up, and to damages because the arrangement with McLeod was not a contract, but only an offer.

Mr. Rufus Isaacs said he would reserve his remarks on behalf of the defendants, and at once call witnesses.

Mr. Ferdinand Fanta said he was managing director of the defendant company, and was also manager of the syndicate before it was transferred to the company. At the interview of March 30th, 1897, when he gave the order for the lamps, he wanted them for the Jubilee. They were to be delivered by May 25th. It was a condition that the lampholders were to be delivered within 8 or 10 days. It was absolutely essential to have the goods some time before the Jubilee, June 3rd or 4th, when they were delivered was not in sufficient time. They were able accidentally to use some of them—some 2,200. He gave instructions to the employés to refuse to take delivery after May 25th, but they were delivered in the absence of the warehouseman. He met Mr. Salmony and Mr. Rosenberg about June 7th or 8th, and told them the goods were useless. As it happened, he was able to use some of them in connection with the illumination of St. James's Street, and plaintiffs agreed that he should do his best to dispose of part of them. He promised to do so. He did what he could, and there was no dispute about the price of those which he used. He never agreed to take the whole of them at the invoice prices. The remainder of the goods in respect of which he had not paid into Court were still on his premises, and could not be used. Plaintiffs told him they would hand over the contracts with Brown and McLeod, which showed £800 or £900 profit, but eventually £700 was agreed upon. He then believed he was getting the contract with McLeod, and the profit, but the company never got a farthing; as a matter of fact, Brown's contract was still in abeyance.

Mr. Tindal Atkinson: What is your complaint with regard to this matter of McLeod's?—Paying £300 for certain contracts, which were represented to us to show £700 profit. We found that no business resulted from it. There was no contract, no sale of anything.

Were you in a position to supply the lamps?—Certainly.

When were you first informed that it was only an offer from McLeod, and that there was no contract?—I found it out when McLeod refused to allow their letters and orders to be assigned to the company without his consent. The syndicate was formed to purchase certain patents and the sale of the lamps in the United Kingdom.

By His Lordship: They expected to get Schwaber's agency.

In further cross-examination, Witness said he thought he had been deceived in the matter of the contracts with McLeod and Brown. The syndicate was formed for the purpose of purchasing certain patents, Schwarber's amongst them. In order to successfully carry out his plans it was necessary that he should obtain the sole agency, which was then in the hands of the plaintiffs, and he had to purchase them out. That was not the principal object he had in view with regard to his agreement with the plaintiffs. In that particular negotiation the principal consideration was that witness would undertake to take delivery of all lamps which Messrs. Salmony might have, not only on their premises but which they might have on their premises six weeks after that date, and it turned out that those amounted to some 10,000 lamps which had been invoiced to them, and which the syndicate agreed to purchase for a higher price than the plaintiffs had paid for them. Witness stated that he never agreed to take the holders in dispute, but would try to dispose of them, acting as the plaintiffs' agents in fact. Witness told Mr. Salmony that if he did succeed in disposing of them, he should require a commission. He did not know that there was any representation as to the commission in the company's books. When the plaintiffs sent the company the invoices, they were returned to them, but re-returned by the plaintiffs to the company. Witness ordered the holders in question for the purpose of using them at the Brussels Exhibition. He told Mr. Salmony that they would not be any use to him unless he could use them for Jubilee Day, and then send them on to Brussels. Witness would have to decide about the Brussels contract in May. Not getting the holders delivered in time, he could not get the contract. As a matter of fact, he did not press for that contract, and it was not accepted.

Mr. Herbert Thompson, book-keeper of the defendant company, gave evidence, generally bearing out that of Mr. Fanta. This evidence closed the defendants' case.

Mr. Rufus Isaacs said the whole question was what was agreed upon between the parties. As to the 25 per cent. commission on the £100, though large, it was not, he contended, exceptional, under the circumstances. Having gone over the correspondence, he contended that the story told by his clients was the most probable one. Under the deed of assignment of the two contracts of McLeod and Brown for £300, he maintained that defendants were entitled to damages for breach of contract. It was said that the counter-claim was a bogus one, and only concocted for the purposes of that case; but nothing could be further from the truth than that assertion, and on that counter claim he was clearly entitled to damages.

Mr. Tindal Atkinson maintained that the counter-claim had been manufactured for the purposes of that trial, and complained that the want of pleadings in the case had materially lengthened the proceedings—a remark with which his Lordship concurred. Plaintiffs denied that they had guaranteed the contracts. The fact was, that McLeod had refused to homologate, and defendants took the risk of that when they made the agreement. He submitted that plaintiffs were entitled to judgment on both the claim and counter-claim.

His Lordship gave judgment on Tuesday morning. Having briefly gone over the evidence, he said there was no question in his mind that the contract with Mr. Brown, of Eastbourne, was an actual contract, and that the transaction with Mr. McLeod, of Glasgow, was one which might fairly be described as a contract in view. It was a contract in view and not in hand, although there was very little difference between them. Proceeding to deal with the counter-claim of the defendants, he said that if it was found that if a document or agreement had missed conveying what it was intended to convey, it was right and just that the document should be reframed for the purpose of getting at what both sides intended and what was meant. He had no doubt that at the time the agreement was made both the parties understood one thing only, and that was that the benefit of the correspondence and arrangement with Mr. McLeod was to be transferred, whatever it was worth. The defendants had the full benefit of the objection they took, but they did not communicate with McLeod, or try to verify what had been said with regard to him for fully two months. In fact, no question was ever raised until nearly a year later, in any serious form. Not until October 22nd did he find any serious complaint, McLeod had then refused to homologate and to transfer his contracts, and it was only after that that the liquidator of the syndicate, Mr. Bartlett, wrote and drew attention to the fact that the contracts with McLeod and Brown had not resulted in the business and profit which plaintiffs had guaranteed, and that Messrs. McLeod and Brown had repudiated the right of the plaintiffs to hand the contracts over to the syndicate. He repeated that there had never been any proper negotiations with McLeod, and that no claim was made with regard to him for nearly a year. The defendants' solicitors' letters were sufficient to show that what was intended and understood to be given was given and accepted on the terms of the guarantee which was written. He did not see why he should give the defendants damages on the counter-claim, because McLeod had declined to trade with them as the persons to whom his contract with another person had been handed over. Defendants took their risk of that. A. could not assign to B. a contract with C. against the latter's will. The defendants took the risk of McLeod agreeing to the assignment, and McLeod declined. He could not, therefore, give defendants damages on the counter-claim. With regard to the claim, the matter stood thus: In March, 1897, a contract was made for the sale of these goods, which had to be manufactured in Germany and supplied to the present defendants. It was said they were not supplied in a reasonable time, but reasonableness of time must depend upon the circumstances, such as the time necessary to give the orders, to construct the articles, and to bring them to England. It must be a time reasonable to the vendor as well as the purchaser. If April 14th was agreed upon, the order could not have been carried out. When the order was carried out, the defendants contended that delivery was too late, and sent back the invoices, but they afterwards took them back, and did, upon some terms which were not disputed, agree to take and pay for the goods. Therefore the question arose, on what terms and in what fashion did they take them as agents, or did they, when they found they could use a certain number, during the Jubilee, take them? The same could not be said as to the lamps, which were said to have been required for Brussels, as their tender there was refused. There was no sufficient weight of evidence to justify him in saying that any special agreement was come to. There was no trace in the books of any correspondence as to any such agreement, and no form of accounts was kept on that basis. In the face of the conflict of evidence, he must be guided by the letters which passed. It appeared to him that there was no proof that the goods should not be paid for, as they were ultimately accepted, taken into the stores, and used by the defendants. He therefore gave judgment for plaintiffs on the counter-claim and also on the claim, with costs. On the application of Mr. Tindal Atkinson, he made an order for the money paid into Court to be paid out.

The House-to-House Electric Light Supply Company.

A petition for the reduction of the capital of this company was sanctioned by Mr. Justice Romer on Saturday. The company was formed in 1888 with an original capital of £350,000, which had been reduced to £200,000. Amongst the shares issued by the company were 100 founders' shares, which it was desired to get rid of, and the general scheme of the petition was that the founders' shares should be surrendered to the company, and that the holders should subscribe for a certain number of ordinary and preference shares which were part of the original capital of the company, leaving the capital at £199,500 instead of £200,000.

Brown v. I. E. S. Accumulator Company.

This case came before Mr. Justice Romer, on Saturday, on motion for judgment as a short cause in default of defence. This company was incorporated in 1895 for the purpose of carrying on business as manufacturers of electrical batteries, and the plaintiff was the holder of debentures in respect of which the company made default. A company named New & Mayne were also made defendants, they being interested in the taking of the accounts. Mr. Justice Romer made the usual order in a debenture holder's action.

CORRESPONDENCE.

Wireless Telegraphy—A Forecast.

When reading the paragraphs appearing now and again in the lay newspaper, recording a further advancing step towards the solution of the problem of telegraphing without the aid of wires, how many are there who realise the possibilities—the certainties, it can be safely said—meant by its accomplishment? Very few, as few probably as foresaw the results of the experiments of Cooke and Wheatstone, 50 years ago, in telegraphing with wires. The adoption and practical application of the new discovery will, however, be probably far more prompt and decisive than those referred to of half a century back; indeed, it would be hard to find a more significant index of the progress made in that short length of time, than in contrasting the eager readiness with which a new invention is now taken up, with the indifferent treatment it then met. For instance, the big London dailies, probably the most liberal and eager of all concerns in availing themselves of any new thing to their advantage, were about the slowest to see the wonderful possibilities—and, to us, evident gain—of telegraphy. Reuter—a specialist even in pre-telegraphic times, in the rapid transmission of news by means of carrier pigeons—one of the first to realise the full meaning of the new discovery, and to utilise it, failed, month after month, in inducing any of the London papers to accept his reports; and even had, ultimately, to supply a month's reports free, that comparison might be made between them, and those of the "special correspondents" of the existing order, to see if his own were true and reliable. The *Daily Telegraph*, to its credit, was the first to accept the new order of things, being, of course, soon followed, in self-defence, by the others; the *Times* coming, with a due and fitting sense of weight and dignity, at the tail end of the procession.

Telegraphing without the aid of wires is already practicable, granted favourable conditions, at distances up to 20 or 30 miles, and as this is simply the thin end of the wedge, when that wedge shall have been driven home, as in due course it must be, to its full length, by the time the butt end is out of sight, telegraphing from one end of the country to the other will be possible. It requires but little imagination to combine the telephone with the new departure; and we will thus have practicable the power of talking in London as readily to a friend, say, in Edinburgh or Dublin, as though he were sitting the other side of the table. Electric energy having by then also become a household requirement, supplied by each municipality, stored, much as coal now is, in a cellar, and fulfilling in an infinitely more ready and cleanly manner all the present purposes of coal—with a host of others to boot, from rocking a cradle and working a sewing machine, to turning the mangle and closing the front gate—there will be everywhere available a ready margin for telephonic use.

Given this necessary first power, the only other thing needful will be suitable transmitting and receiving instruments, in which will be arranged the essentials to success, of ready adaptation to varying distances and directions, and a means of conveying the particular message to the particular receiver in the hands, or at the ear, of the one it is wished to communicate with. But let an instance be taken of probable use to illustrate the point, a traveller, say, wishes to despatch an order to his wholesale house—he would, of course, be himself unnecessary were it not for the necessity of showing samples of his goods. In his room in the hotel he takes out of its case his small portable transmitter, and attaches it by the stud at the end of a short length of wire to the slot in the wall, connected with the electric reservoir and wires in the basement. By the help of a small attached compass and a map, he next turns the revolving body of the instrument upon its stand until an indicator points exactly in the true direction of the receiver, and then sets a second indicating pin, after consulting a table of distances, to the figure representing his distance from head-quarters. There being little danger of his message getting mixed up amongst the thousands of others travelling in the upper air, as each one will take its own distinct path, like rays of light and heat, the only point now remaining is to arrange that the message will be delivered at the right receiving instrument. This will possibly be accomplished by the setting of some combination of letters and figures arranged beforehand by the two correspondents—in much the same way that a safe can only be opened by one who knows the word, or combination of figures the lock has been set to. These simple preliminaries over, the order is sent away by merely speaking against a vulcanite disc—so many yards of material to so-and-so, or so many tubs of butter to somebody else.

It looks a bit strange at first to us; but would not the prophecy of the possibility of sending a message from London to New York, under the sea, in a few seconds, have seemed equally strange, or stranger, to our fathers? Yet this is a commonplace of to-day; telephonic communication between the two centres is also, probably, on the point of being made possible, so there is, after all, but the thin substance of one wire between what is, practically, accomplished, and that which we regard as so strange.

And what a difference it will make both in the smaller and ordinary, as well as the larger and extraordinary, affairs of life! The smaller possibilities of commerce have been touched upon, but we can go much further afield, and anticipate totally different conditions to present ones, for the markets of the world. The American, Russian or Indian wheat grower will be closely and cheaply in touch, by individual word of mouth, with his English broker; the cotton grower with the Manchester weaver; the iron master with those on the spot selected for the placing of his rails and machinery. The fisherman at sea, with his latitude and longitude accurately worked out, will be able to send his Grimsby or Yarmouth buyer full particulars of the fish in the hold of the trawler under his charge; whilst the mariner in general, in the same easy and ready manner, will have it in his power to gratify his love and sentiment, by chatting with his wife and children ashore whenever he has the mind to.

Travellers, again, in distant lands, if they wish—which, in view of the inevitable book, they probably will not—will, at least, have the means of communicating items of their journeyings to friends at home, as it will simply mean the carriage of a battery on the head of an additional porter, or on the back of an extra mule. The Polar expedition of the future, too, instead of trusting to the evident insecurity and frailty of pigeons as news bearers, will be able to speak with the interested ones of the country they belong to—and order off the usual relief expedition at the exact time, and to the exact spot necessary.

In short, as will easily be seen, this one small point gained and the country will be changed in every respect, socially, commercially, and economically; and Signor Marconi, if not the discoverer, in popular estimation certainly the applier of the new style of thing, deserves his statue of bronze if any pioneer of progress ever did, whether the statue, considering the extra pace and nervous strain involved, will remain a well washed and honoured one, is another matter altogether.

J. Rees.

The Electric Arc.

I have been much interested in the renewed speculations with regard to the electric arc that American research seems to have given rise to, and with others have been somewhat amused at their methods. Some of M. Blondel's latest methods seem also to merit some criticism. It is against the laws of Newton that he should be able to detect a counter E.M.F. even $\frac{1}{800}$th of a second after breaking the current (1) because no storage action has been detected in the arc, and if such action did go on it would involve a difference between the striking E.M.F. and the constant E.M.F.

(2) Supposing the counter E.M.F. to persist for a certain time after the impressed E.M.F. has been withdrawn. Let it persist (*a*) for a definite time, say, $\frac{1}{n}$th second. Then, if in the alternating arc we increase the alternations, the resistance due to counter E.M.F. diminishes till at n ~ per second the counter E.M.F. is zero, which is absurd—as we used to say in Euclid.

(*b*) If the counter E.M.F. persists for a certain fraction of the time of impressed E.M.F., this would make peaky E.M.F. curves still more peaky, and would introduce a new harmonic in the curve, suppositions contrary to fact, as the flattening of peaky curves in the arc shows.

I have, therefore, the following hypothesis to offer for the action of the arc, founded on observations and experiments carried on for some time at the electricity station here (at Prospect Hill Waterworks), and I do so before these observations have been completely concluded, in the hope that some "mightier pen" may turn his attention to this aspect of the arc. Let us take the case of the arc between carbon electrodes. Carbon is a tetravalent element at ordinary temperatures, but we know little or nothing of its behaviour at very high temperatures, for instance, that of the arc. It struck me that it was not only possible but probable, that the carbon molecule became dissociated, forming two molecules, each divalent; the tetravalent molecule may be assumed for theoretical considerations to be a compound (of two divalent molecules) which we may term carbide of carbon. This dissociation takes place at the surface of the positive carbon and is a percentage dissociation, a phenomenon not unknown in chemistry. Now, if this be the actual state of affairs the formulæ for electrolytic action should hold good, because, although the second stage of the reactions is different, the first is the same. On this assumption, the electrolyte is carbide of carbon, the ion divalent carbon, whose chemical equivalent is therefore 6. Now,

$$\text{W} = \text{C T } \epsilon$$
$$= \text{current} \times \text{time} \times \text{electro-chemical equivalent.}$$

If C = 10 amperes, T = one second, $\epsilon = \cdot 000010384 \times 6$ we have

$$\text{W} = 10 \times 1 \times \cdot 000010384 \times 6$$
$$= \cdot 00062304 \text{ gramme dissociated per second.}$$

$$\cdot 00062304 \,\underline{)\, 1\cdot}$$
$$1{,}605 \text{ seconds to dissociate one gramme.}$$

Now for the arc under consideration the watts were 400,

$$\overset{\text{Secs.}}{\therefore 1{,}605} \times \overset{\text{Watts.}}{400} \times \overset{\text{Cals. in one watt.}}{\cdot 24} = 154{,}080 \text{ calories.}$$

Again, $10^8 \text{ E} = 10\, \epsilon \text{ H J}$, where E = volts, H = calories, J Joules equivalent,

$$\therefore 10^8 \text{ E} = \cdot 000010384 \times 6 \times 10 \times 154{,}080 \times 42 \times 10^6$$
$$= 40\cdot 316171344 \text{ volts.}$$

This was almost exactly the volts between the terminals of the arc.

Iron was now taken for electrodes, and the same observations carried out. The chemical equivalent of divalent iron is 27·95.

The watts consumed were, on the average, 270.

Taking the two formulæ as before,

$$(1)\ \text{W} = \text{C T } \epsilon. \qquad \text{C} = 10 \text{ amperes, T} = \text{one second.}$$
$$= 10 \times 1 \times \cdot 000010384 \times 27\cdot 95$$
$$= \cdot 00029035 \text{ gramme per second dissociated}$$

$$\cdot 00029035 \,\underline{)\, 1\cdot}$$
$$= 344 \text{ seconds to dissociate one gramme.}$$

$$(2)\ 10^8 \text{ E} = 10\, \epsilon \text{ H J},$$

and $270 \text{ watts} \times 344 \text{ secs.} \times \cdot 24 = 22{,}291\cdot 2$ calories.

$$\therefore 10^8 \text{ E} = 10 \times \cdot 00029035 \times 22{,}291 \times 42 \times 10^6.$$
$$\therefore \text{E} = 27\cdot 182805770 \text{ volts.}$$

This represents the calculated voltage of the iron arc. The iron is tetravalent and is dissociated, the tetravalent molecule becoming two divalent molecules. As before then we may assume an electrolyte "ferrous ferride," and the volts thus calculated are exactly those observed.

Returning to the physical aspect of the arc, it seems to me that the current on arriving at the end of the positive carbon dissociates a certain percentage of the carbon molecules, the electrical energy being absorbed *without heat* to keep up this dissociation. This accounts for the counter E.M.F. which I assume to be the energy of chemical affinity required to keep divalent carbon in that form. But the dissociated carbon molecules at once combine with others to form tetravalent carbon and the latent energy of affinity is given off as heat, and therefore light. But not all the carbon molecules re-unite *in situ*. Some are carried across by some means (akin to ionic progression it may be) and thus form a conductor between the positive and negative carbons. The resistance of this will vary with its length and area. According to observation the amount carried across seems to be almost exactly $\frac{1}{10}$th of the amount dissociated. This led to some experiments on enclosed arcs, the results of which are somewhat interesting, especially with regard to the duration of the carbons. These results together with the calculations for arcs with various electrodes, especially monovalent elements, and photos of arcs taken with special reference to the foregoing hypothesis, I hope to lay before the readers of the ELECTRICAL REVIEW, firstly, if the editors will give their kind permission, and secondly, if no "bolts from the blue" are hurled at my pet theory and bring it with a crash about my ears.

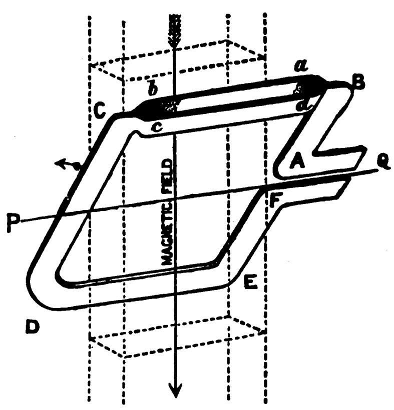
Walter D. Jamieson.

Shielded Conductors.

Mr. Price is evidently trying to get at the truth with regard to eddy currents in buried armature conductors, and I will not deny that he may be very near it; but he made a mistake when he selected one or two of the most carefully worded statements from my letter (which appeared in your issue of January 28th), and used them as a foundation upon which to build a number of misleading and altogether erroneous deductions.

I do not wish to hurt Mr. Price's feelings, and he must not conclude that he has "again incurred my contempt," when I say that, in my own mind, I am quite convinced of his having once more "missed the point." One of the sentences quoted—the one of which I am more particularly proud—is as follows:—"Surely we are right in assuming that, *for a given E.M.F. generated*," (yes, in the main dynamo circuit if you like, or in the path of the eddies if you prefer it), "the eddy current loss in a conductor depends upon the *time* which it takes in passing into or out of the uniform magnetic field under the poles." Of course it does! The eddy current loss depends, not only upon the amount of the eddy currents, and therefore of the E.M.Fs. producing them, but also upon the *time during which these eddy currents are flowing in the metal*; and as this line becomes shorter, the heating by eddy currents will be less, not *more*, as Mr. Price would have it.

In the hope of being able to express myself in the same language as Mr. Price, I will borrow his diagram and his formula.



He says that if N magnetic lines are threaded through the closed eddy current circuit, *a b c d*, in the time, *t*, the heat developed is proportional to $\frac{\text{N}^2}{t}$, which is quite true; but, in his endeavours to prove that my explanation conveys the opposite meaning to that which was intended, he has no right to consider N and t as independent variables. On the contrary, the whole argument is based on the assumption (printed in italics, which Mr. Price has omitted) that the E.M.F. generated $\left(\frac{\text{N}}{t}\right)$ is constant; hence $\text{N}^2 \propto t^2$, and the heat developed, is proportional to t.

Q. E. D.

[Perhaps I ought not to have taken it for granted that the E.M.F. tending to produce eddy currents bears a definite relation to the E.M.F. in the main dynamo circuit; but an inspection of Mr. Price's figure will show that the assumption is correct. A given conductor moves into, and through, a field of a given configuration at a certain speed. Let E be the E.M.F. in the compound bar, B C, as it moves through the field, and *e* the mean E.M.F. generated in the eddy current circuit, *a b c d*, as the bar enters the field. Now double the speed of the conductor, and halve the strength of field. It is quite evident that both E and *e* remain the same as before.]

Having disposed—it is hoped, successfully—of Mr. Price's criticisms, I may, perhaps, allow myself to step down, and say a word or two on his behalf. Although he did not do me justice, that is no reason why I should not deal fairly with him, especially as I am inclined to think that his point of view is the right one.

Mr. Price does not put his case clearly; but what he says amounts to this:—

Firstly, he does *not* believe in the "snapping across" of the lines as the buried conductor enters or leaves the field. On the contrary, he maintains that such a conductor will, other things being equal, take the same time in passing into or out of the uniform field under the poles as a surface conductor. (It is a pity he did not mention this at the start.)

Secondly, the uniform field in which the conductor finds itself after passing through the "fringe," is very much weaker in the case of a buried than in that of a surface conductor. To quote Mr. Price's own words, "The solution of the difficulty lies clearly in the small intensity of the maximum field, the rate of speed at which the bars enter that field being assumed to be constant." (I have slightly altered the second half of the sentence, as it is of more interest to know what Mr. Price meant to say than what he actually said). The fact that the above statement is diametrically opposed to the views which Mr. Price expressed in his article, tends only to enhance its value by clearly proving its author to be actuated by no meaner motive than a desire to get at the truth, and nothing but the truth.

In conclusion, I would advise anyone interested in the subject to go carefully through Mr. Price's letter, skipping only the one or two irrelevant paragraphs. If he will take the time and trouble to go sufficiently deeply into it, he may disinter much valuable information, which will be of use to him in after-life.

Alfred Still.

Is an Electric Traction Engine Subjected to Shocks, or is it not?

I gather from Mr. Raworth's further criticism in your issue of the 4th inst., on Dr. Emery's article, that the doctor, although, no doubt, right in intention, is wrong in contention.

Experience has shown us that it is advisable to employ a higher factor of safety in designing an engine liable to frequent, sudden, and extreme variations of load, as when driving a rolling mill or electric traction dynamo, than for an engine having a constant and regular load such as electric lighting.

In answer to the question at the head of this letter, I know of a peculiar shock to which engines not designed to do the duty they are called upon to perform, are particularly liable. Dr. Emery's experience, I can imagine, causes him to dread this shock, but Mr. Raworth appears to be in happy ignorance of it. I refer to the nasty jar occasioned by precipitation on to the "scrap heap."

I am glad Mr. Raworth no longer poses as the instructor of "young engineers," and the slayer of "dead dogs," for the former are probably competent to form opinions on elementary problems, and the "dog" of American experience and practice, judging by the ominous twinkle in his eye, is far from being killed by Mr. Raworth's frequent bladder belabourings.

I see that Mr. Raworth has now assumed the *rôle* of Pharaoh, which appears to me to be far more profitable and becoming, although it is rather late to dream the dream when the "lean kine" of American enterprise are so rapidly eating up the "fat kine" of British contracts. I can only hope that Mr. Raworth and other English manufacturers will bestir themselves, and speedily acting on the interpretation of the dream will, through their respective Josephs, gather in of the rich harvest of American knowledge before the famine is upon them.

James F. Rossiter.

Mr. Robert Hammond and Shoreditch Destructor.

I read with a huge amount of astonishment in your account of Mr. R. Hammond's opinion of the Shoreditch destructor, that several instruments or parts of our machinery have been rendered useless by reason of the dust, &c., emanating from the destructor. I can only say that no such thing has ever happened; and I certainly think Mr. Hammond should state his authority for the statement or withdraw the same as publicly as he has made it. He is entitled, of course, to his opinion as to the design or merit of the plant, but I must say his remarks do not harmonise with the voluptuous praise he bestowed upon the joint scheme and general design when he and our Gloucester friends were so courteously conducted over our works.

H. E. Kershaw,
Chairman of Electric Lighting Committee, Shoreditch Vestry.

In your last issue I notice, under the heading of "Electric Lighting and Dust Destructor for Gloucester," some comments made by Mr. Hammond, which are absolutely untrue and without the slightest foundation whatever. I refer to his statement wherein he says that some of the machinery has been disabled owing to the dust, and I now wish to state that no machinery or plant whatever has been disabled at this station, through the dust or otherwise.

And, in the interests of other Corporations having destructors under consideration, also of my staff and self, I trust that you will give publicity to this letter in your next issue.

Also, I would point out that such garbled and misleading statements, as put forward by Mr. Hammond, are but a poor return for taking the trouble to show him and his Gloucester friends over these works, when full information and particulars were given him by the Chairman of my Committee (Mr. Kershaw), and

C. Newton Russell,
Chief Electrical Engineer.

Coronet Street, Shoreditch,
February 8th, 1898.

THE ELECTRICAL ENGINEERS VOLUNTEERS.

Certain important modifications have been made in the constitution of this corps, which, we think, will tend to popularise it among engineers. We know from our own experience that a good class of men are ready to join if it is made easy for them to fraternise on terms of equality with their fellow privates. It is obvious, from the rules that have been formulated and reproduced below, that the corps will be one of high standing; that is to say, the terms of entry guarantee the rank and file being composed of men of some position in the industry. In its present form, the corps is deserving of the heartiest support, and we trust that electrical engineers will show their sympathy by enrolling themselves as members.

The following information has been issued from head-quarters:—

The head-quarters of the corps will be at 13, Victoria Street, Westminster.

The uniform will be the same as that worn by other Royal Engineer Volunteers, with such modifications as the War Office approve. Members will pay for their own uniforms; but the corps will reimburse the cost to efficient members to the extent of one-half of the Government grant they earn by their efficiency, so that after two years' efficiency the cost of the uniform will be repaid.

The corps will be armed with the Lee-Metford rifle.

The training is divided into two kinds—military and technical.

The military work consists of infantry drills, musketry, &c.

The technical work includes every application of electricity to war, with the exception of telegraphy, and such other work as will be useful to an electrician or engine driver in carrying out his duties, such as signalling, fitting, loading, priming, and connecting up submarine mines, a certain amount of boat work, and knotting, splicing, &c.

This work will be carried out partly at head-quarters, but mainly at defended ports.

In order to become efficient each member must attend a continuous training at a defended port for at least eight days each year. In addition, 78 hours' technical work must be done each year (48 after passing as "expert"). Each working day—after the first eight—of the continuous training counts as six hours; each full day counts six hours; each half day four hours. The remainder may be made up in periods of 1, 1½, 2, 2½, 3, and 3½ hours.

The capitation allowance is £5.

An allowance of 5s. is made for a whole day, 2s. 6d. for a half-day: but a "recruit" must attend 40, a "trained man" 20, an "expert" 10 hourly drills before earning these allowances. During the continuous training each member earns 5s. a day. The whole of these allowances will be devoted to the maintenance in camp and to the remuneration of efficient members.

Drills—both military and technical—will begin as soon as members are enrolled.

Intending members are requested to study the conditions of efficiency. Every effort will be made to make it easy to comply with them.

Below will be found an extract from the rules of the corps:—

5. Every enrolled member who is non-efficient in any year shall pay to the funds of the corps, on or before November 10th in that year, a sum equal to half the Government capitation allowance which he failed to earn. . . . . The commanding officer shall have power to remit payment, wholly or in part, in special cases.

8. No person shall be admitted as member or honorary member unless proposed by one or more members of the corps, and approved by the commanding officer.

24. Any member wishing to leave the corps may do so on November 2nd, providing he shall have given notice of his intention not later than the 30th of the preceding September. Failure to comply with this rule shall render him liable for half the amount of the succeeding year's capitation grant.

Intending members should write to the adjutant, Captain Brady, R.E., 13, Victoria Street, S.W., who will supply all information. They should give their full name, address, occupation, and electrical qualifications. If they wish to join as engine drivers they should state their qualifications for that work.

Every application must be accompanied by a reference to a member of the corps or to some other person well known to the commanding officer.

Before enrolment, each candidate must be passed as fit by a medical officer.

Every member shall be enrolled for three years at least. A member leaving before completing three trainings shall be liable to a penalty.

Hence a member who serves for three years, and is efficient in each year, will be put to practically no expense, as he will have incurred no penalties, and the cost of his uniform and camp expenses will have been refunded to him.

J. Hopkinson, F.R.S., Major,
Commanding the Electrical Engineers,
R.E. (Volunteers).

BUSINESS NOTICES, &c.

Agency.—We understand that the Edison and Swan United Electric Light Company, Limited, has appointed the Direct Importers, Limited, of Bulawayo, sole agents for Rhodesia.

Art Metal Work.—We understand that the business of Messrs. G. R. De Wilde & Co., carried on for the past 12 years by Mr. George Rexworthy De Wilde at 10 and 11, Archer Street, Shaftesbury Avenue, has been purchased by Messrs. Thomas Potter & Sons, and amalgamated with their own business, of ecclesiastical and art metal workers, which has been carried on since 1827 at 44, South Molton Street. Mr. De Wilde has joined Messrs. Potter & Sons, and will in future have charge of this branch of their business.

Bankruptcy Proceedings.—The *London Gazette* gives notice of the release, on January 12th, of the trustee (T. H. Stephens) in *re* Thomas Maddren (T. Maddren & Co.), electrician, of Cardiff.

A first and final dividend of 3s. 9d. in the £ has been notified under the failure of George Thompson (G. Thompson & Co.), electrical engineer, of Queen's Road, Brighton.

Brussels Exhibition Awards.—In last Friday's *London Gazette* we observe a long list of the awards made in the British Section of this Exhibition. Among the members of the Executive Committee of the British Commission, who have received awards, are the following:—*Diplomes d'Honneur* to Sir A. K. Rollit, Mr. James Dredge, C.M.G., Sir E. H. Carbutt, and *diplomes commemoratifs* to Sir F. A. Abel, Major S. Flood Page, Mr. E. Windsor Richards, Mr. Alex. Siemens. *Diplomes commemoratifs* have also been awarded to Mr. W. H. Massey, Mr. R. W. Blackwell, and Mr. Philip Dawson. Among the industrial exhibitors are the following awards: *Hors Concours* to Mr. R. W. Blackwell. *Grands Prix* to Brush Electrical Engineering Company (in participation with the Electrical Syndicate, Brussels Exhibition), Eastern Telegraph Company, Elliott Bros., Fielding and Platt (in participation with the Electrical Syndicate, Brussels Exhibition). *Diplomes d'Honneur* to Fielding and Platt, W. T. Glover, C. A. Parsons & Co., J. S. Raworth, Ruston, Proctor & Co., Tangyes, Limited. Gold medals to—Eastern Telegraph Company and Horsfall Furnace Company, Thomas Parker and Co. Silver medals to—Forced Draught Syndicate, Roller Bearings Company. Among the awards to collaborators are:—*Diplome d'Honneur* to Mr. George Elphinstone (Messrs. Elliott Bros.), and a gold medal to Mr. F. B. Behr (lightning express).

Electrical Wares Exported.

Week Ending Feb. 1st, 1897.

	£	s.
Adelaide	150	0
Alexandria	29	0
Amsterdam	55	0
Bombay	263	0
Buenos Ayres	22	0
Calcutta	333	0
Cape Town	256	0
" Teleg. mat.	221	0
Colombo	18	0
Copenhagen. Teleg. mat.	35	0
Demerara. Teleg. mat.	113	0
Durban. Teleg. mat. ...	243	0
East London	3,133	0
Fremantle	12	0
" Teleg. mat.	2,965	0
Gothenburg	18	0
" Teleg mat.	146	0
Hamburg	225	0
Launceston	21	0
Melbourne	1,400	0
" Teleg. mat.	709	0
Ostend	30	0
Port Elizabeth	519	0
Rangoon	33	0
Reval	90	0
Saigon	98	0
Shanghai	105	0
Singapore	64	0
Stockholm. Teleg. mat.	209	0
Sydney	1,002	0
Tientsin	25	0
Wellington. Teleg. mat.	971	0
Yokohama	508	0
Total	£14,021	0

Week Ending Feb. 1st, 1898.

	£	s.
Adelaide	37	0
Amsterdam	360	0
Bangkok. Teleg. mat. ...	71	0
Beira	1,355	0
Bombay	13	0
Boulogne	69	0
Brisbane. Teleg. poles ...	1,975	0
Buenos Ayres. Teleg. mat.	386	0
Cape Town	1,324	0
Calcutta	220	0
Channel Isles	25	0
Christiana	10	0
Colombo	199	0
Constantinople	1,060	0
Copenhagen	19	0
Delagoa Bay	83	0
Durban	469	0
East London	168	0
Flushing	19	0
Fremantle	771	0
Gibraltar	79	0
Gothenburg	15	0
Hamburg	78	0
Hong Kong	76	0
Lisbon	300	0
Ostend	35	0
Rio Janeiro	195	0
Rotterdam. Teleg. mat.	150	0
Shanghai	522	0
St. John's, N.B.	20	0
Stockholm	30	0
" Teleg. wire	179	0
Sydney	582	0
Wellington	105	0
" Teleg. mat.	292	0
Yokohama	3,978	0
Total	£15,260	0

Foreign Goods Transhipped.

	£	s.
Alexandria	9	0

Electrical Wares Exported.

Week Ending Feb. 8th, 1897.

	£	s.
Aden. Teleg. cable	10,080	0
Albany	221	0
Antwerp	226	0
Bangkok	55	0
Bombay	41	0
Calcutta	76	0
Cape Town	89	0
Colombo	198	0
" Teleg. mat. ...	61	0
Demerara. Teleg. mat. ...	18	0
East London	1,117	0
Gibraltar. Teleg. mat.	36	0
Gothenburg	20	0
Hong Kong	110	0
Merosyne. Teleg. mat. ..	27	0
Montevideo	30	0
Passages	155	0
Port Elizabeth	453	0
Rio Grande De Sul Teleg. mat. ...	40	0
Syra. Teleg. mat. ...	31	0
Rangoon. Teleg. mat. ...	18	0
Reval	120	0
" Teleg. mat.	206	0
Shanghai	55	0
Singapore	78	0
Wellington	206	0
Yokohama	31	0
Total ...	£13,801	0

Week Ending Feb. 8th, 1898.

	£	s.
Albany	55	0
Alexandria. Teleg. mat.	205	0
" Teleg. cable	387	0
Amsterdam	107	0
" Teleg. mat.	13	0
Auckland	44	0
Bombay	97	0
" Teleph. mat. ...	21	0
Boulogne	188	0
Buenos Ayres	824	0
" Teleg. pole	300	0
Calcutta	345	0
Cape Town	1,794	0
Charters Towers ...	120	0
Colombo	160	0
Durban	249	0
" Teleg. mat.	17	0
East London	368	0
Flushing	23	0
Gibraltar	60	0
Gothenburg	148	0
Hamburg	276	0
Malaga	210	0
Melbourne	610	0
Naples	13	0
Port Elizabeth	119	0
" Teleg. mat.	267	0
Rotterdam. Teleg. mat.	110	0
Shanghai	33	0
Stockholm	1,850	0
Sydney	370	0
Trinidad	27	0
Wellington	26	0
Total ...	£9,436	0

Calendars.—From the Peckham Truck Company (Mr. R. W. Blackwell, 39, Victoria Street, S.W.) we have received a calendar for the year, 1898. It is made up of very large sheets—one for each month, on each of which there appears a good photographic view of electric and cable cars, trucks, &c., supplied by this well-known company.

Messrs. King & Co., electrical engineers and contractors, Leith, also send a neat calendar.

A handy-sized and serviceable wall calendar has been brought out by Messrs. Nalder Bros. & Thompson.

Catalogues.—Mr. Harry W. Cox, of Cursitor Street, has issued a pamphlet describing and pricing various apparatus supplied by him for use in Röntgen ray research, such as induction coils, focus and vacuum tubes, screens, batteries, &c.

The Electrical Sundries' Company, of Berners Street, have issued a new and enlarged catalogue of their electrical fittings and accessories. Cut-outs, switches, fuses, wall plugs, lampholders, standards, counterweight and other hanging fittings, brackets, pendants, hall lanterns, electroliers, lamps, &c., are among the variety of electric light apparatus and fittings.

Copper.—Messrs. H. R. Merton & Co. have prepared tables showing the stocks of copper in England and France, and advised from Chili and Australia. Their statement is as follows:—

	Tons.		£	s.	d.
Jan. 31st, 1895	54,848	at	40	5	0
" 1896	46,128	"	43	17	6
" 1897	32,307	"	51	2	6
Dec. 31st, "	31,955	"	48	5	6
Jan. 15th, 1898	33,033	"	48	15	0
" 31st, "	29,746	"	49	0	0

The following figures show the total supplies and deliveries:

	Supplies Tons.	Deliveries Tons.
Feb. 28th, 1895, to Jan. 31st, 1896	142,928	152,648
" 29th, 1896, to " 1897	206,924	220,045
" 28th, 1897, to " 1898	221,195	228,756

Croydon Tramways Company v. The British Electrical Traction Company.—In the Appeal Court on Tuesday, the Master of the Rolls, Lord Justice Rigby, and Lord Justice Vaughan Williams, heard an appeal by the Croydon Tramways Company against a judgment of Mr. Justice Kekewich in the Chancery Division. This judgment was briefly referred to in the ELECTRICAL REVIEW for January 21st, page 79. In January, Major-General Kaye sued in the Lower Court, on behalf of himself and other ordinary shareholders in the Croydon Tramways Company, asking that the company might be restrained from carrying out an agreement for the sale by them of the undertaking and its lines to the British Electric Traction Company. After hearing counsel's arguments, Mr. Justice Kekewich granted an interim injunction restraining the directors from carrying out the agreement to sell their undertaking to the British Electric Traction Company. Mr. Cripps, Q.C., Mr. Warrington, Q.C., and Mr. Rowden appeared for the appellants; Mr. Bramwell Davis, Q.C., and Mr. Bradford for the respondents. The case was opened on behalf of the appellants, and Mr. Bramwell Davis and Mr. Bradford replied for the respondents, after which the hearing was adjourned.

When the case was resumed yesterday, the Master of the Rolls said their lordships had come to the conclusion that it would be extremely difficult to do justice in the matter in the absence of the British Electric Traction Company. He therefore thought that the appeal had better stand over in order to allow of the purchasing company being added to the motion. The case was adjourned for a fortnight.

"Isolacit."—This is the name of an insulating and acid proof material made by Messrs. Baeumcher & Co., of Dresden, who have just appointed Mr. Archibald Campbell, of 28, Gray's Inn Road, W.C., sole agent in England. It is stated to have given great satisfaction to a number of the best-known electrical manufacturers and electric railway companies, also in battery establishments, in Germany. It is produced in different mixtures, liquid, semi-liquid, and solid, and among the advantages claimed for it are the following:—It does not burn, ignite, or entirely lose its elasticity, but adheres to the movements of ductile and pliable objects without becoming brittle or cracked. It is not troublesome to use, and there are no unhealthy evaporations. It is not affected by the most acrid acids.

Lists.—Mr. C. R. Heap, 47, Victoria Street, S.W., the sole importer for the United Kingdom for the C. and C. Electric Company, of New York, sends us lists of that company's bipolar dynamos and motors. The list gives some very neat blocks of the straight and curved field types, and detailed particulars of same. The C. and C. slow speed generator is also described.

Lloyd & Lloyd v. D. & W. Henderson & Co.—Sheriff Strachan, on 31st ult., heard proof in an action at the instance of Lloyd & Lloyd, of Birmingham, holders of letters patent in the United Kingdom for the Benardos system of electric welding, against D. & W. Henderson & Co., engineers and shipbuilders. The pursuers sought to bind the defenders to an agreement which they entered into in 1892 to pay a royalty of £200 per annum for the use of the inventions comprised in the pursuers' patent. After paying royalty for two years, the defenders, it is alleged, refused to further implement the agreement, assigning as a reason, among others, that the invention could not perform the operations which it was alleged to be able to perform. Pursuers denied the defenders' allegations, and contended that the defenders, by letter, agreed to hold themselves bound by the deed and signature of Mr. Andrew Henderson. When the hearing was resumed, Mr. Bannatyne, addressing the Court for the defendants, said the first and most important question was whether or not there was a completed agreement between the parties, and the second point was, assuming there was a completed agreement, could the document be set aside on the ground of fraud and essential error. He did not mean deliberate fraud, but innocent and unintentional concealment of material alterations, amounting to fraud in a civil action. The precedents showed that, in order to have perfect obligation, there must be deliberate and voluntary consent. Defendants' case was that they were induced to sign the license sued on through concealment on the part of plaintiffs. The duration of the license was a matter of importance to defendants. They bought the plant for experimental purposes, and never contemplated the further burden of an annual payment of £200 to the end of the patents. The draft they approved of did not contemplate that, and it was amended to place the question of duration beyond doubt, if possible. If there was doubt about the meaning of the clause, apart from amendments, it must be read against plaintiffs. The Court would have to find there was no consent given by defendants to this contract. It was a Scotch contract, and must be construed by the law of Scotland. Accordingly, it should have been signed on each page by both parties before witnesses, and by all the partners of the firms. It was not a mercantile document, but it was a formal deed, and not being executed according to the formalities of signing in Scotland, the license could not be enforced in Scotland. Judgment was reserved.

Personal.—Mr. T. Scott Anderson, of Sheffield, asks us to state that his practice as a consulting engineer is being carried on as before, and is not a branch of the new firm of Scott Anderson and Beit. We understand that he has just received instructions from the District Council of Kilnhurst to survey and report upon the lighting of their district. He is further retained by the directors of new steel works in Yorkshire to report upon the complete equipment in their works of lighting, welding, and motor plants.

Private Bills.—The Examiners of Private Bills sat at the House of Commons on Monday to consider the standing order proofs of Bills lodged for consideration during the present session. There was "no appearance" registered in the case of the Folkestone Electric Tramways Bill. In the case of the Hastings and St. Leonards Tramways Bill, which had been part heard by the examiners, the petition was endorsed "no appearance on adjournment." The consideration of the Bill was further adjourned until the 21st inst. The consideration of the London United Tramways Bill and the Blackpool and Fleetwood Tramroad (Tramways Extensions) Bill was postponed.

South African Electrical News.—The *British and South African Export Gazette* has the following items:—A scheme having been mooted for lighting Kokstad, Cape Colony, with the electric light, opportunity will shortly be afforded for electric engineering firms to tender for the requisite material. Overhead wire to the extent of 47,300 feet, for the purpose of lighting Bulawayo, has been supplied to the order of the Bulawayo Waterworks and Electric Light Company. The installation of the electric light in the railway workshops at Mafeking is under the consideration of the Railway Department, and the extension of the system to the town is also mooted. In this event very considerable orders for machinery and material will shortly be placed. The two large alternating current dynamos, of 15,000 lamps capacity each, with 1,250 revolutions per minute and a voltage of 2,288, required for the electric lighting of Bulawayo, have been supplied to the Bulawayo Waterworks and Electric Light Company by the General Electric Company of New York. The completion of the equipment of the Village Main Reef gold mine only awaits the arrival of the electric plant, for some time on order, but delayed owing to the engineering strike. An order for a small dynamo, to supplement the existing electric lighting plant, has been placed by the Durban Municipality. Two automatic cut-off engines of 150 H.P. each have been supplied by Messrs. McIntosh, Seymour & Co. for the Bulawayo Waterworks and Electric Light Company.

Sunderland Exhibition.—At this Exhibition the Sunderland Forge and Engineering Company, who carried out the electric lighting of the buildings, putting in 50 arc lamps and about 30 100-C.P. and 250 16-C.P. incandescents, exhibit at their stand two inverted vertical compound double-acting enclosed self-lubricating central valve engines coupled direct to two compound-wound dynamos of the inverted two-pole pattern. They also show several ship lighting plants, and a 25-B.H.P. enclosed motor driving a joggling machine.

ELECTRIC LIGHTING NOTES.

Aberystwyth.—It is proposed, in view of having a fresh agreement with the Electric Lighting Company, to obtain their terms for the extension of the arc lighting and also for three years' incandescent lighting.

Beckenham.—The District Council has agreed to supply electricity to the district at an estimated cost of £36,000.

Bedford.—A correspondent says that the annual balance-sheet of the Bedford Liberal Club shows that by adopting the electric light a saving of £40 has been effected, for whereas electricity costs £41, with a gas bill of £5, the gas bill alone formerly amounted to a sum of £90.

Belfast.—The Electric Committee says that it cannot supply current for the Exhibition Hall, Botanic Gardens Park (as required for the year) until the new supply station is in working order. But as the parties will rest content for the present with 50 8-C.Ps., the supply is to be furnished and a main laid. The storage battery and switchboard contractors are ready to begin delivery. The central station is already partly insured in the Fine Art and General, and other companies are being negotiated with. The electrical engineer is to wait on Messrs. Harland & Wolff in reference to their application, and ascertain "what voltage they would require the electric current to be supplied at, and also to inform them that the Committee would be prepared to supply up to 1,000 Board of Trade units per annum on a maximum demand of not more than 500 H.P. at 2½d. per unit, and beyond that on the same maximum demand at 1½d. per unit, the cable to be laid to their gate."

The Board of Guardians are asking Mr. Clegg to submit an estimate of the cost of electric lighting plant, and the maintenance thereof, for the Workhouse.

Bromley.—The Bromley Urban District Council are still holding over the transfer of the Electric Lighting Order, having, in response to their inquiries, received what they consider to be a most unsatisfactory reply from the company.

Burnley.—The Council has accepted a tender (£4,888) for the supply of two combined engines coupled with dynamos for extending the electric lighting works.

Cardiff.—The electrical engineer has reported to the Lighting Committee upon the mains generally throughout the town. He suggests that the cables supplying the arc lights be replaced by others, and that the lamps be connected to them in accordance with the latest Board of Trade requirements. If this were not done, he would not be surprised at a failure of some of the lamps after any heavy wet weather.

Devonport.—The Council has appointed Prof. Kennedy to prepare an electric lighting scheme for the district.

Dorking.—The District Council has, after discussion, resolved to introduce the electric light into Dorking, and an Electric Lighting Committee has been appointed to report.

Dover.—Some of the consumers have been conferring with the Electricity Supply Company *re* the charges for current.

Dublin.—The Local Government Board having considered Mr. Cotton's report, have notified the Corporation that the £20,000 asked for will be "loaned" subject to approval of the specification and detailed estimates in connection with the new cables and works. The Corporation will therefore have financial resources so far to carry out their new scheme for an extension of the electric lighting of the streets.

Dudley.—The contract for lighting by electricity the Public Hall, for the purpose of the Industrial Exhibition, was carried out by Messrs. Webster, Michelson & Co., of Dudley. There were 4 2,000-C.P. arcs and incandescents equivalent to 500 16's. The plant employed for the purpose comprised a combined high speed vertical engine and multipolar dynamo. The same firm have a stand at the exhibition where they show various electrical fittings and several "C" type Dudley dynamos and motors.

Dundee.—Four electric lamps are to be erected in High Street, Lochee, the electric plant at the public baths supplying the current.

Durham.—At the last City Council meeting a letter was read from Edmundson's Electricity Corporation, Limited, stating that proposals had been made to them by the Dean and Chapter of Durham for putting down plant for supplying the Cathedral and College with electric light. They proposed to leave a margin for the use of private consumers, and asked the consent of the Council to mains being laid through the streets to enable them to supply intending customers. The consent asked for was granted.

Ealing.—A report is to be prepared on the subject of the proposed application of incandescent lamps to the arc lamp posts. A mechanic is to be engaged to remedy, as far as possible, the defects in the present arc lamps.

Edinburgh.—A committee of the Scottish Conservative Club report that they have entered into a contract for the re-wiring and extension of the electric light installation of the Club, as well as for the supply of electric light fittings at a total cost of £1,400. The re-wiring and fitting of the smoking and reading rooms has been completed, and the remainder of the work is to be carried out during the current year.

At the meeting of the Electric Light Committee on the 1st inst. it was reported that over 2,200 8-C.P. lamps had been applied for during the last two weeks.

Fire Station Lighting.—The L.C.C. Fire Brigade Committee has been going into the question of electric lighting for the chief fire station, with the chief officer. He suggests that the National Electric Free Wiring Company's system of wiring should be adopted, and he proposes that, instead of the necessary plant being obtained from various firms, a contract should be entered into with the company for the supply and fixing of the plant and fittings, but that some of the fixing and the making of brackets, &c., should be executed by the workshops' staff, the company reimbursing the Council the wages of the men thus employed. The company has submitted a tender amounting to £992, such sum to include the provision and fixing of an engine and dynamo, with switchboard, cables, mains, distribution boards, branch wires, switches, incandescent lamps, batteries, &c., and 14 arc lamps. The company undertakes to employ the Council's men to assist in every possible way. The Committee recommend the Council to accept the tender of the National Electric Free Wiring Company, Limited, to carry out the electric light installation at the chief station of the fire brigade for £992, less the amount of the wages of the Council's employés who will be engaged on part of the work.

Glasgow.—A member of the Corporation is to move that in view of the unsteady character of the electric light in St. Andrew's Hall, of the noises emitted by the arc lamps used, and of the fact that the roof is practically invisible under the present method of lighting, a system be adopted which will be both efficient and silent.

Greenock.—There is a suggestion that before anything further is done in connection with the electric lighting scheme, a plebiscite of the residents be taken. The Council require to notify the Board of Trade shortly whether or not they intend to apply for a provisional order, and Mr. Tighe, electrical engineer, Paisley, has been appointed to consult with the sub-committee.

Grimsby.—The Public Lighting Committee has been considering the report of the sub-committee on electric lighting. The following places were visited for the obtaining of information:—South Shields, Newcastle, Leeds, Manchester, Brighton, Shoreditch, and Westminster. The sub-committee recommended the engagement of Prof. Kennedy as consulting engineer. The sub-committee added that overtures had been made by the Tramway Company as to the supplying of energy for tramway traction, and authority was asked to negotiate with the company, and obtain a definite proposal from them. It is proposed to ask Prof. Kennedy to prepare an estimate.

Hampstead.—The Vestry has decided to apply for a loan of £40,000 from the London County Council in order to pay for some very extensive plant for electric lighting it has just added to the central station in Finchley Road. It is hoped to finish in about six weeks' time the installation of the public electric lighting from Heath Street to Chalk Farm, about a mile and a half in length.

Islington.—The Electric Lighting Committee's report just issued, of the working of the electric lighting system in Islington during the year 1897, shows that whereas in the previous year a profit on revenue account had been shown of £1,615, in 1897 the profit made was £4,432. With the repayments on capital account, the loss on the two years was reduced from £1,836 to £318 14s. 4d., and this loss might have been turned into a profit but for some delay in starting the new plant. Mr. Gay, the electrical engineer, in a note to the account, says the number of units sold in 1896 was 298,000, and this produced a revenue of £7,573. In 1897 there were 504,000 units sold, or an increase of 206,000, being equivalent to 69 per cent. In 1896, the working cost was £5,958, equivalent to nearly 4½d. per unit. In 1897, it was £7,858, an increase of £1,900, and equal to 31 per cent.; the cost per unit falling to 3⅝d., or a penny per unit less than the previous year. Thus, with an increased cost of production of 31 per cent., the out-put has increased 69 per cent., and the revenue 62 per cent. The gross profit in 1896 only amounted to 21 per cent. on the revenue, but last year it rose to 36 per cent., a very satisfactory increase. The capital account now stands at £150,850, of which £6,623 remains in hand.

The increasing demand for current here has necessitated further extensions, and £12,000 has been voted by the Vestry for purchasing and erecting the new plant, which will include two boilers, a 1,500 H.P. engine, and 1,300 kw. alternator, at a cost of £7,180. The steam and other pipes and fittings, also foundations, accumulators, boosters, and various accessories, will amount to £4,820. The Electric Lighting Committee has reported to the Vestry on the steps being taken by other local bodies regarding the payment of the trade union rate of wages.

Lambeth.—The Lighting Committee has reminded the vestry that the South London Electric Supply Corporation undertook to supply energy, free of charge, for 25 arc lamps, to be erected by the vestry in certain streets. The committee submitted a list of positions.

Lancaster.—The Electricity Committee has accepted the tender of Mr. Wm. Massey for oil, and the Scottish Asbestos Company for packing.

The Electricity Committee has increased the salary of Mr. C. E. M. Johnstone, electrical engineer, from £120 to £140 per annum.

Leeds.—At the present time part of Wellington Street, Boar Lane, and Briggate are illuminated at night by means of gas and electricity. It is intended shortly, however, to dispense with gas until midnight. At that hour the gas lamps will be lighted, and electricity switched off.

Leith.—The Special Committee on Electric Lighting has accepted the following tenders for the electric light station buildings:—Mason work, Kinnear, Moodie & Co., £7,693; joiner work, Kinnear, Moodie & Co., £934; plumber work, Patrick Knox & Sons, £269; iron work, A. Mather & Son, £1,972; glazier work, Robert Graham, £307; slater work, M'Lean & Reid, £99; plaster work, Stuart's Granolithic Stone Company, Limited, £69.

Leyton.—The Guardians having asked for terms for a supply of current for lighting all the workhouse buildings for two years, the Council has resolved to charge 3½d. per unit. A deputation from the Council is to go to Brighton to see how they charge for current there.

The resident engineer has reported as follows:—Electricity generated during December, 25,062 amperes; units sold, 15,981 amperes; number of applications during December, 8; total applications to date, 100; largest number of lights on at any one moment, 3,734, being 71 per cent. of the total connected.

Liverpool.—The electrical engineer has been empowered to proceed with a portion of the extension of the mains provided for by the estimates for the current year. The estimated cost of this work is £16,947.

London.—At last week's meeting of the Vestry of St. George, Hanover Square, a proposal was brought forward that an additional sum of £1,000 be granted on the lighting contracts in order that electric lighting might be introduced into the parish and the experiment made in Piccadilly. It was stated that the parish of St. George is behind all other metropolitan parishes in this matter. After discussion the motion was lost.

Loughborough. — A London company's proposal for obtaining a provisional order for electrically lighting the borough has been referred to the General Purposes Committee.

Merthyr.—Mr. Dan Thomas has given notice of motion to consider the expediency of including a sum in the next estimates, with a view to the engagement of an expert to report upon the electric lighting of the district, and probably on a scheme of electric tramways.

Newcastle.—A meeting of the Special Committee appointed over two years ago for the purpose of considering the provision of the electric light for the city was held last week. There was a discussion on the electric lighting of the city, and it was decided to ask the city engineer to report as to the number of arc lamps that would be required to illuminate the principal streets, and as to the power that would be required. It was felt, however, that it would be necessary to await the action of the new Tramways Committee before proceeding further, as should the committee decide in favour of electric trams, the same power might be used to supply the electric light. The city engineer is to furnish a report as to the amount of power to be produced from the waste energy of the Byker refuse destructor.

Newington.—Some members of the Vestry seem to fear that the London Electric Supply Corporation is cutting the ground from under its feet, by inducing the public to take current from it at 5d. per unit—a lower rate than the Vestry will itself be able to supply at when the municipal installation is put down.

Russia.—The annual report of the St. Petersburg and Moscow Electric Lighting Company for the year 1896-7 states, according to the *Shareholder*, that the total gross takings were £168,100, divided pretty equally between the two towns of St. Petersburg and Moscow, and the expenses were £101,000. The net receipts amounted to £59,160, and after deducting £5,060 for cost of administration for both towns there is a profit remaining of £54,100, of which £10,820 is written off for depreciation, £2,160 for Government taxes, and £4,640 for the reserve and insurance fund, leaving a net profit of £36,480, to which was added the sum of £11,300 carried over from the previous year, giving a total available for distribution of £47,780. A dividend at the rate of 6 per cent. was declared. The length of the streets in which cables have been laid is 33 miles, and next spring it is contemplated to put in 13 miles more, as the applications for connections are very numerous.

Salford.—At the last Council meeting, Councillor Wheatcroft asked how long it was intended to leave the electric lighting arrangements of the streets in their present condition with the wires exposed. He thought it was probable that there would be a serious leakage in consequence of this state of affairs. Councillor Hamblett, replying to the question, said that at the next meeting of the subcommittee, which had charge of the experiments, it would be suggested that the temporary arrangements referred to should be discontinued. It was a fact that there had been a considerable leakage and waste of electrical power.

Sheffield.—The City Council on Wednesday decided to purchase the Sheffield Electric Light and Power Company's undertaking. Pending the completion of the purchase shareholders are to receive 10 per cent. dividend.

Shoreditch.—In addition to the statement made by Mr. Kershaw at last week's Vestry meeting, we take from a local paper the following further remarks reported to have been made by him in answer to the objections raised by several members to too hasty a reduction in the charge per unit. Major Wenborn had stated that it would be very unwise of the Vestry to pass the report until they were placed in the possession of the information given in Committee. Mr. Kershaw said "this undertaking must be run in a commercial spirit. Their loss on the first quarter was £500, but in the second quarter they recouped that loss and got £300 to the good. One of the contractors had not yet fulfilled his guarantee, and if the figures given to the committee got into print it might be the worst day's work the Vestry ever did." This is a strong statement from the chairman of an electric lighting committee, and readers may be pardoned for wondering what figures it is so imperative to keep secret.

Shoreham.—The Southern Cross Shipyard and Engineering Company have offered to submit estimates and specifications to the District Council for electric lighting.

St. Marylebone.—For the electric lighting requirements at the new central administrative block at Marylebone Road Workhouse, 18 tenders were received, ranging from £870 to £1,765. It was proposed to accept the lowest (Messrs. H. F. Joel & Co.), but a member moved that the tender of the Marylebone firm be accepted at £927 odd. The matter was in the end referred to a Committee to make inquiries.

Stockton.—At last week's Town Council meeting the electric lighting question was under consideration. Mr. W. Ford, gas manager, had gone into the matter of site. He had selected three sites as being adapted for the purpose. So far, reasonable provision had been made, not only for covering the compulsory area, but for an area of something like five miles radius from the site selected. His design of the proposed buildings for engines, dynamos, and boilers had been approved by the expert. Mr. S. C. Vesey Brown reported that he had considered the three sites. He had estimated on a plant capable of supplying a total of 3,000 lamps alight, each lamp taking 30 watts. This meant that about 4,200 lamps of a similar size could be wired. The system was to be the continuous three-wire system with a pressure of 230 volts between either outer wires and the neutral wire. The cost of erecting and supplying an electricity works with boiler, economisers, engines, dynamos, pumps, pipes, crane, switchboard, storage battery, cables, meters, buildings, and chimney was:—Site No. 1, £15,145; No. 2, £15,652; No. 3, £14,297. It was resolved that a special meeting of the Gas Committee be held to consider the following resolutions:—"That the report be approved, the question of site being left for the consideration of the Council," and "That the Council be recommended to empower the committee to invite not exceeding six electric lighting engineering firms to submit sketch plans, specifications, and estimate of the cost of an installation to meet the suggestions contained in Mr. Ford's report."

Swansea.—It is probable we have heard the last of the triple scheme, which was the cause of so much local wrangling. The Lighting Committee has been going into the matter again, and as the Tramway Company seems determined to make their own arrangements for supplying the current for their system, the Committee has approved of a scheme for the electric lighting of the town independently. The provision of a day load for the plant was the chief matter of solicitude, but, from the promises received and the possibilities of certain works and industries taking power from the Corporation works, it is hoped by the committee that the scheme can be most profitably carried through.

Wallasey.—The chairman of the Gas Committee stated some days ago that their electrical installation, though only established about a year, had made a substantial surplus.

Winchester.—Mr. Murray, electrical engineer, Worcester, was to visit Winchester one day this week to inspect the plans and advise the committee.

York.—The question of dust destructors has been raised here in connection with electric lighting. A sub-committee is to report on the form of destructors.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Airdrie and Coatbridge.—The directors of the British Electric Traction Company will probably concede certain points objected to by the Corporation Committee, so as to avoid opposition to the scheme when it comes before the Light Railways Commissioners in a few weeks.

Blackpool.—The electrical engineer, and such members of the Tramway Committee as please are to visit Hanover, Dresden, Berlin, and Paris, for the purpose of inspecting the electric tramway systems in those towns.

Bournemouth.—The promoters of the light electric railway schemes, which are opposed by some of the local authorities, are still pegging away, though, we are afraid, with little prospect of success.

Bristol.—The Sanitary Committee has reported to the Corporation at considerable length upon the Bristol Tramways (Extensions) Bill, and the Bristol Tramways (Electrical Power, &c.) Bill, being promoted by the Tramways Company. The Committee recommend the Council to resolve—(1) "That until the question as to the right of the Corporation to regulate the mode of traction to be used throughout the city on existing and future tramways, raised by the company by the promotion of the Electrical Power Bill, has been settled by Parliament, the consent of the Corporation be not given to the Extension Bill." (2) "That the Electrical Power Bill be opposed by the Corporation, and that the conduct of the opposition be entrusted to your Committee."

The Tramways Company met the sub-committee of the Sanitary Committee on 4th inst., for a conference on these matters, but nothing particular was done.

Clontarf.—A deputation has laid before the Corporation their views in favour of doubling the line of trams between Talbot Street and Nelson's Pillar. The Tramway Company considers the proposal tends to facilitate the traffic to Clontarf.

Dover.—For the week ended Saturday, 29th ult., the receipts were £103 odd, averaging £17 4s. per day, the number of passengers carried being 24,811 for the week. The total receipts since the opening have been £2,368 odd.

Dublin.—The directors of the Dublin and Lucan Steam Tramway Company report to the shareholders that they are still negotiating for the electrical equipment of the line.

Edinburgh.—A sub-committee has resolved that, as arrangements had already been made for the cabling of the line as far as Meadowbank, the Portobello section just acquired by the Corporation should be cabled likewise. At one time, it is said, there was some talk of the Portobello section of the system being worked by electrical traction.

Folkestone.—It is stated that though the Corporation have decided not to approve of either of the two schemes before them for the construction of electric tramways in the borough at the present stage, they do not intend to offer any active opposition.

Gateshead.—The Parliamentary Committee has had an interview with the Gateshead and District Tramways Company with reference to the suggested substitution of electric traction in place of steam on the tramways.

Great Orme.—There was a conference between the Council's representatives and the promoters of this tramway scheme at Llandudno last week, and it is understood that the promoters agreed to take the supply of electrical energy from the Council. The Council offered terms of purchase at the end of 28 years, on a basis of 4 per cent. dividend, but the promoters declined, and a 5 per cent. basis is probable.

Hastings.—Last week the Council had a lengthy discussion regarding the light railway and electric tramway schemes which had been proposed for the district by private companies. The Roads Committee submitted their report dealing with the proposals, stating the result of their negotiations with the promoters, and made the following recommendations:—1. That the scheme for a suggested system of tramways submitted by Mr. T. W. Barber, C.E., be not entertained. 2. That consent be not given to the Hastings and St. Leonards Tramways scheme. 3. That the Hastings and St. Leonards Light Railways scheme, of which the British Electric Traction Company, Limited, are the promoters—under which it is proposed to construct a line from a point near the west end of George Street *viâ* Castle Street and Robertson Street, to a point near the Bo-peep Hotel, and a line from the Albert Memorial *viâ* Bohemia Road to Hollington—be not assented to. 4. That consent be given to the carrying out of the Hastings, Bexhill, and District Light Railways (Electric) scheme, with certain stipulations; and that it be referred to the committee to negotiate with the promoters as to the terms and details, and report. These recommendations were not all approved by the Council. An amendment was carried receiving and adopting the report, excepting that part referring to the light railway scheme; no part of the front line is to be used for experiment with trams; all inland lines to be laid by the Corporation; the Town Clerk to oppose all schemes. The matter was referred to the Council in committee, the voting on the amendment being 26 in favour and five against.

Kirkcaldy.—The Provost and magistrates of Dysart have cordially taken up this electric lighting and tramway scheme, and appointed a committee to confer with the Kirkcaldy committee.

Leeds.—The Tramways Committee has decided to recommend the Council to extend the tramways from Wall End, Armley, to the city boundary at Stanningley. The Committee has also had under consideration the question of the equipment of the Headingley, Chapeltown, and Hunslet sections with electricity, on a similar principle to that employed on the Roundhay and Kirkstall sections, but the matter was postponed for a month.

Light Electric Railway.—The Earl of Jersey, Colonel Boughey, and Mr. Gerald Fitzgerald, Commissioners under the Light Railways Act, held an inquiry in the Middleton Town Hall on Saturday last to obtain information with regard to an application made by the British Electric Traction Company, Limited, for an order authorising the construction of a light railway in the district. Mr. S. Morse, of London, appeared for the company. The Lancashire County Council, the Middleton, Oldham, Rochdale, Heywood, Chadderton, and Castleton authorities, the Lancashire and Yorkshire Railway Company, and the Rochdale Canal Company were represented. They did not oppose the grant of the order, but sought to secure their interests under the order. From the statement of Mr. Morse it appeared that the Electric Traction Company propose to construct a tramway a little over 8 miles long, at an estimated cost of about £52,000, to run from Rhodes to Middleton, and to branch from thence in two directions, one running through Chadderton to Oldham, the other proceeding towards Rochdale by Castleton. The tramway is to be laid along the main road, on the electric overhead wire system. Evidence was given with regard to the great lack of means of communication by road between the places named, and it was stated that as the rails for the proposed system would be laid to the ordinary gauge of 4 feet 8½ inches, they could, as regarded the Oldham tramway system, be eventually coupled up or connected. The Oldham authority—the Town Council—opposed the grant to the company of power to construct a piece of the line, about 300 yards long, which would lie within the borough boundary. Oldham, it was said, might, when the present leases expire, decide to carry on its own tramway system. It was stated that there will be no engineering difficulties in laying the proposed line, and that no widenings of the road will be required. Asked as to the possibility of extending the line westwards from Rhodes to the Manchester tramway system at Cheetham Hill, Mr. S. Sellon, the engineer to the company, said that at the time the application was drawn it was understood that the Manchester Corporation were opposed to the overhead system. He understood it was now different, and if Manchester agreed there should be no difficulty in bringing the two systems together. The proposed tramway will run through a very populous district, which absolutely needed road connection. The Commissioners afterwards went through the clauses of the proposed order.

Liverpool.—The Tramways Committee are understood, says the *Liverpool Post*, to be working hard to have the experimental line of electric trams from St. George's Church to the Dingle ready and in working order by May 1st. The new machinery necessary to supply the motor power has already been laid down at the Paradise Street generating station, and the armatures rewound to give the more powerful 500-volt current necessary for the service. The wires have been manufactured and delivered, and the rails have already been shipped to Liverpool. Trolley poles have been specially designed for the Corporation, and one is now being cast from working drawings by Dr. Hopkinson. Several of the cars to be used on the line have already been delivered. Their design is novel. They are entered from the sides. The front part of the car is enclosed, and comfortably fitted up with seats divided one from another by arms as in first-class railway carriages. The ventilating arrangements are of the latest type, and the lighting throughout will be by electricity. The rear half of the car will be open, and will take the place of the present "outside." The seats are arranged cross-wise. Each car has been constructed to carry 36 passengers. As the speed will be too great to admit of passengers jumping on and off while the car is moving, it has been decided to have a stopping station at the corner of each important cross-street along the line of route. The rate of speed, with stoppages, will be eight miles an hour.

Madrid.—The directors of the Tramways Union Company, in their report for 1897, say that the formal sanction of the Madrid Municipality having been obtained for electrical traction, the work of transformation is now in active progress, and the directors hope the line will be in full working order early in the coming summer.

Manchester.—The Stretford District Council will oppose the Manchester Carriage and Tramways Bill, 1898, for using mechanical power on their lines, &c.

Norwich.—At the Norwich Police Court, on 3rd inst., an application was made on behalf of the Norwich Electrical Tramways Company, Limited, under the Land Clauses and Consolidation Act, for a certificate that the capital of the company had been subscribed, which was necessary before they could acquire any lands. Documentary evidence was handed in. It was shown that all the capital of the company (£240,000) had been subscribed, and 50 per cent. paid up. The magistrates, after consultation, said they had come to the conclusion that the evidence in its present state was insufficient to grant a certificate. The list of members produced was not verified in any way. The application was accordingly adjourned. The matter came before the Court again on 5th inst., and the necessary certificate was granted, an affidavit being produced from the secretary of the company stating that the book produced was the registered membership roll of the company.

Sheffield.—The construction of the track for the electric tramways is being pushed forward, according to the *Sheffield Independent*. Work was commenced on January 3rd. The road from Tinsley to the Wicker is practically level all the way. From Lady's Bridge, up Waingate, and then along the Fruit Market and up High Street, a heavy gradient is encountered, and the line runs through the busiest commercial part of the city, while, after leaving the Moor, the efficiency of the traction will be tried in Cemetery Road, by one of the steepest gradients to be found in Sheffield. If the electric overhead system proves equal to all the demands made upon it in the six miles from Tinsley to Nether Edge, it is likely to be successful in any other part of the city in which it is to be employed. The rails are supplied by the Barrow Steel Company; the steel points, crossings, &c., by Askham Bros. & Wilson, and Mr. R. W. Blackwell is supplying the well-known Chicago bond. The rails are laid on a solid bed of concrete. The city surveyor (Mr. C. F. Wike) is superintending the laying of the track. It is proposed to use 25 double-decked cars, each taking 51 passengers. The centre trolley poles, which will be fitted with lamp carriers, are being supplied by Messrs. Macfarlane & Co., of Glasgow, and a large number of the side standards will be made by Mr. J. Spencer, of Newbury. As already stated, the British Thomson-Houston Company will furnish the electrical equipment.

Electric Power Distribution.—At last week's meeting of the Dudley Town Council, a discussion took place with reference to the Electric Power Distribution Company and its proposals. The Mayor stated that he and Councillor Hooper attended the meeting at Birmingham in connection with the application of the Electric Power Distribution Company. That company was only in course of formation, and it was a mistake to say that they had offered power at 1d. per unit. It might be 1d. and it might be 3d. No offer had yet been made likely to induce that corporation to surrender their electrical powers. When they were ready with any such offer or guarantee that council would be ready to welcome them. He proposed the extension of the executive powers of the Electric Committee for two months, and this was carried.

Electric Power Distribution.—The representatives of the principal firms in the Mansfield district met at the Swan Hotel to discuss the proposed scheme of the General Power Distribution Company with the company's representatives. Mr. Devonshire (of the British Thomson-Houston Company) explained the proposals. Various questions were put as to the cost of the current to consumers, out and out cost, or hire cost of motors, &c. The Derby Town Council will oppose the company's Bill.

TELEGRAPH AND TELEPHONE NOTES.

Bolton Telephone Service.—In response to the complaints of the Bolton Chamber of Commerce as to the unsatisfactory condition of the telephone service, the Post Office authorities have replied stating that in so far as was practicable in the absence of details of specific cases, the matter has been carefully inquired into by the department's surveyor for the district. From a return which has been taken of the trunk traffic at Bolton, it appears that, of the trunk calls originated by subscribers at Bolton, 62·40 per cent. were put through, so far as the department is concerned, in less than five minutes, and 87·21 in less than ten minutes, and, on the whole, there does not seem to be any reason to suppose that a satisfactory service is not given.

Delays in Australian Telegrams.—The Postmaster-General of South Australia, Sir Charles Todd, must by this time have realised that the hopes which he expressed in a letter of reply to the protest made by the London Chamber of Commerce, complaining of the delays in the transmission of cable messages to Australia, were over sanguine. In this letter, dated Adelaide, August 31st, 1897, this gentleman, after suggesting that delays are due to various causes and that the lines in the Colony of South Australia were seldom at fault, says that "as a rule messages are transmitted very quickly over the line between Adelaide and Port Darwin, and our difficulties as regards the new code have been completely overcome; I do not, therefore, anticipate any further complaints." With the above opinion before us, it may not be out of place to detail the interruptions and delays which have occurred since the date of Sir Charles Todd's letter, viz.:—

September	6th, 1897.—	Port Darwin line unworkable.
"	17th, "	" " " interrupted.
November	19th, "	Both trunk lines cut off from Melbourne.
December	9th, "	Port Darwin line interrupted for about four days.
"	15th, "	Port Darwin line interrupted by floods.
"	18th, "	" " line working very badly north of Hergott Springs.
"	22nd, "	Both South Australian lines between Eucla and Adelaide unworkable for some hours.
January	4th, 1898.—	Considerable delay in press messages due to irregularity in the working of the landlines in Australia.
"	8th, "	Australian landlines working badly; no cables through from Adelaide.
"	19th, "	Cables from Adelaide delayed.
"	20th, "	Communication from Adelaide in many cases as much as 24 hours late.
"	31st, "	Delay in communication to London, unable to supply usual Adelaide prices.
February	1st, "	Government wires in Australia working very badly; telegraphic communication between Australia and England greatly delayed.

These interruptions, it will be seen, are by no means rare, occurring as they do on at least 13 occasions during the last five months. As he is a strenuous opponent to the Pacific cable scheme, a means by which the inconveniences referred to would have been avoided, it is interesting to gauge the value of the opinion so confidently expressed by the Postmaster-General of South Australia. It is widely suggested throughout the press, that a remedy for the above mentioned delays and interruptions will be found in a system of cables, which the Eastern Telegraph Company propose (for certain considerations) to lay to the Cape, and from thence on to Perth in Western Australia; but as this cable will land some 1,600 miles from Adelaide, 2,000 miles from Melbourne and 2,500 miles from Sydney, to say nothing of the 3,000 miles of landline intervening between Perth and Brisbane, it will be seen that the proposed remedy cannot be considered as in the least degree likely to supply the want which is so badly felt, not only in Australia, but in England.

The Deutsche See-Telegrafen-Gesellschaft.—We learn that the Emden-Vigo cable, which was laid about a year ago for the above-named company, has again broken down. If, as we have heard, this cable is intended to form the first link of a system which is to put Germany into communication with the United States without touching on English territory, it would seem prudent to duplicate the first section before going any further in the matter, as this is, we believe, the sixth occasion on which this cable has broken down in the space of a year. Such a record is not calculated to inspire much confidence in the minds of the Deutsche See-Telegrafen-Gesellschaft.

The London Authorities and the Telephone Service.—Both the Court of Common Council and the London County Council have been discussing in earnest the question of the telephone service. The L.C.C. is to obtain an inquiry into the service through an application for a licence to establish a municipal service for London. The Court of Common Council is applying for an inquiry and will hold a conference of local authorities at the Guildhall into the matter.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1898 ...	...
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1898 ...	...
Curaçao-La Guayra ...	Jan. 5th, 1898 ...	...
Paramaribo-Cayenne ...	Jan. 27th, 1898 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Saigon-Hong Kong	Jan. 8th, 1898 ...	...
Para-Maranham	Jan. 22nd, 1898 ...	Feb. 8th, 1898.
Bolama-Bissao	Jan. 28th, 1898 ...	...
Emden-Vigo	Feb. 7th, 1898 ...	...
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1898 ...	...
Cartagena-Barranquilla ...	July 4th, 1896 ...	...
Majunga-Tananarive... ...	Feb. 2nd, 1898 ...	Feb. 5th, 1898.
Nicaragua landlines	Feb. 8th, 1898 ...	...

CONTRACTS OPEN AND CLOSED.

OPEN.

Bilbao.—February 28th. The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Consul at Bilbao, reporting that the provisional board appointed in connection with the electric tramway which it is proposed to lay from Zumarraga to Zumaya, in the province of Guipuscoa, invite plans and tenders, to be received by February 28th, for the construction and equipment of the line. Further particulars of the conditions of the tenders for the above-named tram line and branch, which together measure 30 miles, may be inspected at the Commercial Department of the Foreign Office any day between the hours of 11 and 6.

Belgium.—February 16th. Tenders are being invited by the Société Nationale des Chemins de Fer Vicinaux, of Brussels, for the supply of 38 electric tramcars. Tenders to be sent to, and particulars may be obtained from, the offices of the company, Rue de la Science, 26, Brussels.

Berlin.—March 15th. The Municipal Traffic Deputation of the Town Council have opened a competition for the construction of several new electric tramways in that city. Exhaustive details concerning this project are contained in the *Elektrotechnische Zeitschrift* of the 13th inst., which mentions that proposals will be received by the Stadtische Verkehrsdeputation Rathhaus III, Berlin, by March 15th.

Bristol.—February 21st. The Electrical Committee want tenders for 214 arc lamp posts. Electrical engineer, Mr. H. Faraday Proctor. See our "Official Notices."

Canterbury.—February 23rd. Tenders are invited for the electric wiring and fittings for the Beaney Institute for the Town Council. Specifications, &c., to be obtained at the office of the City Surveyor, 28, St. Margaret's Street.

Denmark.—The Formand for Byraadets Udvalg for Elecktricitetsvaertet (Sugförer Edv. Lau), of Kolding, are inviting tenders for the supply of (1) the engines and boilers; (2) the dynamos and other electrical plant and apparatus; and (3) the supply and laying of mains required in connection with the projected central electric lighting station in the town. Particulars may be had on applying as above for the sum of 50 krondos (returnable on receipt of *bonâ fide* tender). Tenders addressed as above.

Denmark.—March 12th. Tenders are being invited for the supply of the engines, dynamos, accumulators, &c., required in connection with the new central station at Frederiksberg, near Copenhagen. Tenders to be sent to the Frederiksberg Sporveis-og Electricitets Aktieselskab, Gammel Kongerie, 140, Copenhagen V., from whom particulars may be obtained.

France.—February 16th. Tenders are being invited by the French Naval Authorities at Toulon for the supply of circuit breakers, rheostats and dynamo wire. Particulars from, and tenders to, Le Bureau du Détail des Approvisionnements de la Marine Nationale, Toulon.

France.—March 31st. Tenders are being invited by the Municipal Authorities of Saint Chamond (Loire) for the concession for the lighting of the public streets of the town, either by gas or electricity. Particulars from, and tenders to be sent to, La Mairie de Saint Chamond (Loire).

Glasgow.—February 18th. Tenders are invited for the construction of several sections of tramways for the Corporation. Specification, &c., from Mr. John Young, general manager, 88, Renfield Street, Glasgow.

Hammersmith.—February 16th. The Vestry want tenders for general stores for the electricity works. See our "Official Notices."

Harrogate.—February 24th. The Corporation invite tenders for the supply and erection of vertical steam engine, dynamo, switchboard, motor, overhead conductors, &c., for sewage pumping plant. Mr. Geo. Wilkinson, borough electrical engineer. See our "Official Notices."

Italy.—February 16th. Tenders are being invited by the Italian Naval Authorities at Spezia for the supply of a large number of 12-C.P., 16-C.P., 25-C.P. and 100-C.P. incandescent lamps of different voltages. Tenders to be sent to La Dires Torpedine e Materials Elettrica, 1° dip. Marittimo, Spezia, Italy, from whence particulars may be obtained.

L.C.C.—February 16th. The London County Council Asylums Committee want tenders for a great variety of sundries. One of the items is for electric lighting sundries for Claybury. Particulars at the office of the Asylums Committee, 21, Whitehall Place, S.W.

Madrid.—February 22nd. The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Chargé d'Affaires at Madrid, enclosing copy of a Royal decree announcing that a public auction for the contract for repairing the national submarine telegraph cables during the next five years will be held at Madrid on February 22nd. Further particulars as to the cables in question may be inspected at the Commercial Department of the Foreign Office any time between the hours of 11 and 5.

Northwich.—March 5th. The Weaver Navigation Trustees are inviting tenders for the construction and erection of the necessary electric power plant for lighting and working the new swing bridges at Northwich. Current will be supplied by the Northwich Electric Supply Company. Engineer, Mr. J. A. Saner, M.I.E.E. See our "Official Notices" this week.

Pembroke (Ireland).—March 5th. The Lighting Committee want tenders for the supply and erection of various plant, machinery, &c., for electric lighting. See our "Official Notices" this week for full particulars. Consulting engineer, Mr. Robert Hammond.

Plymouth.—February 21st. The Council want tenders for the erection and completion of a refuse destructor with all necessary flues, fittings, boilers, &c. Borough engineer, Mr. James Paton, Municipal Offices.

Portsmouth.—February 22nd. The Corporation want tenders for the supply and erection of Lancashire boilers, feed pumps, mechanical stokers, &c. Consulting engineers, Messrs. Kincaid, Waller & Manville. See our "Official Notices" this week.

Redditch.—February 14th. The District Council want tenders for the supply of buildings, gas producing plant, gas engines, alternators, cables, transformers, &c., for the electric lighting of the district. Consulting electrical engineer, Mr. J. A. McMullen. See our "Official Notices" January 28th.

Rochdale.—February 19th. The Corporation want tenders for steam dynamos, balancer, and boosters, &c. Engineers, Messrs. Lacey, Clirehugh & Sillar. See our "Official Notices" January 14th.

Roumania.—March 15th. Tenders are being invited by the General Direction of the Roumanian Post and Telegraphs in Bucharest for the supply of 56,000 metres of galvanised iron and steel wire.

St. Helens.—February 21st. The Corporation want tenders for various plant and machinery, &c., in connection with the proposed electric tramways. See our "Official Notices" January 28th for particulars. Consulting engineer, Dr. J. Hopkinson.

St. Pancras.—February 22nd. The Vestry want tenders for dry back marine boilers with superheaters and brickwork seatings. See our "Official Notices" February 4th.

The War Office.—April 27th. The Secretary of State for War is prepared to receive offers, competitive designs and specifications for the supply of portable electric search light apparatus. Particulars from the Director of Army Contracts, War Office, Pall Mall, S.W. See our "Official Notices" February 4th.

Victoria.—March 21st. The Telegraph Department of the Victorian Government Railways is inviting tenders for the supply of alternating current transformers and one main switchboard. Tenders to the Telegraph Superintendent's Office, Spencer Street, Melbourne.

Wallasey.—March 17th. The District Council want tenders for the supply of engine, alternator, exciter, two Lancashire and one water-tube boilers, and condensing apparatus. Engineer, Mr. J. H. Crowther. See "Official Notices" this week.

Watford.—March 16th. The District Council want tenders for the supply and erection of various plant for the electric lighting of the district. For details of the seven sections see our "Official Notices" this week. Mr. W. C. C. Hawtayne, consulting engineer.

CLOSED.

Blackburn.—The contract for the 500-kilowatt C.C. steam dynamo for the Council has been placed with Messrs. Siemens-Belliss. The following are the tenders with Belliss' engines:—

	£	s.	d.
Electrical Company	6,500	0	0
Westinghouse	4,754	6	0
Crompton & Co.	4,666	0	0
J. A. Holmes	4,624	0	0
P. R. Jackson	4,492	0	0
Mather & Platt	4,405	0	0
Electric Construction Company	4,384	0	0
Siemens Bros.	4,340	0	0

The order for the steam alternator has not yet been definitely placed. Mr. Lacey is the consulting engineer.

Bradford.—We understand that the tender of the Westinghouse Electric Company, Limited, has been accepted for the electrical equipment of tramways in this city for the sum of £14,664.

Brighton.—The following is a list of the tenders submitted for the completion of the electric lighting, wiring, &c., of the Town Hall. Only those marked * were, says *Daily Tenders and Contracts*, entertained, they being the only tenders complying with the specification, which required samples of materials and fittings to be submitted:—

	£	s.	d.
Whipp & Co., Manchester	625	0	0
*A. H. Wood, Army and Navy Mansions, London, S.W. (accepted)	705	0	0
*H. V. James Mills & Co., Manchester	860	0	0
The Nelson Electrical Engineering Company, Nelson	874	0	0
Lawrence & Blaiberg, London, W.	875	12	0
*Page & Miles, Brighton	899	14	0
*C. G. Reed & Son, Brighton	965	10	0
*Laing, Wharton & Down, Ltd.	1,010	15	0
*W. J. Fryer & Co., Ltd., London, W.	1,288	5	0
M. Fileman, Brighton	1,500	0	0
E. A. Tasker, St. Paul's	1,865	0	0

London.—The following tenders were sent in for the electric light wiring of the Abbey Mansions, North Block, Victoria Street, S.W. Consulting engineer, Mr. Morgan Williams, C.E.:—

	£	s.		
Electrical and General Engineering Co.	1,656	0	0	
Hill, Gifkins & Co.	1,248	14	0	Estimated total, with branch wiring for 610 3/22 S.W.G. points.
H. M. Leaf	1,147	10	0	
Drake & Gorham	1,095	0	0	
Townsend, Tamplin & Makovski	1,046	2	6	
Laing, Wharton & Down	991	9	6	
Warburg, Dymond & Co.	968	0	0	
Belshaw & Co.	909	15	0	
C. A. Hemingway (accepted)	838	12	0	

London.—The following tenders were submitted for the electric light wiring of Messrs. Welch, Margetson & Co.'s new warehouse, Moor Lane, E.C. Consulting engineer, Mr. Morgan Williams, C.E.:—

Name of firm.	Tender No. 1 (Mains and Distribution Boards).			Tender No. 2 (Branch Wiring per point)				Estimated total for 721 points of 3/22 S.W.G.		
				7/21½ S.W.G. point.		3/22 S.W.G. point.				
	£	s.	d.	s.	d.	s.	d.	£	s.	d.
H. M. Leaf	390	0	0	28	0	22	0	1,188	2	0
Strode & Co.	247	0	0	30	0	21	0	1,004	1	0
Townsend, Tamplin and Makovski	278	18	9	21	6	17	6	904	16	3
Belshaw & Co.	230	0	0	27	0	15	0	770	15	0
Spagnoletti and Crookes (accepted)	270	0	0	18	0	12	0	702	12	0

Newport.—The contract for the supply of an electric lighting plant for 130 16-C.P. lamps and six 500-watt arc lamps for temporary lighting at Westwood waterworks for the Corporation has been given to Mr. C. D. Phillips, of Newport.

Stafford.—The County Lunacy Committee has reported that the Cheddleton Sub-Committee had invited tenders for the installation of the asylum with electricity, upon plans and specifications prepared by Mr. Henry Lea, C.E., of Birmingham, and of the four tenders received the following had been accepted:—Mavor and Coulson, £6,240 (generating and storage plant); Walsall Electrical Company, Limited, £3,195 16s. 6d. (wiring and fittings).

West Hartlepool.—It is stated that the following contracts have been given out by the Corporation for electric lighting plant:—Boilers, Anderton & Son; engines, dynamos, switchboard, motor-dynamos and arc lamps, Crompton & Co.; storage battery, Tudor Accumulator Company.

Dinner in Honour of Mr. James Dredge.—A dinner in honour of Mr. James Dredge, C.M.G., Executive Commissioner of the Brussels International Exhibition of 1897, took place on Wednesday night at the Grand Hotel, Trafalgar Square. Sir Albert K. Rollit, M.P., occupied the chair. On behalf of the exhibitors in the British section the chairman presented Mr. Dredge with a beautiful album containing a general view of the exhibition buildings and an illuminated address, to which were appended the signatures of the subscribers.

THE MAKING OF CHLORIDE ACCUMULATORS.

It is, perhaps, almost unnecessary to say that the company which make the chloride cell is the Chloride Electrical Storage Syndicate, Limited, and the syndicate practically controls the whole of the patents in the world, with the exception of the United States, Canada, and France, where chloride cells are made by allied companies. The original patents were held by the Electric Storage Battery Company, of Philadelphia, from whom the patents for this company and the rest of the world, with the above exceptions, were acquired by the Chloride Syndicate.

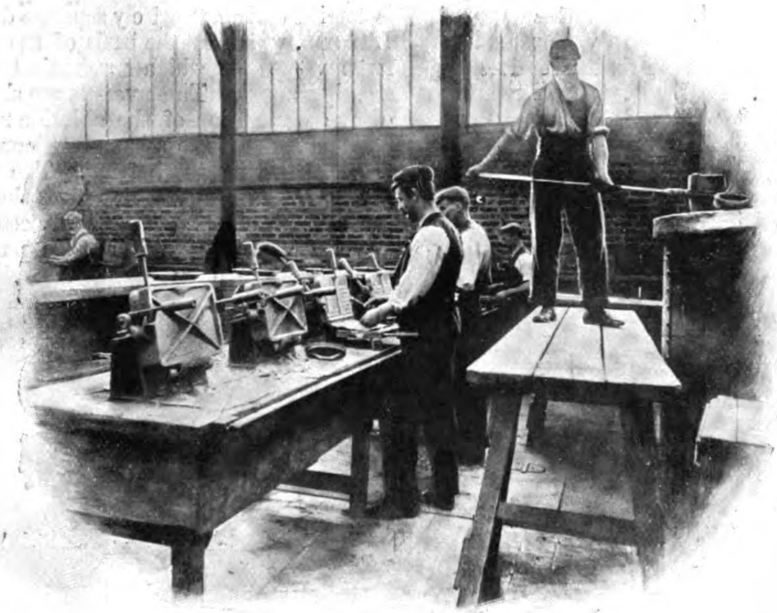


Fig. 2.—Casting Chloride Pastilles.

The home of the chloride accumulator is at Clifton Junction, some five miles from Manchester, and here an old chemical factory has been converted into up-to-date sanitary accumulator works. The conversion has been effected by pulling down old buildings, and erecting substantial, airy, and light ones in their place. The area of the works covers some three acres of ground, the greater portion of which is covered in. The site is most conveniently situated with regard to rail and water, the Bury and Bolton canal being contiguous to the works, and the railway within a stone's throw. There is more order, more cleanliness, and better surroundings than one usually associates with such works. The chairman of the company is Dr. Bowman, who is well known in electrical circles, and the general manager is Mr. G. A. Grindle, who, it is hardly necessary to say, is one of the best known engineers in the profession.

It is perhaps almost an act of supererogation to set forth the many directions in which the chloride accumulator has done distinguished service; but perhaps this account ought to include some reference to the growing use that is being made of the chloride cell. It is not only in electric lighting systems that this cell is performing good work, but in the perhaps more exacting services demanded in a tramway system. Some months ago we had occasion to describe the extensions that had been carried out on the Manchester Corporation electric lighting system, and we then took cognisance of the large battery that had been erected by the Chloride Company. When this battery was put

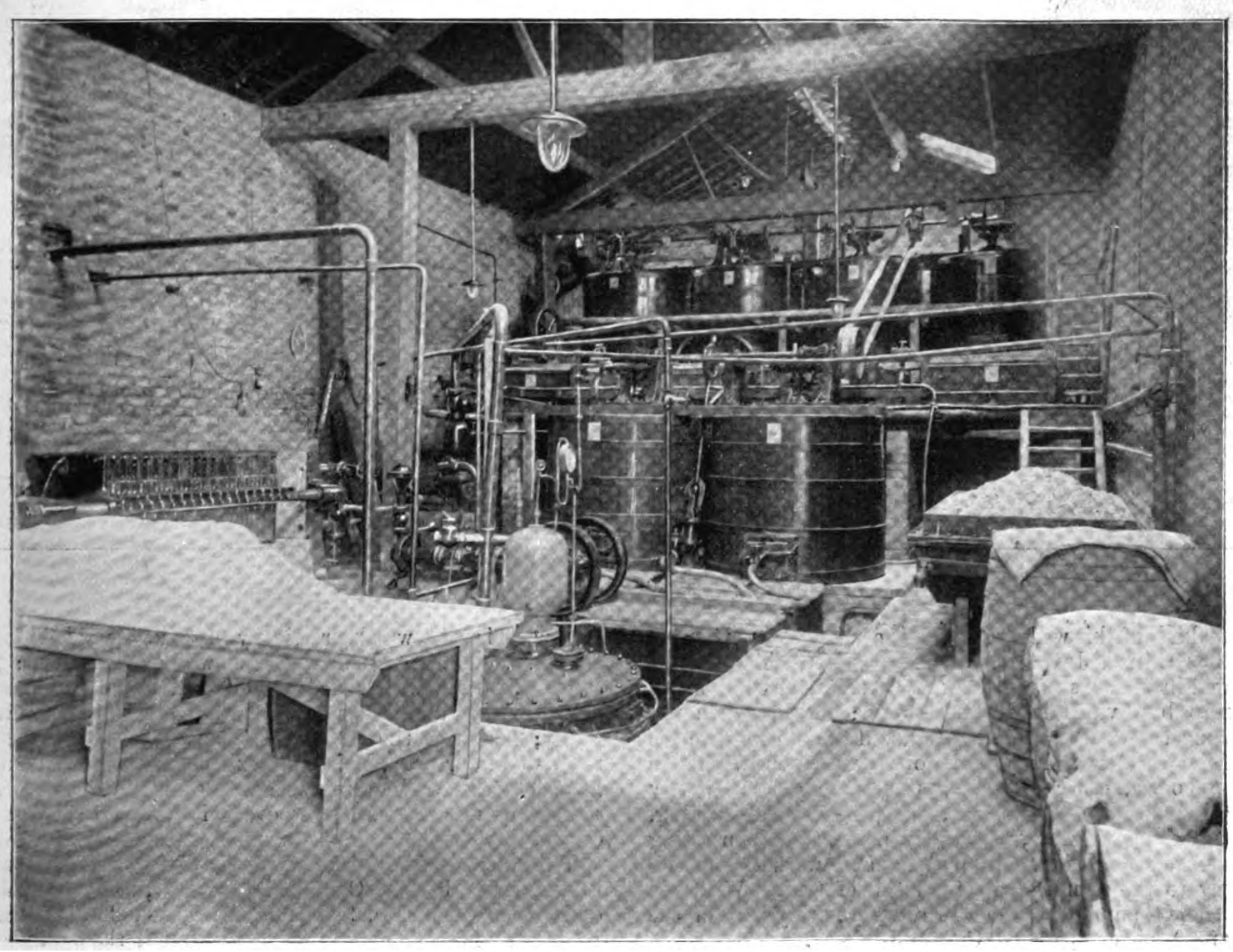


Fig. 1.—The Chloride of Lead Machinery.

down it was probably the largest in the country, and the objects that led to its introduction into the Manchester system were to save running a new feeder; to enable the station to be shut down at night, and to act as a balancing device. In every respect we believe this battery has been entirely successful. Although electric tramways are practically beginning in this country, the chloride accumulator has been intimately associated with some of the lines that have been completed. On the Douglas and Laxey line, this type of cell is used at a half-way house to assist the dynamos and to maintain the pressure; it is also serving similar services on the Snaefell Mountain Railway. At Leeds, the most recently completed tramway system, great reliance is being put upon chloride accumulators, where they are arranged in two substations.

The position attained by the chloride accumulator in the electrical industries is sufficient justification for giving some account of the various processes that attend its manufacture.

The name of the cell is obtained from the use that is made of chloride of lead which is employed in the negative plate, the positive plate being made up of ordinary metallic lead. It is, of course, the negative plate that constitutes the chief feature of this type of accumulator, and in accordance with the fitness of things we ought to describe the methods that are followed in the various stages of making the plate.

The first step is the manufacture of chloride of lead, which is carried on in an entirely separate department of the works. Litharge, which is the basis of the product, is dissolved in large vessels in which mechanical stirrers are being constantly rotated. These vessels are shown in the background of the illustration of the chloride room (fig. 1), and it will be observed that the stirrers are connected by suitable gearing and belting to shafting. The litharge is dissolved by means of acetic acid, which gives the resultant compound of acetate of lead. After the lead acetate has been drawn off and allowed to settle, it is then precipitated by means of

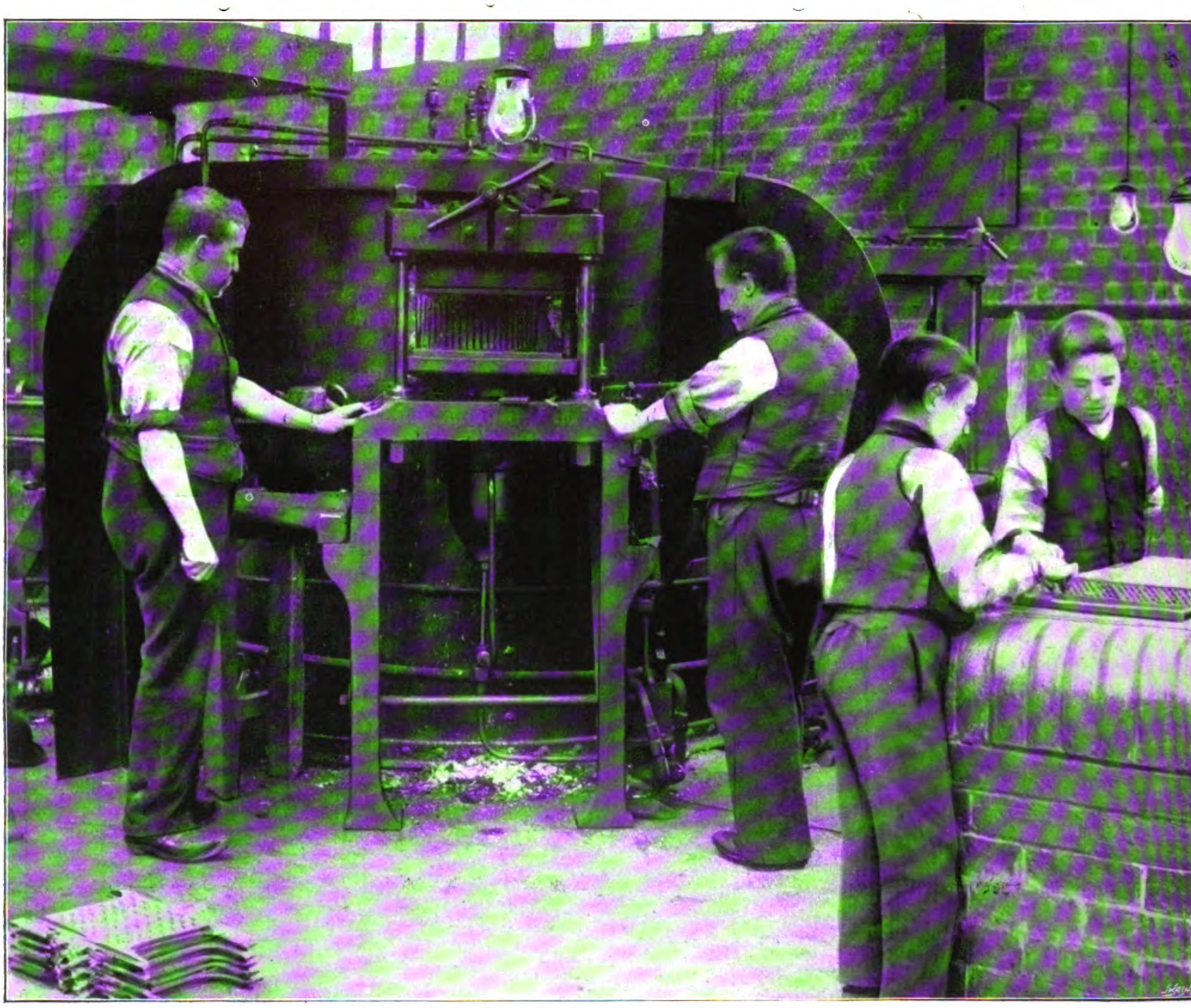


Fig. 3.—Framing the Pastilles.

The making of this well-known cell is carried on in extensive works at Clifton Junction, near Manchester. The process followed in the construction of this accumulator enables the works to be divided into two sections: one in which the mechanical work is done on the cell, and the other where the chemical and electrical manipulations are performed. There are, of course, other departments that are only indirectly associated with the cell making, such as the wood working, mechanics' departments, the boiler house, the generating station, the gas making, and a portion of the works is given up entirely to the manufacture of chloride of lead. With the exception of purchasing the raw material, every part of the accumulator is completed at Clifton Junction.

It is hardly necessary to say that both the manufacture of the positive and the negative plates call forth some very interesting and pretty operations, and by means of the illustrations we shall be able to demonstrate some of them.

hydrochloric acid, which practically gives us chloride of lead. The process is not quite so simple as we have described; for instance, when the compound has reached the acetate of lead stage it is carefully analysed, so that its nature is known to a nicety; moreover, the solution of chloride of lead is passed through a filter press, which squeezes out the acetic acid and leaves chloride of lead in the shape of whitish cakes. At one end of this room are large ovens in which the cakes of chloride are dried.

The chloride of lead next makes its appearance in what is known as the Pastille Casting Department, the name being derived from the special shape in which the chloride is used. In this room are large iron pans in which the chloride of lead is melted. The pans are protected by means of refractory linings, and a seal of lead, some inches in thickness, protects the bottom; they are capable of holding between two and three tons of molten chloride, and are heated by

Fig. 5.—Casting Negative Sections.

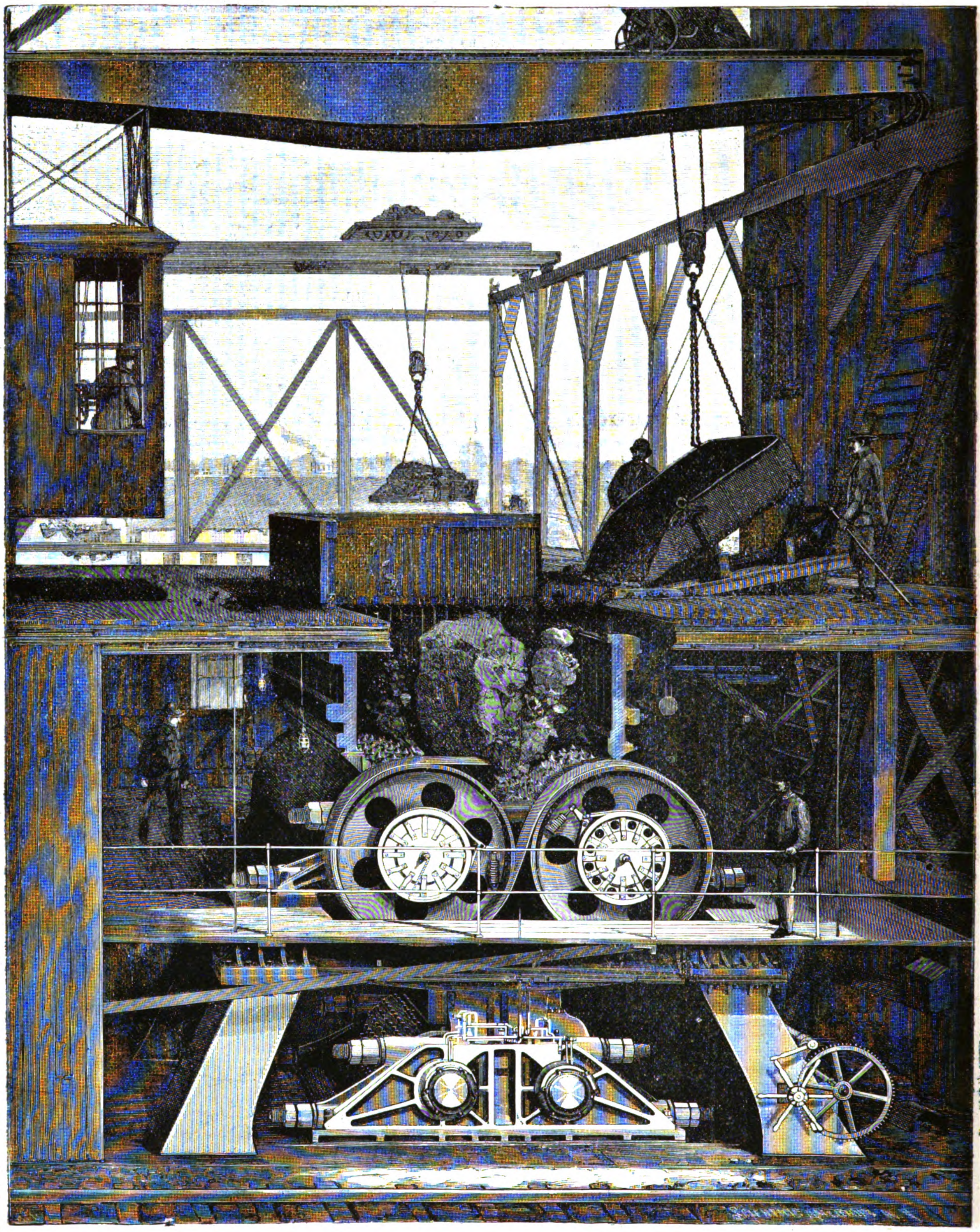
cast in moulds into small hexagon pastilles, suitable for framing. The operation of ladling the chloride and casting the pastilles is shown in fig. 2. The pastilles are then carried away to be framed, and this operation is distinctly interesting. The pastilles are arranged in the bottom half of a plate mould, the top half of the mould being permanently fixed to the top side of a hydraulic press. After the pastilles have been arranged on the mould, it is placed in position on the ram by means of stops, and water being admitted to the ram chamber, the press is closed, and the top half of the mould comes down on to the bottom half. The next operation is to inject molten lead under pressure to fill in the interstices left in the mould. This is done through a nozzle, which by means of a screw connects the molten lead chamber to the mouth of the mould. Compressed air is then admitted into the top of the lead chamber with the result that lead is forced into the mould, completely filling it and bedding in the pastilles. Fig. 3 shows one of the lead presses and boys placing pastilles in the lower half of the mould. The lead chambers are all submerged in a large pan of molten lead, four chambers and presses being arranged round each lead pan. The compressed air is delivered into the lead chambers at a pressure of 150 lbs. per square inch. The operation of the lead press is sufficiently safeguarded to prevent pressure being applied to the lead chamber until the press has been completely closed. Fig. 3 shows the operation of framing pastilles, the boys on the right of the illustration, whose expression has been lost in the complicated process of making the block, are fitting the pastilles into the lower half of the mould, and the men in the background are working the lead press. The next process is to trim the plates, and after this they are taken to the reduction tanks (shown in fig. 4) where they are set up alternately with rolled zinc plates, with the result that the chlorine in the chloride of lead pastilles leaves the pastille uniting with the zinc and forming chloride of zinc in the tank, the final state being that each pastille is converted into one of pure spongy lead. After a process of washing, the plates are then given

Fig. 4.—Reduction Sheds.

Dowson gas. The chloride is put into the pans with a small percentage of zinc, and becomes perfectly fluid at about 600° C. It is ladled out by means of plumbago ladles, and

a hydrogen bath to ensure absolute freedom from all trace of chlorine. That operation practically completes the making of the negative plate, they are not quite finished with, however, for they are then passed on to the plumbers, who cast them up into sections ready for sending out. Quite a simple operation is the casting up, and simply depends upon putting the plates in a specially shaped mould, in which molten metal is poured; the process of casting the negative sections is shown in fig. 5.

(*To be continued.*)



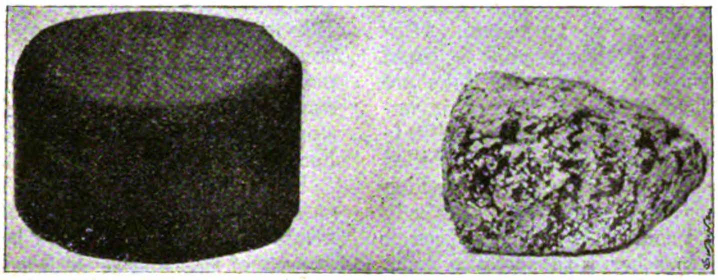
The Giant Rolls at the Edison Magnetic Concentrating Works.

THE EDISON MAGNETIC CONCENTRATING WORKS.*

Before describing the remarkable process of crushing and magnetic separation at Mr. Edison's concentrating works in the mountains of New Jersey, it will be well to speak of the elaborate system of prospecting which was carried out to determine the location of the various bodies of low grade iron ore which it is proposed to work by the new process. In iron mining, just as in gold mining, there is a limit to the grade or richness of ore which it is profitable to work in the existing state of the art. Hence the prospectors, who for many years have worked over the Eastern iron ore districts, have made no record of the existence of deposits which were not fairly rich in iron. As the Edison process was designed to render the hitherto neglected low grade ores commercially profitable, it was necessary to make a systematic prospect of the belt of magnetite deposits. The work was done by means of the dipping needle, and the survey was the most complete ever carried out. It embraced a strip of country 25 miles

* *Scientific American.*

wide, reaching from the Canadian border to the mountains of North Carolina. Several corps of surveyors ran lines across the magnetite belt at intervals of a mile, and wherever the dip of the needle showed indications of ore, a more thorough search of the locality was made. The results were plotted on a map, which is the most unique and thorough work of its kind in existence. When this was completed, the company proceeded to purchase or lease the most desirable properties, their holdings at present amounting to some 16,000 acres.



A Briquette, 68 per cent. of Iron. Fig. 2. A Lump of Iron Ore, 20 per cent. of Iron.

The New Jersey and Pennsylvania Concentrating Works are located on the site of the old Ogden mines, one of those many abandoned iron mines of New Jersey from which the veins of richer ore have been worked out during the century or more in which iron mining has been carried on in this district. The body of ore averages about 200 yards in width, and extends for a distance of over two miles. The average richness of the ore is about 20 per cent. of iron. It should be mentioned that although the works at Edison witnessed the first attempt to carry out magnetic concentration on a commercial scale, Mr. Edison had conducted a series of preliminary experiments at Llewellyn Park, N.J. The operations at Edison commenced about six years ago, and the characteristic energy and lavish expenditure with which they have been carried on have resulted in the present enormous and extremely interesting plant.

The visitor to Edison who is familiar with the scope of Mr. Edison's inventive genius — and who is not? — in the design and perfecting of such delicate or complicated devices as the incandescent lamp, the phonograph, or the vitascope, will find that in the totally different fields of mining and milling, with their massive machinery and vast operations, Mr. Edison has shown a characteristic originality and freedom from the trammels of tradition. This is evident, not merely in the application of an entirely new system of concentration, but in the preliminary work of mining and crushing, where, surely, most men would have been content to follow the beaten track.

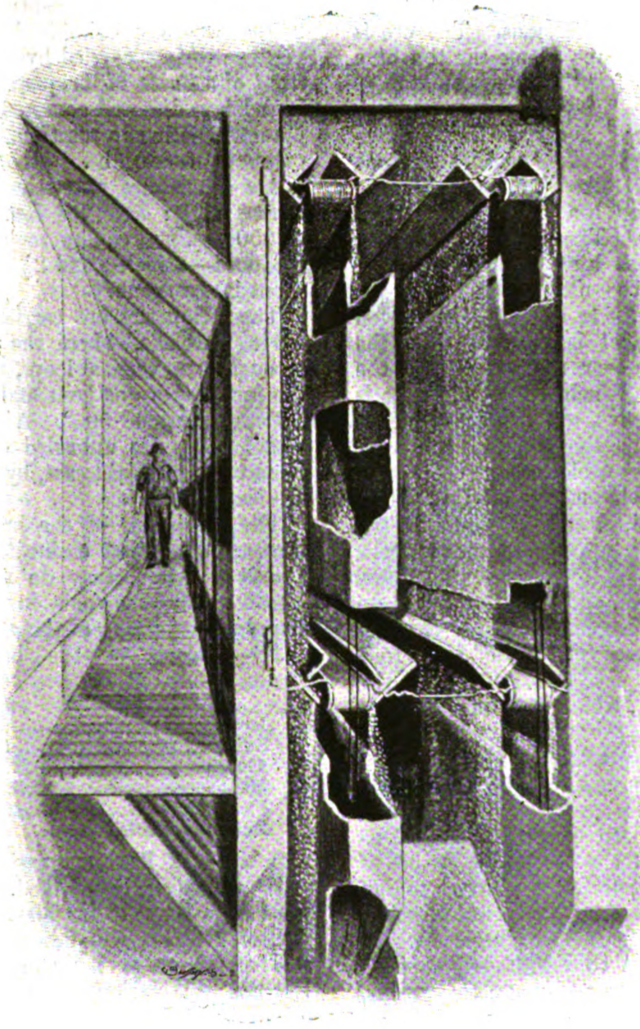


Fig. 1.

To carry out the process of magnetic separation called for the design of an entirely new plant in itself, and involved long years of patient and costly experiment; and, with a view of cheapening the work of getting out the rock and crushing it to the desired fineness for the magnets, an entirely new method of quarrying and crushing was devised and put into successful operation.

The works are situated approximately midway of the length of the deposit. A system of tracks runs from the crusher house to two powerful steam shovels which are working their way into the ore bed in two different directions. One of these weighs 60 tons and the other—a magnificent fellow weighing 93 tons—is the biggest of its kind ever built. In getting out the rock ready for the crushers, no attempt is made to shatter it to the usual size of, say, 100 lb. lumps by the free use of dynamite. The latter is used merely to loosen up the rock sufficiently for the great shovel to tear it loose and load it on the cars. Consequently it is frequently dug out of the cut in solid masses, weighing as much as five and even six tons apiece, and sent to the rolls in this shape. A double track, with a switch at the far end, runs through the cut on a slight up grade. The empties are pushed up and allowed to run back, by gravity, past the shovel, where the rock is deposited on 5-ton skips, of which there are two to each car. The tracks run on each side of the crusher house, and here the skips are picked up by a pair of 10-ton electric travelling cranes, and placed on an inclined table in front of the hopper above the "giant rolls." At the foot of this table is a revolving cylinder controlled by the operator, over which the material is fed to the rolls. This arrangement is clearly shown in the engraving on the previous page, where a load is shown falling from the skip into the rolls.

The giant rolls are what might be called the spectacular feature of the whole plant, and to see them seize a 5-ton rock, and crunch it with less show of effort than a dog in crunching a bone, gives one a vivid sense of the meaning of momentum—for it is momentum that does the work. The rolls are 6 feet in diameter, with a 6-foot face, and when they are running, the masses in motion weigh about 70 tons. They are spaced 7 feet 2 inches between centres, having a 14-inch space between their faces. The faces are covered with heavy cast-iron "slugger plates," which consist of a soft backing, with chilled 2-inch knobs. There are also two lines of massive knobs on opposite sides of one roll, which project 4 inches from the face. It is these which strike the smashing blows upon the large masses of rock, and break them up for the smaller knobs to act upon. The rolls are run at a normal circumferential speed of 3,500 feet a minute, and it is the energy stored up in the 70-ton mass at this speed which does the work. The rolls are driven by a belt, which serves to speed them up to the desired velocity, but is not depended upon to do the crushing. The pull of the belt is transmitted to the rolls by means of a strap brake acting on the neck of the rolls—as shown in the engraving—which is adjusted by means of a coil spring.

The 93-ton shovel and giant rolls combined do the work, which, in the ordinary methods of mining, is done by a freer use of dynamite, and it is just here that the first notable economy of this plant is realised.

The rock falls now upon the "intermediate rolls," shown immediately below the "giant rolls." They are 4 feet in diameter, have a 5-foot face, and are covered with knobbed plates. Their faces are $7\frac{1}{4}$ inches apart. The two sets can handle 3,000 tons of rock in a day of 10 hours. After passing through the intermediate rolls the rock is lifted by a wire rope elevator, in which the usual side links are replaced by side ropes in sets of four—an Edison invention, designed to reduce weight and lubrication and facilitate fast running—to a set of 36-inch rolls faced with chilled corrugated iron plates, the aperture between faces of which is about $2\frac{1}{2}$ inches. Unlike the giant rolls, these are positively driven; but to avoid breakage a connection is made through a split wobbler, which is held together with shearing bolts whose total cross section is such that they will shear off before any breaking strain can be transmitted to the rolls. From the first set of 36-inch rolls the rock passes down to a second set, which is similar to the first, but spaced with a $1\frac{1}{2}$-inch aperture. From these it falls into a third set, which are 24 inches in diameter, with a 20-inch face. These are not positively fixed, but are kept in place by coil springs.

By this time the rock has been crushed to a size of not over $\frac{1}{2}$ inch. It falls on to an elevator which carries it to the top of the "drier," a structure 9 feet square and 50 feet high, which is filled with a series of cast-iron plates 7 inches wide, which reach across the interior from wall to wall, and are arranged one above the other at an angle of 45°, the successive plates facing in opposite directions. The ore is then elevated to a conveyor which runs along the top of a stock house, 75 feet wide by 300 feet long, whose storage capacity is 16,000 tons.

From the stock house the material is carried to the three-high rolls in the concentrating mill. This consists of three rolls, the centre one of which turns in fixed bearings, while the upper and lower rolls are carried in bearings which are free to slide vertically in the housing. The lower roll is driven through a shearing wobbler, of the kind already described, and the bearings at each end of the upper and lower rolls consist of loose sleeves, on the outside of which are seven grooves. Around the grooves, that is to say, below the grooves of the lower sleeve and over the grooves of the upper sleeve, is wound an endless $\frac{1}{2}$-inch wire rope, which is finally carried up over a single sheave, which is acted on by a pneumatic piston. By this means the strain on the rope, and therefore the pressure of the movable rolls on the centre fixed roll, may be closely regulated, and an elastic adjustment is provided which removes all danger of breaking the rolls. The ore is fed between the upper and middle rolls and returned between the middle and lower rolls. The faces of the three-high rolls are smooth, and they are trued up in place when worn by means of a removable tool carriage mounted on the housing. There are four sets of these rolls in all.

The next step is the screening, which is carried on over 10 sets of 14-mesh screens. The rejections are sent back for recrushing in the three-high rolls, and the material which passes through the screens is now ready for the process of magnetic separation.

This process, which takes the place of what is known as the jig process of concentration, is the distinctive feature of the Edison plant. The crushed material is allowed to fall in a thin sheet in front of a series of magnets, which deflect the magnetic particles, but allow the non-magnetic rock to fall in a practically vertical line. A thin knife-edged partition board separates the magnetic and non-magnetic streams, technically known as, respectively, the concentrates and tailings, the concentrates being taken to the drier and subjected to further screening and magnetic separation, and the tailings, in the shape of sand, being sold as building sand in the open market. The latter, on account of its sharpness, is in great demand, and the company readily disposes of all that the works produce.

There are three sizes of magnets: The 12-inch, the 8-inch and the 4-inch. The crushed ore is first allowed to fall in front of a series of three 12-inch magnets (Fig. 1). The tailings, or the crushed particles of rock which are not drawn over by the magnets, are allowed to go to the sand heaps, while the concentrates, which have been drawn out of the falling stream by the magnets, are carried to a drier or sent back to the three-high rolls for recrushing. The dried concentrates are then passed through 50-mesh screens and allowed to fall in front of a series of three 8-inch magnets. The tailings again go to the sand heap and the concentrates are taken to what is known as the dephosphorising room, where they are treated by a special process, invented by Mr. Edison, for reducing the phosphorus. From this room the concentrates are allowed to fall in front of a series of 4-inch magnets, the tailings being sent to the sand-heap and the concentrates being taken back for recrushing or being stored in concentrate stock houses. The stock in these houses carries a percentage of 68 per cent. of iron.

It was at this point in the process that a difficulty was encountered which called for an extended series of experiments and much costly work before it was overcome. The process of smelting in the blast furnaces demanded that, for the best results, the ore should not be delivered in the finely divided state which characterised the concentrates from the Edison plant. It was necessary to furnish the material to the furnaces in a condition which would allow the furnace gases to act upon it to the best effect. The Edison concentrates, on account of their fine subdivision, would be apt to choke the furnaces and prevent the rapid reduction of the ore.

In order to meet this requirement, it was decided to compress the concentrates into briquettes (fig. 2) and deliver them in this form to the blast furnaces. A complete briquetting plant was therefore designed, which has fulfilled all requirements. The concentrates are carried to a mixing house, where a suitable binding material is added, the mixture being carried by means of a trough conveyor in front of a series of briquetting machines. The mixture is forced into dies and compressed in them by means of three plungers, acting in rotation. The first fills the die under a pressure of 800 lbs. to the square inch; the next plunger exerts a pressure upon the briquette of 14,000 lbs. to the square inch; and the last plunger exerts a pressure of 60,000 lbs. per square inch. Two sizes of briquettes are produced—3 inches and $2\frac{1}{2}$ inches; the larger sizes weighing about 20 ozs. each.

The briquettes are carried by a bucket conveyor to the baking furnaces, where the conveyor passes up and down through five vertical loops, the briquettes being retained in the furnace for one hour and nine minutes, and exposed to a temperature of 500°. After they have been thoroughly baked, they are unloaded on to a conveyor, which carries them to the railroad cars, by which they are taken direct to the blast furnaces.

The behaviour of the briquettes in transit and at the furnaces has been eminently satisfactory. They do not absorb moisture, they do not break in handling and they present sufficient voids in the blast furnaces to insure a complete circulation of the gases around them for smelting.

An analysis of the briquettes shows the following results:—

	Per cent.		Per cent.
Iron	67	to	68
Silica	2	to	3
Alumina	0·4	to	0·8
Manganese	0·05	to	0·10
Phosphorus	0·028	to	0·033
Binding material	...	to	0·075

with traces of lime, magnesia and sulphur.

It will naturally be asked, What results have the Edison briquettes shown at the blast furnaces when tested in actual practice? This was determined in 1897, by a trial which was carried out at the Crane Iron Works, Catasauqua, Pa. In these tests various percentages of briquettes were tried in a furnace, which produces an average of 105 tons of pig per day, when using the ordinary burden. The test was started with 25 per cent. of briquettes, and extended over five days, 100 per cent. of briquettes being used on the last day. With 25 per cent. of briquettes, the output was 104 tons of pig, and with 100 per cent. of briquettes the output rose to $138\frac{1}{2}$ tons per day.

From a study of these figures the reader will see that the yield of pig is largely increased by the use of the briquettes over that secured by the use of the usual ores. Moreover, the trial proved that the consumption of limestone is reduced from 30 per cent. to 12 per cent. of the charge of ore, with a corresponding reduction in the quantity of fuel used.

The question has frequently been asked: How can this system of concentration be made commercially profitable with its elaborate plant and its frequent rehandling of the material? The answer is, that the principle of labour saving, by the adoption of automatic appliances, which has enabled American industries to compete successfully against the world, is here carried out to its fullest development in every part of the works. In the mining, with its giant 83-ton shovel; in the "giant rolls" crushing; in the elevators running at a speed of 250 feet per minute; and in the system of magnetic separation, there is a minimum of manual and a maximum of mechanical labour.

Costly and elaborate as the plant may be, it is noteworthy that about 5,000 tons of ore per 20 hours can be mined, crushed and concentrated with a working force of only 125 men per shift. From the time the deposit of ore is loosened by blasting ready for the steam shovel to the time when the concentrated result is shipped on the cars in the shape of briquettes ready for the blast furnaces, the material never once calls for manipulation by hand.

Herein lies the promise and potentiality of this latest and most radical development in the mining and metallurgy of iron.

NOTES.

The General Electric Company.—On Saturday evening last the staff of the General Electric Company, Limited, held its eighth annual dinner and smoking concert in the Empire Room of the Trocadero Restaurant. Some 160 ladies and gentlemen were present, the guests being numerous, and more or less well known in electrical circles. In proposing respectively the toasts of the "Guests" and the "Staff," Mr. Gustave Byng and his brother Max developed a talent for witticisms which would have done credit to Scotchmen; and Mr. Bevis, in reply to the second toast, gave an impromptu address on three-phase working which took all the scientists present by surprise at the very simplicity of the system. The banquet was followed by a well-arranged smoking concert, and the humorous ditties, especially those of a cerulean hue, had an immediate effect upon a certain transient luminous body, which, uneasy during the early hours of the evening, speedily found peace and happiness in Paradise regained. At the time we made the acquaintance of Mr. Gustave Byng, some 16 years since, he had been guilty of reading a paper before a society which shall be nameless, and in a place where he would scarcely venture now, and his staff consisted of his brother and an office boy. To-day the General Electric Company's employés number some 1,600 all told, and it is not a little curious to observe how the figures 1 and 6 enter into this brief notice of a successful firm. Employers (and here we take the opportunity of including Mr. Hirst, who has just returned to convalescence after a serious illness) and employed, are alike to be congratulated on the gigantic undertaking which has been evolved from such a small beginning.

The Glasgow Technical College Electrical Engineering Laboratory.—Owing to the liberality of Mr. George Weir, late of the Holm Foundry, Cathcart, who resigned his directorship of the Technical College when he went to Australia, the above laboratory has recently been presented with a delicate Sullivan's universal galvanometer for the measurement of voltages, currents, and resistances. This galvanometer, as we have already pointed out, possesses several novel qualities, and is equally well suited for use on board a telegraph ship and a laboratory on shore.

Smoking Concert.—A staff smoking concert of the City of London, Metropolitan, and London Electric Lighting Companies will be held at the Freemason's Tavern, Great Queen Street, Holborn, W.C., on Friday, February 18th, at 7.30 p.m. Hon. secretary, Mr. A. W. Whieldon, 64, Bankside.

Electric Power from the Shannon.—It is stated that a company has been formed to utilise the water power of the Shannon for the development of electricity. The directors of the company, which is called the Shannon Electric Power Syndicate, Limited, are Lord Lurgan (chairman), Colonel Sir Gerald Dease, J. F. Bannatyne, D.L., Vere Ward Brown, and Richard W. Booth. It is proposed to construct a canal from a point above Castleconnell to the outlet below Doonass, to provide for storage of a certain volume of water in Lough Derg during the summer, and the company are in communication with the Limerick Fishery Board, so that fishery rights on the river may not be interfered with by the intended scheme.

Royal Institution.—At Tuesday's meeting the special thanks of the members were returned to Mrs. Tyndall for her liberal donation of £1,000, presented in the name of the late Dr. John Tyndall, D.C.L., F.R.S., for the promotion of science. Thanks were also returned to Sir Frederick Abel, Sir Andrew Noble and Prof. Dewar for donations to the fund for the Promotion of Experimental Research at Low Temperatures. It was announced that the centenary of the Royal Institution would be celebrated next year.

Municipal Electrical Association.—Mr. A. B. Mountain, the secretary of this association, informs us that at a meeting of the Council of the Municipal Electrical Association, held at the Westminster Palace Hotel on Friday, the 28th ult., Mr. A. H. Gibbings was (as stated in the Electrical Review last week) elected president for the year 1898. It was decided to hold the Convention in London on June 8th, 9th, and 10th, papers having been arranged upon the following subjects: Management of Electrical Undertakings; Repayment of Loans and Appropriation of Profits; Uniformity of Plant and Apparatus; Electric Traction; The Use of Accumulators in Connection with Lighting and Traction Systems; Switchboard Apparatus; Auxiliary Apparatus; Stand-by Supply. Mr. J. E. Stewart, of Derby, was elected a member of the council, and the following applications were considered and approved. Elected as members: T. A. Chamen, Glasgow; J. E. B. Thornhill, Taunton; H. W. Clayden, Morley; T. H. Minshall, Croydon; A. L. C. Fell, Sheffield; Electric Lighting Committee, Stockport; Electric Lighting Committee, Morley. Elected as associates: D. McFarlane McLeod, Aberdeen; P. S. Thompson, Huddersfield; W. N. Legge, Halifax; A. Sugden, Halifax.

City and Guilds of London Institute.—The students of Finsbury Technical College will hold their annual conversazione at the above College on the 18th inst. Dr. Thompson has promised to lecture on "Wireless Telegraphy." Mr. Ives will give an exhibition of colour photography, and glow-lamp making will be demonstrated by Mr. Robertson.

The Royal Society.—The following was among the papers to be read before this society yesterday afternoon: W. G. Rhodes.—"Contributions to the Theory of Alternating Currents."

Appointment Vacant.—The Crown Agents for the Colonies want an electrical engineer in connection with the working of an electric light plant at Lagos, West Coast of Africa, for six months at £25 per month. See our "Official Notices."

Coventry Technical Institute.—Prof. Ayrton gave the address at the annual meeting and prize distribution in connection with the Coventry Technical Institute, on Friday. He urged that British manufacturers should be more enterprising in inducing wants in the people. He referred to the progress of electrical traction in America, and remarked that while the steam locomotive had given way to the electric motor on American modern overhead railways, the use of electric traction on the underground railway in London, where it was of more pressing necessity, was only under consideration. The substitution of electric traction for horse traction in the streets might interfere at first with the employment of some people, like stablemen, harness makers or corn dealers, but ultimately the number of people employed by the practical application of scientific principles in the development of electric traction, would certainly be enormously increased.

Webb Testimonial.—The executive committee are now issuing to contributors resident in the United Kingdom and Ireland invitations to the Presentation Reception which will be held at 9.30 on Monday, the 21st, at the Whitehall Rooms of the Hotel Metropole, immediately after the dinner already announced.

Northern Society of Electrical Engineers.—The annual dinner of this society is to take place at the Grand Hotel, Manchester, on Thursday, 17th inst., Mr. Raworth presiding.

Lectures.—A lecture on "Earthquakes and Other Movements of the Earth's Crust" was delivered by Prof. John Milne, F.R.S., on 3rd inst., before the Wolverhampton Literary and Scientific Society.

At the Wakefield Mechanics Institution, on Monday last week, Mr. H. Scholey delivered a lecture on "Some Modern Applications of Electricity." The lecturer showed numerous experiments in electric lighting, transmission of electrical power, electric welding and smelting, and electrodeposition of metals, and interest was added to his remarks by several lantern slides, showing the progress which had been made in electric lighting and traction within the last seven years. Mr. Scholey had the loan of apparatus from the General Electric Company, the Lithanode Company, Mr. F. J. Borland, Messrs. Cuttriss Wallis & Co., and the Electric Metal Working Syndicate.

Before the Glasgow Architectural Association on 25th ult., Mr. W. B. Sayers delivered a lecture on "Electric Light, Heat and Power: their Efficient Installation and Cost."

At a meeting of the Aberdeen Mechanical Society in Robert Gordon's College, on 1st inst., Mr. Alfred Blackman, city electrical engineer, read a paper on "Public Electricity Supply."

Obituary.—We hear with deep regret of the death of Mr. G. K. Winter, F.R.A.S., which occurred at Madras on January 17th. Mr. Winter joined the Madras Railway Company in the year 1864, and had, therefore, completed a long period of service in India. He was telegraph superintendent of the Madras Railway Company from its very commencement. To him that company was indebted for its "block" system. He had several patents for block signalling instruments, and his system was employed not only on the Madras, but other railways in India, New Zealand, and South America. His latest invention was the improvement of the electrical block ticket service apparatus which is now being taken up. We learn that experiments with his inter-communication system are now being conducted in England, several carriages being now in progress of fitting up for the purpose of a Board of Trade inquiry. Previous to going out to India, he was assistant to Mr. W. T. Ansell, in Ireland, for the Electric and International Telegraph Company. The deceased gentleman was a member of several electrical and other scientific institutions, and 25 years ago he contributed a paper to the British Association on "The Use of Electromagnetic instead of Electrostatic Induction in Cable Signalling." He was a valued contributor to the ELECTRICAL REVIEW as long ago as 1872. Mr. Winter was in failing health last year, and came home for a few months' leave. He returned to India feeling better, but he had only been back on Indian soil a couple of months when the end came.

FORTHCOMING EVENTS.

1898.

Friday, February 11th.—Second day of the annual general meeting of the Institution of Mechanical Engineers, at 25, Great George Street. Discussion on Mr. Philip Dawson's paper on "Mechanical Features of Electric Traction." A paper and discussion on "First Report to the Gas Engine Research Committee; Description of Apparatus and Methods, and Preliminary Results," by Prof. Frederic W. Burstall.

Physical Society (rooms of the Chemical Society, Burlington House). Annual General Meeting at 5 p.m.—Address by the President. After which at an Ordinary meeting: "On Electro-magnetic Induction in Plane, Cylindrical and Spherical Current Sheets, and its Representation by Moving Trails of Images," by G. H. Bryan, M.A., F.R.S.

At 9 o'clock. Royal Institution, Albemarle Street, W.C. "The Metals used by the Great Nations of Antiquity," by J. H. Gladstone, Ph.D., D.Sc., F.R.S., &c.

At 8 o'clock. Institution of Civil Engineers (Students). "Protection of Power Transmissions from Lightning," by J. T. Morris.

Monday, February 14th, at 8 o'clock. Northern Society of Electrical Engineers, at Palatine Hotel, Victoria Street, Manchester. Paper by Mr. J. G. Statter, on "Electric Cranes."

Yorkshire College Engineering Society. "The Steam Turbine Engine, and its Applications," by J. D. Baillie (C. A. Parsons & Co.).

Latest date for Redditch Corporation electric lighting plant tenders.

Wednesday, February 16th.—Liverpool Engineering Society, Royal Institution, Colquitt Street. Paper by Dr. J. H. T. Tudsbery, M.I.C.E., on "Engineering Survey Work."

At 8 o'clock.—Society of Arts, "The Protection of Industrial Property," by J. F. Iselin, M.A., LL.M.

At 7 o'clock.—Third of Prof. Thompson's course on "Electro-deposition," at the City and Guilds Technical College, Finsbury, E.C.

At 12 o'clock.—The last of Mr. Mervyn O'Gorman's three lectures on "The Design and Testing of Power Cables for Specific Purposes," at the Central Technical College.

At 7.30 p.m.—Institution of Electrical Engineers. Students' meeting, Mr. F. K. Jewson will read a paper on "Telephones and Telephonic Apparatus."

Thursday, February 17th, at 8 o'clock. Chemical Society, Burlington House. Papers to be read:—"Some Lecture Experiments," J. Tudor Cundall, B.Sc. "Observations on the Influence of the Silent Discharge of Electricity on Atmospheric Air." W. A. Shenstone and W. T. Evans.

At 7 o'clock. Annual dinner of the Northern Society of Electrical Engineers at the Grand Hotel, Manchester. Mr. J. S. Raworth will preside.

Friday, February 18th, at 6.30 p.m.—Institution of Electrical Engineers. Students' visit to the generating stations of the St. Pancras Vestry. Applications to join this party should be made at once to the Students' Hon. Sec. (Mr. S. Grant, 28, St. Mary Abbot's Terrace, W.)

Finsbury Technical College Conversazione. Lecture on "Wireless Telegraphy," by Dr. S. Thompson, &c.

At 7.30 p.m. Staff smoking concert of the City of London, the Metropolitan, and the London Electric Lighting Companies, at the Crown Room, Freemason's Tavern, Great Queen Street, Holborn, W.C. Chairman, Mr. P. W. D'Alton.

Tuesday, February 22nd.—The Federated Institution of Mining Engineers, 26th general meeting at Newcastle-upon-Tyne. Various papers on mining matters are to be read, and among those to be open for discussion are the following: "Light Railways," by Mr. Leslie S. Robinson. "A One-rail or Trestle System of Light Railway," by Mr. Fred. J. Rowan. "On Some Dangers attending the Use of Steam Pipes," by Mr. A. L. Steavenson. "Machine Coal-mining in Iowa, U.S.A.," by Mr. H. Foster Cain. "Latest Developments and the Practical Application of Alternating Multiphase Machinery for Power Transmission," by Mr. Walter Dixon. Visits will be paid to the Telegraph and Telephone Departments at the General Post Office, Mr. A. W. Heaviside, Superintending Engineer.

Wednesday, February 23rd.—Second day of the Federated Institution of Mining Engineers. Various excursions, including visit to the works of Ernest Scott & Mountain, Limited, Newcastle-on-Tyne.

CITY NOTES.

Cambridge Electric Supply Company, Limited.

THIS company continues to show most striking progress, and it has now reached the prosperous state indicated by a 6 per cent. dividend. We have more than once pointed out the difficulties that this company has to contend with in the shape of a curious load, and the success achieved under the peculiar conditions prevailing in Cambridge amply demonstrates the soundness of electricity supply business generally. The increase in the year's output has not been especially marked, it being only 12 per cent. upon that of the previous 12 months.

The following are the chief points in the directors' report:—

During the year 1897 there has been added to the company's mains, the equivalent of 2,562 8-candle-power lamps, making the total 21,195. The number of units supplied has been 221,507, an increase of 23,992 or 12 per cent. The total cost of coal has been diminished by 5½ per cent. 42 new consumers have been added, making the total 329.

The capital expenditure for the past year has been £5,872 11s. 4d.; 2,027 yards of main conduit pipe and cable have been laid down, making the total at present 15,298 yards. To insure the continuity of supply in the event of an accident to any one line a duplicate system of distribution has been nearly completed, a large amount of the cable laid has been for this purpose.

During the year the mains have been extended from the end of Regent Street as far as Norwich Street and Harvey Road, a sub-station having been built to supply this district. Preparations have been made to convey the mains to Madingley Road in order to supply the new Presbyterian College, now building, and the district.

The company after paying all charges, placing £400 to the reduction of preliminary expenses, and £300 to depreciation account, has a balance of £2,460 19s. 10d., which, added to £278 19s. 7d. brought forward from last year, makes £2,739 19s. 5d. An interim dividend of £953 9s. 10d. and interest on debenture and temporary overdraft £48 1s. 8d., have already been paid, leaving a net balance of £1,738 7s. 11d., out of which the directors recommend the payment of a dividend of 3½ per cent., making, with 2½ per cent. already paid, 6 per cent. for the year. This will absorb £1,445 11s. 1d., leaving a balance to carry forward of £292 16s. 10d.

The following table gives the cost per unit:—

	1897.	1896.
Total capital expended...	£48,922	—
Number of units sold	221,507	—
Number of lamps connected	21,195	—
Revenue from sale of current	£5,856	—
Net revenue	£2,461	—
Average price obtained per unit ...	6·3d.	

Cost of Production.	£	s.	d.		Per unit.
Coal	1,099	0	0		1·19d.
Oil, waste, water, and engine room stores	134	0	0		·14d.
Salaries and wages at generating station	803	0	0		·87d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	417	0	0	Works' cost 2·65d.	·45d.
Rent, rates and taxes	339	0	0		·36d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges and insurance	669	0	0		·72d.
Depreciation of buildings and plant account	—				—
Renewal fund account	—				—
Total	£3,461	0	0		3·73d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	5,858	0	0	—
Meter rents, &c.	293	0	0	—
Other items	473	0	0	—
Total	£6,624	0	0	—

Total cost per unit (exclusive of depreciation and renewal accounts), 3·73d.; works' cost, 2·65d.

The Electric Lighting Companies' Dividends.

The following are the complete dividends of electric lighting companies up to the moment of going to press:—

London.	1897.	1896.	1895.	1894.
	%	%	%	%
Charing Cross and Strand Electricity Supply	7	6	5	—
St. James' and Pall Mall	14½	10½	7½	6¼
Westminster	12	9	7	5
Provincial.				
Cambridge Electric Supply Company	6	5	3½	—
Newcastle-upon-Tyne Electric Supply Company	7	5	—	—
Scarborough Electricity Supply Company...	5	—	—	—
Yorkshire House-to-House Company	6	6	5	4

The St. James' and Pall Mall Electric Light Company, Limited.

The ordinary general meeting of the shareholders of this company was held on Tuesday last at the offices, Carnaby Street Central Station, Golden Square, W., Mr. Eustace J. A. Balfour in the chair.

The Chairman, in proposing the adoption of the report and accounts, said: "Gentlemen, before I ask you to pass the resolution, I will just briefly go through a few points, and I will ask any gentleman afterwards who may have any questions to ask to put them to me, and I will endeavour to answer them satisfactorily. The working of the past year, as you will have seen by the accounts, has been, on the whole, very satisfactory. At the end of the year we have 126,000 8-candle-power lamps connected, being an increase of about 18,000 for the year, and there is reason to believe that with the growing increase in popularity of electricity, both for lighting and power purposes, this rate of increase will not only be fully maintained, but largely exceeded. Recognising that such an increase will be best obtained by reducing from time to time the price to consumers, the directors have had put into force, from January 1st, a new rate, by which 6d. per unit is charged for the first £100 of the annual bill, and 4d. per unit for the rest, while all electricity for motive purposes is charged 3d. per unit. The St. James' Company now stands ahead of all other companies as regards its works' cost and total cost per unit sold, and we think this is a very creditable position for a company like this, which is by no means the biggest in the metropolis. Out of the profits of the year the directors propose to pay a dividend of 14½ per cent. We see at once that this dividend will excite a certain amount of criticism from local authorities and other consumers, and, perhaps, others interested; but, in reply to this, I want to point out that the average price of 5d. per unit, which the board will receive for the current year, is a fair and reasonable one, and considerably below the statutory price, and below the charges made by most other Metropolitan electric light companies. The ordinary, and, in fact, the total capital of the company is exceedingly small for its output, as compared with other companies, and the directors hold that the shareholders are entitled to a fair return as the result of careful expenditure and good management. Moreover, this dividend of 14½ per cent. is fictitious, for under the articles of association the founders' rights compel a division of the whole of the surplus without allowing for any reserve—a very necessary item in a business of this description. Happily for all parties an agreement with the founders—subject to your approval to-day—is practically settled, and the company will then be at liberty to provide a proper reserve fund, which will render the credit and dividends of the company more stable. I think it should be clearly understood that we have a lease of life of only 35 years from this year. The investment, therefore, is rather like a leasehold investment, in which you would not only expect a fair return for your money, but would also expect to be able to put by such a sum as at the end of those 35 years would leave you where you stood before you made the investment. It should also be borne in mind that, although we have very little in the way of precedent to go upon as to the price at which a concern of this kind would be purchased, yet what little precedent we have in the case of the County Council and the tramways is absolutely against the probability of our receiving anything at all for the goodwill of the concern; it would simply be a valuation of the buildings, plant, and machinery and property. Therefore it should be recollected that a 14½ per cent. dividend does not, and should not, represent the true earnings of the company. It appears on the face of it to be a very large figure; but if we were able, as we shall be able I hope in the future to deduct from that money to form a redemption fund, then I hope no local authority, or any of our customers will have any just grounds for complaint, and at the same time, of course, the shareholders will be benefitted to exactly the same extent as they are at present. The extension of the Carnaby Street station will shortly be completed, and the company will then have a total horse-power of over 6,000, with mains of sufficient capacity to carry the full output, and it is anticipated that with this provision, the company's works can be carried on with the existing stations for two further winter seasons. The directors attribute a large portion of the success of the company to the fact that it has been their policy to keep their resources, in the way of plant, &c., well ahead of their requirements, so that they have been able to deal with their customers promptly, and to carry out alterations in their system without interfering with the supply. Following out this policy, it has become necessary to provide at once for further extensions of the company's work, so that it may be ready before their present resources are outrun. The directors have therefore secured a valuable freehold site in every way most suitable for the most economical generation of electricity, and they are now carefully considering the best methods of dealing with this extension in the best interests of the shareholders. As the negotiations are necessarily very delicate, the directors trust that the shareholders will be satisfied with this statement, that in all future issues the policy of the directors of giving a preferential allotment to their own shareholders will be continued, and before raising any large amount of capital they will take an opportunity of putting the scheme very fully before the shareholders. I have nothing more to add, but, as I said, I shall be very happy to answer any questions that may be put to me."

Mr. Latimer Clark seconded the resolution.

Mr. Foster said he noticed that £12,000 of the proposed new shares of £5 each were to be issued to the holders of the founders' shares, but he should like to know to whom the balance of 8,000 would be allotted, and at what price? According to the articles of association, the directors were entitled to 10 per cent. on the interest paid, which, for the past year, amounted to £3,000. They had, however, only credited themselves in the accounts with £2,500. Was that to be taken as a precedent?

The Chairman replied that apart from the proposed issue to the founders in exchange for founders' shares, all issues of capital were governed by the articles of association, which provided that "subject to any direction to the contrary that might be given by the meeting that sanctions an issue of capital, all new shares shall be offered to the members in proportion (as nearly as conveniently can be), to the existing shares held by them."

Mr. Foster enquired if the privilege would be extended to new shareholders.

The Chairman said it would apply to all on the register at the time of the issue. As to the directors' fees, he said that the action of the board this year in taking less than the sum to which they were entitled, was not to be considered as a precedent.

Mr. Bowin thought the shareholders would like to know the intentions of the directors with reference to the proposal made some time ago for reducing the interest on the debenture stock of 3½ per cent.

Mr. Leaf, one of the directors, said the reason the board made the proposal referred to by Mr. Bowin, was that they thought they were paying too much. So soon, however, as they had settled matters with regard to the founders' shares and the new extension site, they hoped to be able to deal with the interest on the debenture stock.

The resolution was carried unanimously.

The retiring directors were then re-elected, as were also the auditors.

An extraordinary general meeting followed, at which, on the motion of the Chairman, seconded by Mr. Latimer Clark, the resolutions passed at a recent extraordinary general meeting, approving of an agreement with the founders' shareholders, and an increase of the capital to £300,000, were unanimously confirmed.

Anglo-American Telegraph Company.

The ordinary general meeting of the proprietors of the above company was held on Friday last at Winchester House, Old Broad Street under the presidency of Mr. F. A. Bevan, the chairman.

Mr. P. H. Wells (the secretary) having read the advertisement convening the meeting, the report was taken as read.

The Chairman, in proposing the adoption of the report, said he had very few observations to make. As they had probably observed, the report itself contained very little, and happy was the country that had no history. However, he was glad to say that what he had to tell them was of a cheerful nature. For the first time since 1884 they were able to declare a dividend of 3 per cent. upon the ordinary stock, which meant the maximum dividend of 6 per cent. on the preferred stock. He thought that was matter of congratulation, especially when they took into account that it did not arise from any spasmodic increase of traffic, but that it was the result of a steadily-growing traffic, which had been increasing during the last four or five years. He would give them the figures as to the share that came to the Anglo-American Company out of the pooled traffic during the last four years. Four years ago the figure stood at £284,000; the next year it was £307,000; the next £326,000, while in the year they were now reviewing, it was £354,000, which gave an increase of £70,000 in four years, while during the same period the expenses had remained practically at the same figure, viz., £111,000, so that the shareholders had reaped the full benefit of the increase of traffic. But notwithstanding that large increase of traffic, the directors would not have been able to pay a 3 per cent. dividend, unless they had been helped by what he might call a considerable amount, from the work of their repairing ship, *Minia*. In the first half of the year, the *Minia* earned for them £8,455, and in the last half, £2,820, making altogether £11,275, and he would like to impress upon the shareholders that but for that windfall, as he might call it —for they could not calculate that they would always make that amount out of their repairing ship—they would not have been able to pay the dividend of 3 per cent. The shareholders would be glad to know that the current year had opened very well, and that the receipts for January were a record over every other January that they had ever had, and therefore they began this year with things looking very well. One, of course, could not predict that that increase would continue, but they might fairly hope that this current half-year would be a good one. He would now compare the figures of the last half-year with those of the corresponding six months in 1896. For the half-year under review, their total net increase of receipts was £9,258 7s. 10d., and the increase of expenses was only £371 16s. 8d.; but he might add that the increase in the expense of repairs of cables amounted to £469 9s. 3d., and therefore, but for that increase, there would have been an actual decrease in the expenses. They brought forward to the current half-year £6,704 0s. 8d. more than in the corresponding half of 1896, so that they had available for dividend £15,590 more than at that period. The dividend in February, 1896, was at the rate of 29s. per cent.; what they now proposed was at the rate of 33s. 6d. per cent. That meant an increase of £15,750, rather more than the figure he had given above, so that they carried over £159 8s. 2d. less than they did in the corresponding period of last year. He thought the shareholders would consider those statements very satisfactory. Coming to the renewal fund, he would remind them that the directors attached very great importance to that fund, which, in their opinion, was not as yet at all equal to what it should be, taking into consideration the fact that their cables were getting older each year, and that the two oldest cables were 24 and 23 years old, so that if they had to replace one of those cables they would have at once to spend a very large portion of the renewal fund. During the past year they had only added £33,000 to the fund, for though, according to their usual practice, they had taken £24,000 from the revenue, and the interest amounted to another £20,000, they had had to spend £11,000 in repairing their 1880 cable, so that the net result was that they had only added some £33,000 to the fund. It now amounted nominally to £760,000 odd, which was only about 10 per cent. of the capital, and he ventured to express the hope that no shareholder would suggest to the directors that they should in any way cease from maintaining that reserve fund, but that the shareholders would back the directors in continuing to add to it. Regarding the investment of the fund, a portion of it constituted their working capital, and some was invested in their leasehold premises at the end of Throgmorton Street. They had over £600,000 invested, but the market value would be considerably in excess of that sum. But looking at all the circumstances; to the age of their cables, and that they had no other fund to apply to, he trusted they would agree that the fund was by no means too large, and his (the chairman's) own opinion was that it was not nearly large enough. He was glad to be able to say that their cables were all in good working order, except a short cable on the other side, which broke down since the report was printed. But that was really a matter of no moment, and when the proper time came it could be mended without difficulty. He was also able to say that their traffic had never been carried better than it was now, and that the staff had never been more efficient. Since he last addressed them, he had had an opportunity of visiting the station at Valencia, and was very much pleased with all he saw there. One of the oldest men in their employ—Mr. Graves, was superintendent there, and a most valuable man he was. He had got together a staff of very efficient workers, and all that he saw there of the work gave him great satisfaction. It was in great part owing to the efficiency of their staff that they were able to maintain the traffic, and therefore increase the dividend.

Sir Gerald Fitzgerald, K.C.M.G., seconded the motion.

Replying to a short discussion, the Chairman said the policy of the board was to carry on the company, and do what was best for the good of the shareholders generally, irrespective of what were called the rights of preferred or deferred shareholders. He had all along been of opinion that it was a mistake to have split up the stock, but at the time it was forced upon the directors by the shareholders, so that the board were not responsible for it.

The report was then adopted.

Sir Gerald Fitzgerald and Mr. C. Burt, the retiring directors, were re-elected, and the auditors were also re-elected for the current year.

Newcastle-upon-Tyne Electric Supply Company, Limited.

The directors' report to the tenth general meeting of the shareholders states that the demand for electricity continues to improve satisfactorily, the units sold having been 660,906, against 535,953 last year. The total profit for the year, including the balance brought forward from last year, represents a sum of £5,059 10s. 3d. Out of this the directors recommend a dividend at the rate of 7 per cent. per annum for the year, on account of which an interim dividend at the rate of 5 per cent. per annum was paid on July 15th last. The total dividend will absorb £3,144 15s. 6d., leaving a balance of £1,914 14s. 9d., which the directors have dealt with as follows:—

	£	s.	d.
(a) In writing off the preliminary expenses in connection with the recent increase of capital sanctioned last year	62	15	0
(b) In increasing the reserve and depreciation account to £2,200 by a further sum of	1,200	0	0
(c) In carrying forward to next year the balance of ...	651	19	9
	£1,914	14	9

In order to meet the developments rendered necessary by the constantly increasing demand for electrical energy, it is intended to issue, at once, part of the new capital sanctioned at the last general meeting. The directors recommend that the shares be offered to existing shareholders *pro rata* at a premium of £1 10s. per share: the amount of this premium to be added to the fund for depreciation and reserve. The directors feel themselves greatly indebted to the Durham College of Science for assistance in scientific questions on various occasions in their past history, and they desire to receive authority from the shareholders to make an annual subscription of not exceeding £50 to that institution.

The Cuba Submarine Telegraph Company, Limited.

The report of the directors for the half-year ending December 31st, 1897, to be presented at the fifty-third ordinary general meeting of shareholders, to be held on February 16th, 1898, states that the gross receipts amount to £19,167 7s. 9d., and the gross expenditure to £6,602 10s. 9d., leaving a sum of £12,564 17s., which, added to the balance of £3,317 9s. brought from the last account, leaves £15,882 6s. at the credit of revenue account. The sum of £4,827 17s. 1d. has been added to the reserve fund, together with £1,274 7s. profit on investments realised, while £17,830 4s. 10d. part cost of the new Manzanillo-Santiago cable, and £271 19s. 3d. for repairs have been charged to this account, leaving a balance of £106,000 to its credit. The dividend on the preference shares will absorb £3,000 and leave £8,054 8s. 11d., out of which the directors recommend the payment of a dividend on the ordinary shares at the rate of 6 per cent. per annum, free of income-tax, the balance, £3,254 8s. 11d., being carried forward to the current half-year. The traffic receipts show a decrease of £9,662 17s. 9d. as compared with the corresponding period of last year, due principally to the loss of the French company's traffic, which is now conveyed by that company's new line between Hayti and New York, as explained in the report of December 31st, 1896. The directors much regret that, owing to the falling off in the receipts, a reduction in the rate of dividend on the ordinary shares has become necessary. In consequence of the establishment of the new line between Bermuda and Jamaica—subsidised by the British Government on the basis of a charge of 3s. per word between the United Kingdom and Jamaica—the Cuba Company have been compelled to accept reduced rates which will result in a considerable loss of income. The new cable between Manzanillo and Santiago, referred to in last report, is now being laid, and on the completion of this work the vessel will proceed to the repair of the Cienfuegos-Santiago 1881 cable. The other sections of the company's cables have continued in good working order throughout the half-year, with the exception of some slight repairs to the harbour lengths at Santiago.

United Ordnance and Engineering Company, Limited.

The prospectus of the above company (with which is incorporated the business of Easton, Anderson & Goolden, Limited), has been before the public this week. The authorised capital is as follows: £275,000 in £1 5½ per cent. cumulative preference shares; £275,000 in £1 ordinary shares; £250,000 4½ per cent. first mortgage debenture stock. The whole of this £800,000 has been offered for subscription. The company is formed:—

1. To manufacture and sell guns, gun carriages, ammunition, and war material, and to carry on business as electrical, hydraulic, mining, and general engineers.

2. To acquire a licence dated November 19th, 1897, granted by Messrs. Schneider & Co., of Creusot and Havre, the celebrated manufacturers of guns and war material, to manufacture and sell the Schneider-Canet artillery.

3. To acquire and take over as a going concern the undertaking of Easton, Anderson & Goolden, Limited, the well-known engineers, of Erith and London.

The last item (3) is arranged in order to lessen the delay inseparable from the establishment of new works. Messrs. Easton, Anderson and Goolden's premises and plant are valued by Messrs. Fuller, Horsey, Sons & Cassell in a report dated April, last year, as follows:—

Freehold engineering works, with fixed and loose plant (exclusive of goodwill), £202,257.

Messrs. W. P. Peat & Co., value the stocks, stores, and assets of the undertaking in hand on June 30th, 1897 (exclusive of goodwill), £154,955, making the total £357,212, which sum is subject to liabilities at June, 1897, amounting to £35,956.

The business has been carried on from June 30th, 1897, down to December 31st, 1897, from which date it is to be taken over by the company, on the account and at the risk of Mr. Ernest Terah Hooley, who will indemnify the company against any risk of loss arising from the recent engineers' strike and lock-out, or otherwise during that period. The agreement for the purchase of this business provides that Messrs. Wilson & Baynes, directors of Easton, Anderson and Goolden, Limited, shall be appointed managing directors of the company for a period of five years. In addition to the manufacture of ordnance and war material, the company will continue, develop and extend the general engineering business of Easton, Anderson and Goolden, Limited, and in connection therewith special attention will be devoted to electrical traction and electrical transmission of power, in both of which branches there will undoubtedly be great developments, both at home and abroad, in the immediate future. Several important schemes have been submitted to Easton, Anderson and Goolden, Limited, and will be carefully examined by the directors of this company.

The directors of the company are Admiral Sir H. F. Nicholson, K.C.B., H. McCalmont, M.P., F. Elgar, LL.D., F.R.S., Charles Cammell, Colonel Paget Mosley, T. Perceval Wilson (chairman of Easton, Anderson & Goolden, Limited), a managing director: H. K. Baynes (director of Easton, Anderson & Goolden), a managing director. The secretary is Mr. W. E. Davies, and the registered office is at Broad Sanctuary Chambers, Westminster, S.W. The list closed on Wednesday, 9th inst.

Liverpool Overhead Railway Company.

The ordinary half-yearly general meeting of the Liverpool Overhead Railway Company was held on Tuesday, 8th inst., at the Law Association Rooms, Cook Street, Liverpool. Sir Wm. Forwood, chairman of the company, presided.

The report showed that the gross revenue receipts for the half-year amounted to £37,583, and the working expenses to £24,240, after deducting the interest on mortgage debentures; and adding the balance of £3,810 brought forward from the previous half-year, there was £13,753 available for dividend. Out of this it was proposed to pay dividends of 5 per cent. on the preference shares, and 3½ per cent. on the ordinary shares, leaving £2,878 to be carried forward to next half-year.

The Chairman, in moving the adoption of the report and accounts, said he had pleasure in being able to congratulate the shareholders upon the progress and position of the company. In the corresponding half of last year they paid a dividend of 3 per cent. per annum, and last half-year 3 per cent., making 3¼ for the year with the dividend recommended that day. During the year they had paid to the Liverpool Tramway Company £2,000, in conformity with the terms of their agreement with them. That agreement had now come to an end, having terminated on the 10th of last month. There had been an increase in the traffic during the past six months of 545,000 passengers, or, for the year, of 1,078,000. Part of that increase was due to the opening of the Dingle Station, at the south end. They carried last year 8,736,000 passengers, the number they carried in the first completed year after the opening of the railway being 5,400,000, so that they had increased by 3,200,000 passengers—a rate of progress in five years which he had no doubt they would consider eminently satisfactory. They had run during the half-year 371,000 miles, against only 320,000 in the corresponding half of last year. They were keeping the expenditure carefully in hand. Their ratio of revenue to expenditure worked out at 64·54 per cent. That might strike them as being rather high, but when they eliminated the amount carried to renewal and contingent funds, and the amount paid to the Tramway Company, neither of which were fair charges upon the traffic, their traffic expenses were reduced to 56 per cent. of the revenue, which he thought was a very reasonable and moderate figure. The expenditure per train mile during the half-year was 15·65d., against 15·67d. in corresponding half of last year. The revenue per train mile was equal to 24·25d., against 23·79d., which was a slight increase. The locomotive expenditure was 3·71d., against 3·68d. per train mile—practically the same. They endeavoured to maintain the efficiency of the line in every way, and it was to-day in better condition from one end to the other than five years ago, when it was opened to the public. The electrical equipment was also maintained in the highest state of efficiency, and though it but cost a little more to revenue, they felt they would be recouped fully by doing so. They had now £10,700 to the credit of the renewal and contingent funds. The traffic upon the south extension was showing a very satisfactory growth. The complaints which had formerly been made as to the lighting of the carriages had received attention, and during the past fortnight the booster they had ordered had come to hand, and would be placed in position at the south end, so that, he was glad to say, the light was now as steady as possible. Their experience of the booster would make them get one for the north end also. All the carriages had now been heated with electric heaters, and were now very comfortable. When it was borne in mind that they only charged 3d. for a journey that would cost 13d. on the London and North-Western Railway, it would be seen that they were doing a great public service.

Mr. Richard Hobson seconded the motion.

The Chairman, replying to Mr. Menzies, who said he did not think a dividend of 3¼ per cent. per annum, was a sufficient rate of progress, said they were paying the dividend this year entirely out of profits. Of course a railway company could not be measured by any industrial concern; it was not expected to pay at any time large dividends. He thought the growth of the line had been very satisfactory. If they had had no payment to make to the tramway company, the dividend would have been perhaps 3¾ per cent. He had no doubt the line would pay a larger dividend in the future.

The motion was then carried unanimously, and it was also agreed to pay the dividends referred to above.

Messrs. Edward Lawrence and G. H. Robertson were re-elected directors.

The Chairman, replying to a vote of thanks to the directors for their services, said he would like to remark upon how much they valued the services of their very excellent engineer and manager, Mr. Cottrell. They were largely indebted to him for his zeal and watchfulness. Very few men in this country had his technical knowledge of electricity, and he had also great tact and organisation in dealing with working men, which were very valuable qualities.

The proceedings then terminated.

The National Telephone Company, Limited.

The report of the directors for the half-year ending December 31st, 1897, to be presented to the shareholders at the twenty-first ordinary general meeting of the company, to be held at the City Terminus Hotel, Cannon Street, London, on Thursday, February 17th, 1898, at 1 o'clock p.m., reads as follows:—

"The income accrued in respect of the business of the half-year amounts to £507,602 17s. 3d., as compared with £439,978 2s. 4d. for the corresponding period of 1896, being an increase of £67,624 14s. 11d. The working expenses for the half-year amount to £283,085 12s. 11d., as compared with £245,278 13s. 9d. for the corresponding period of 1896, being an increase of £37,806 19s. 2d. The net result for the half-year (after deducting the Post Office royalties amounting to £46,059 16s. 8d.) is a profit balance of £178,457 7s. 8d., as compared with £154,982 8s. 4d. for the corresponding period of 1896, being an increase of £23,474 19s. 4d. The rentals carried forward for unexpired terms of running contracts amount to £473,586 17s. 10d., as compared with £414,714 9s. 8d. at the corresponding period of 1896, or an increase of £58,872 8s. 2d.

"Out of the available balance of £156,435 8s. 5d. shown by the net revenue account (No. 3) the board will recommend the payment of a dividend at the rate of 6 per cent. per annum, less income-tax, on the first and second preference shares, 5 per cent. per annum, less income-tax, on the third preference shares, and 6 per cent. per annum, free of income-tax, on the ordinary shares. The board also propose to transfer £40,000 to the reserve fund, and to carry forward the balance of £10,034 3s. 5d.

"Capital Expenditure.—The sum of £267,375 1s. 3d. has been expended on capital account during the half-year, partly in the erection of 5,633 additional exchange and private lines and partly in the construction of underground lines in substitution for overhead wires in several important places. Notably in Manchester, the corporation of that great centre of industry were the first to realise the many advantages to the commercial community to be secured by the concession, upon reasonable terms, of the necessary powers, and as a consequence the entire system of underground mains in that area has been completed. The financial burden cast upon the company is considerable, but the board have faced it in the confident belief that greatly increased efficiency will lead to a corresponding extension of the use of the telephone. Similar concessions having been made by the authorities of Belfast, Birmingham, Blackburn, Bradford, Bristol, Dublin, Dundee, Leeds, Liverpool, Nottingham, Portsmouth, Sheffield, and other leading cities and towns, the underground works in these places are being proceeded with as rapidly as possible. In the interest of the more perfect intercommunication between subscribers in the several localities, which must immediately result from the change of system, it is to be hoped that other important places will speedily follow the enlightened lead of the great telephonic centres above enumerated.

"It having been determined that the valuable services of Mr. Alderman Joseph Thompson could be more advantageously absorbed in a more specific attention to the affairs of the company in Manchester, where he is so generally known and appreciated, he was good enough to undertake those duties, and a vacancy in the board resulted. This has been filled by the election of the Rt. Hon. Sir Henry Hartley Fowler, G.C.S.I., M.P., whose residence in and long connection with the very important telephone area of which Wolverhampton is the centre, appeared to justify his being invited to join the board in the interest alike of the company and the public."

Westminster Electric Supply Corporation, Limited.

The report of the directors states that the business of the corporation continues to make satisfactory progress. The supply of current which, on December 31st, 1896, was provided for the equivalent of 249,318 lamps of 8-C.P., had increased by December 31st, 1897, to the equivalent of 290,561, and at the present time there are on circuit the equivalent of 292,883 lamps of 8-C.P., and applications have been received for a further 10,886. The length of roadway in which mains have been laid now exceeds 44 miles, making about 180 miles of ways, into which upwards of 152 miles of copper (strip and cable) have been drawn.

The extension of the central stations, rendered necessary in consequence of the increase in the business of the Corporation, as reported at the last general meeting, has been proceeding during the year, and the board are glad to be able to report that the additional buildings and plant are now nearly completed. The plant and machinery have been working satisfactorily throughout the year, and have been fully maintained from revenue, and the directors consider that, although the economical working of the stations has been greatly affected by building operations, it is satisfactory to note that there is no increase in the cost per unit generated.

As stated in their last report, the board had approached the holders of the founders' shares, and had agreed with them a scheme for cancelling the founders' shares, but on further consideration it was found that difficulties might arise thereafter, and an amended scheme was proposed, in accordance with resolutions passed at special meetings of the shareholders called for that purpose. Your directors have pleasure in stating that, owing to the way in which they were met by the holders of the founders' shares, those shares have ceased to exist, and all the shareholders are now on the same footing.

The net revenue of the year amounts to £49,461 3s. 10d. An interim dividend, at the rate of 8 per cent. per annum, for the half-year ending June 30th, 1897, has been distributed. The balance to the credit of the account is £34,013 17s. 5d.; the board, therefore, recommend the payment of a dividend at the rate of 16 per cent. per annum, less income-tax, for the past half-year, making 12 per cent. for the year ending December 31st last, carrying forward a balance of £3,119 4s. 1d.

The directors having considered the question of provision of future capital, gave notice to pay off the present mortgage debentures bearing interest at the rate of 5 per cent. and 4½ per cent. per annum on March 1st next, and have created new first mortgage debentures of £250,000, bearing interest at the rate of 3½ per cent. per annum. Of this amount £200,000 has been issued, and after providing for repayment of the old debentures, the balance will be expended in further plant and machinery, and the extension of existing stations. The board much regret that owing to the issue having been subscribed four times, they were unable to make any allotment to a large number of applicants.

Portrush and Giant's Causeway Tramway Company.

The twenty-second ordinary meeting of this company was held on 1st inst. at Portrush. Dr. Anthony Traill presided. After the routine business the directors' report was submitted and adopted. It stated: "Your directors have to report a falling off in the receipts during the past year, as compared with those of the year of 1896. In the passenger traffic there has been a decrease in numbers, the total number being 79,015. This falling off has arisen from the interference of the Board of Trade with our electric traffic, and from the unusual wetness of the summer season."

The Dublin United Tramways Company (1896), Limited.

The report of the directors submitted to the meeting held at the Imperial Hotel, Lower Sackville Street, Dublin. The directors submit the accounts for the half-year ended December 31st, 1897. The receipts amount to £19,250 1s. 6d. from the Dublin United Tramways Company, and £3,581 15s. from the Dublin Southern District Tramways Company, making, with the balance brought from last half-year, and the profit on Bank of Ireland Stock, sold, £23,409 7s. 5d. at credit of revenue account. Deducting mortgage debenture interest, £1,429 9s. 2d., and directors' fees, £450, a sum of £21,529 18s. 3d. will remain available for division. Out of this sum the directors have declared a divided at the rate of 6 per cent. per annum on the preference shares, and at the rate of 4 per cent. per annum on the ordinary shares, leaving a balance of £922 18s. 6d. The section of the Clontarf line from Dollymount to Annesley Bridge has been worked by electricity since November 11th last, with very satisfactory results, and it is expected that within the next few months the electric cars will be running to Nelson's Pillar from Annesley Bridge on the north side, and from Haddington Road (Dalkey line) on the south. The new line connecting Rathmines with Ball's Bringe *viâ* the Appian Way and Pembroke Road, is being constructed. A Bill to permit of increased speed on the Haddington Road and Dalkey line is being promoted by the Dublin Southern District Company, and the directors expect that it will successfully pass through Parliament.

Waterloo and City Railway Company.

Mr. Wyndham S. Portal presided yesterday over the eighth half-yearly meeting of the shareholders of this company held at Waterloo, and in moving the adoption of the report said that the whole of the share capital, £540,000, had now been received, and the total outlay, up to December 31st last, had amounted to £473,776, which included £25,000 for interest paid to the shareholders during the construction of the line. The directors hoped to be able to arrange with the London and South-Western Railway Company for bringing the line into use by the middle or end of next month.

Col. Campbell seconded the motion, and the report was adopted.

The City of London Electric Lighting Company, Limited.—Gross revenue return, quarter ended December 31st, 1897. Gross revenue from sale of current for public lighting (after deduction of allowances), quarter ended December 31st, £3,119; corresponding quarter last year, £2,970. Gross revenue from sale of current for private lighting (after deduction of allowances), &c., quarter ended December 31st, £59,796; corresponding quarter last year, £53,399. Gross revenue from other sources (estimated), quarter ended December 31st, £2,000; corresponding quarter last year, £1,000; total, quarter ended December 31st, £64,915; corresponding quarter last year, £57,369; increase £7,546. Equivalent of 8-C.P. lamps connected on December 31st, 1897, 296,012; increase during quarter, 17,850. Equivalent of 8-C.P. lamps connected on December 31st, 1896, 247,785; increase during corresponding quarter last year, 19,045.

British Electric Traction Company.—The Electric and General Investment Company have offered for subscription a first issue by the British Electric Traction Company, Limited, of 10,000 6 per cent. cumulative preference shares, of £10 each, at £12 10s. per share. The share capital of the latter company is £600,000, in equal proportions of 6 per cent. cumulative preference and ordinary £10 shares, and the undertaking was, the prospectus states, formed in November, 1896, to acquire the business of the British Electric Traction (Pioneer) Company, and to develop electric traction in the United Kingdom and elsewhere. It is pointed out that all the ordinary shares (30,000) have been subscribed and paid up in full, and that applications from holders of these for the present issue will be preferentially considered. The subscription list opened on Tuesday, and was to close yesterday.

The Edison and Swan United Electric Light Company, Limited.—The directors have resolved that a payment on account of the dividend of the current year be made at the rate of 5 per cent. per annum, less income-tax, on the "A" shares of the company, in respect of the half-year ended December 31st, 1897. This will work out at 1s. 6d. per share on the partly paid £5 shares £3 paid, and 2s. 6d. per share on the fully-paid £5 shares, less income-tax. The payment will be made upon the register as it stands this day, and the dividend warrants will be issued on the 24th inst.

W. T. Henley's Telegraph Works Company, Limited.—The directors have resolved to recommend a dividend at the rate of 12 per cent. per annum on the ordinary shares, including the interim dividend of 3 per cent. paid in September.

Metropolitan Electric Supply Company, Limited.—A meeting of the holders of founders' shares of this company was held at Winchester House on Tuesday, but our representative was informed that the meeting was private.

Stock Exchange Notices.—The committee have ordered to be quoted in the Official List:—Direct West India Cable Company, Limited—£120,000 4½ per cent. registered debentures, Nos. 1 to 1,200.

Telegraph Construction and Maintenance.—The directors announce a further dividend of 10 per cent., making 15 per per cent. for the year 1897.

TRAFFIC RECEIPTS

The City and South London Railway Company. The receipts for the week ending February 6th, 1898, were £1,068; week ending February 7th, 1897, £1,128; decrease £60; total receipts for half-year, 1898, £6,456; corresponding period, 1897, £6,611; decrease, £155.

The Liverpool Overhead Railway Company. The receipts for the week ending February 6th, 1898, amounted to £1,283; corresponding week last year, £1,241; increase, £42.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 4th, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company. Limited, were £2,856.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, Feb. 2nd.	Closing Quotation, Feb. 9th.	Business done during week ended Feb. 9th, 1898. Highest.	Lowest.
137,400*l*	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	...	...	100 104	100 —104	...	...
25,800	Amazon Telegraph, Limited, shares...	10	...	...	...	6 — 7	6 — 7	...	...
125,000	Do. do. 5% Debs. Red.	100	...	...	...	93 — 96	93 — 96	...	...
923,960*l*	Anglo-American Teleg., Ltd.	Stock	£2 9s.	£2 13s.	3 %	62 — 64	62 — 64	63⅝	63½
3,038,020*l*	Do. do. 6 % Pref.	Stock	£4 18s.	£5 6s.	6 %	112½ - 113½	113 – 114	113⅜	112⅞
3,038,020*l*	Do. do. Defd.	Stock	...	...	...	13¼ – 13¾	13¼ – 13¾	13⅞	13¼
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	...	...	16¾ – 17¼	16¾ – 17¼	17	16 15/16
75,000*l*	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	...	...	112 –116	112 –116	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	4 %	4 %	...	3 — 3½	3 — 3½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	...	187 —192	187 —192	197	...
653,586*l*	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	106 —108	106 —108	107½	106½
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	2 %	...	1/16 – 3/16	1/16 – 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	...	8 — 9	8 — 9	8⅝	...
6,000	Do. 10 % Pref.	10	10 %	10 %	...	18 — 19	17½ - 18½	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	...	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	...	10 — 11	10 — 11	...	...
30,000*l*	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	...	103 – 106%	103 —106%	...	...
60,710	Direct United States Cable, Ltd.	20	2½%	2½%	...	10½ – 11	10¾ – 11¼	11¼	10⅞
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	...	18 — 18½	18 — 18½	18⅜	18 1/16
70,000	Do. 6 % Cum. Pref.	10	6	6%	...	19 — 20	19 — 20	19 1/16	19
89,900*l*	Do. 5 % Debs., repay. August, 1899	100	5 %	5%	...	100 —103 xd	100 —103	...	...
1,302,615*l*	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4%	...	131 – 134	131 —134	133½	131¼
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7%	...	18¾ – 19¼	18¾ - 19¼	19	18¾
25,200*l*	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5%	... ...	99 - 103	99 –103	...	...
100,500*l*	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5%	...	100 - 103	100 —103	...	...
320,000*l*	Do. 4 % Deb. Stock	Stock	4 %	4%	...	130 —133 xd	130 —133	...	...
51,100*l*	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5%	... ...	99 - 103	99 —103	101¾	...
69,200*l*	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5%	...	100 —103	100 —103	...	...
300,000*l*	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1906	100	4 %	4%	... ...	102 – 105 xd	102 —105	...	...
200,000*l*	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4%	...	108 —111 %	108 —111%	109	108½
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	...	12 — 12½xd	12 — 12½	12½	12⅛
180,042	Do. do. 6 % Pref.	10	6 %	6%	...	17¾ — 18¼xd	17¾ - 18¼	18 3/16	18
150,000	Great Northern Teleg. Company of Copenhagen	10	10 %	10%	...	27 — 28	27 — 28	...	...
160,000*l*	Do. do. do. 5 % Debs.	100	5 %	5%	...	101 —104	101 —104	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10%	...	52 — 55	52 — 55	...	...
100,000*l*	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6%	...	108 —111	108 - 111	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	...	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5½%	5½%	6 %	6¾ — 7	6¾ - 7	7	6⅞
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	14 — 16	14 — 16	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6 — 6½	6 — 6½	6⅝	6 3/16
130,766	Do. do. Nos. 119,235 to 250,000, £5 paid	5	...	...	5 % ...	6 — 6½	6 — 6½	...	...
329,471*l*	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	104 —109	104 —109	106	104¾
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	⅝ — ¾	⅝ — ¾	...	...
100,000*l*	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	... ...	105 —108	105 —108	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	8 — 9	8 — 9	8	...
3,381	Submarine Cables Trust	Cert.	...	...	...	140 – 145	140 – 145	142	...
58,000	United River Plate Teleph., Ltd.	5	4 %	...	...	4 — 4½	4 — 4½	...	...
146,733*l*	Do. do. 5 % Debs.	Stock	5 %	...	...	101 —106	101 —106	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	nil	...	4 — 5	4 — 5	...	...
213,400*l*	Do. do. do. 5 % Debs.	100	5 %	5 %	...	103 - 106	103 —106	...	...
64,268	Western and Brazilian Teleg., Ltd.	15	3 %	2 %	...	10½ - 11	10½ - 11	10¾	10⅝
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	...	7½ — 8	7½ - 8	7 13/16	7⅝
33,129	Do. do. do. Def. Ord.	7½	1 %	...	...	3½ — 4	3½ — 4	3 13/16	3⅝
382,230	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	105 —107	105 —107	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅜%	1 %	...	½ — ¾	½ — ¾	11/16	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	7¾ — 8¼	7¾ — 8¼	8¼	7 13/16
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	5 — 7	5 — 7	...	...
80,000*l*	Do. do. 5 % Debs. No. 1 to 1,600 ...	100	5 %	5 %	...	105 – 108	105 – 108	...	...
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7%	...	105 —110	105 —110	...	...
160,100*l*	Do. do. 6 % Ster. Bonds.	100	6 %	6%	...	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	1895.	1896.	1897.	Closing Quotation, Feb. 2nd.	Closing Quotation, Feb. 9th.	Highest.	Lowest.
30,000	Charing Cross and Strand Electy. Supply	5	5 %	6 %	7 %	14 — 15	14 — 15	14⅝	14
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6¼ — 6¾	6¼ - 6¾	6⅝	...
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	...	11¼ — 11¾	11¼ — 11¾	11 13/16	11½
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	4½%	4½%	...	112 —114	112 —114	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	7 %	...	29½ - 30½	28½ — 29½	29½	28¾
10,000	Do. do. Prov. Certs.	5	...	...	...	29 — 30	27½ — 28½	28½	27½
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	...	17½ — 18½	17½ - 18½	18 1/16	17⅞
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	...	129 —134	129 —134	132½	...
30,000	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—30,000	10	nil	nil	...	15¾ — 16¼	15¾ - 16¼	16⅛	15¾
20,009	Do. do. do. 6% Pref., 40,001—60,000 ...	10	6 %	6 %	...	15¾ — 16¼	15¾ — 16¼	16⅛	15 13/16
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5	...	..	...	10½ — 11½	10½ — 11½	10 13/16	...
10,000	Do. do. 7 % Cum. Pref. ...	5	...	...	...	11½ — 12	11½ — 12	...	..
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	4 %	5 %	...	20 — 21	20 — 21	20¾	20½
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem. ...	10	...	...	...	19½ — 20½	19½ — 20½	...	...
220,000*l*	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	117 —121	117 — 121	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	2 %	4 %	...	18 — 19	18 — 19	...	...
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,000	5	7½%	10½%	14½%	18 — 19	18½ - 19½	...	...
20,000	Do. do. 7 % Pref., 20,981 to 40,000	5	7 %	7 %	7 %	10 — 11	10 — 11	10⅞	...
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	4 %	101 —104	104 —107	...	...
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2⅞ — 3⅛	2⅞ — 3⅛	3 1/16	2 15/16
79,900	Westminster Electric Supply Corp., Ord., 101 to 80,000 ...	5	7 %	9 %	12 %	18 — 19	18 — 19	18⅜	17⅞

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first par of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation Feb. 2nd.	Closing Quotation, Feb. 9th.	Business done during week ended Feb. 9th, 1898. Highest.	Lowest.
30,000	British Electric Traction	10	...	...	...	18½— 19	17½— 17¾	18⅞	17½
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	2	...	...	...	2⅛ - 2⅜	2⅛— 2⅜	2 3/16	2⅛
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	...	...	2⅛— 2⅜	2⅛— 2⅜	...	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock... ...	Stock	...	...	...	109 - 113	109 —113	...	...
50,000	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	102 —105	102 —105	...	...
19,126	Central London Railway, Ord. Shares	10	...	...	...	9¾— 10¼	10 — 10½	10¼	10
143,106	Do. do. do. £6 paid	10	...	...	...	5¾— 6¼	5¾— 6¼	6¼	6
58,830	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1¼— 1¾	1¼— 1¾	1⅝	1½
61,777	Do. do. Def. do. £5 pd. ...	...	...	...	...	4¼— 4¾	4¼— 4¾	4⅝	4½
630,000*l*	City and South London Railway	Stock	1 3/16%	1 3/16%	1⅞%	69 — 71	69 — 71	70¾	70
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	...	...	2¼ - 2¾	2¼— 2¾	...	...
99,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 99,261	5	5 %	5½%	...	2½ - 3	2½— 3	2⅞	2¾
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5½%	...	4½ - 5½	4 — 5	4⅞	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	5 %	6 %	...	2¾ - 3xd	2¾— 3	2 15/16	2¾
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 ...	2	7 %	7 %	...	3⅛ - 3⅜	3⅛ - 3⅜	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	...	...	...	½ - ¾	½— ¾	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	...	...	...	½ - ¾	⅜ - ⅝	...	..
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	10½%	...	...	9 - 11	9 — 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	8 %	10 %	12 %	21½ 22½	22½ - 23½	23½	22¾
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	19 — 20	19 — 20	19½	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½%	110 115	110 —115	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	...	22½ - 23½	22 — 23	22½	22¼
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	103 —107	103 —107	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	2⅞%	2⅞%	...	11 5/16 - 11 7/16	11¼ - 11⅜	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	...	16 — 16½	16 — 16½	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	15 %	15 %	39 — 42	39 — 42	40¾	39½
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105	...	...
54,000*l*	Waterloo and City Railway, Nos. 1 to 54,000	10	...	...	...	13½— 14	13½— 14	14	13⅞

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0°/₀; 1891—7°/₀; 1890—8°/

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

* Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 11.

Electric Construction Corporation, 6 % Debentures, 104—106.

House-to-House Company, 4½% Debentures of £100, 111—112.

Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 16—16½; 1st Preference Cumulative 6 %, £5 (fully paid), 8¼—8¾. Dividend, 1896, on Ordinary Shares 7 %.

London Electric Supply Corporation, £5 Ordinary, 4½—4¾.

* T. Parker, Ltd., £10 (fully paid), 12⅜.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8—8½. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount 3 per cent. (October 14th, 1897).

THE WATT ANNIVERSARY.

At the recent James Watt anniversary dinner of the Institution of Engineers and Shipbuilders in Scotland, Lord Kelvin proposed "The Memory of James Watt" in the following terms:—He had, he said, to thank them for their kindness in allowing him to propose the toast on this great occasion. They had referred to the connection of James Watt with the University of Glasgow. In the apparatus room of the Natural Philosophy Class there now was, he might remind them, the model which Watt was employed by the University to repair in some minor details, when, in considering it, he saw not only what should be repaired, but some of the defects of the principles which it realised, and was led on from that small beginning to the great work which they were met to commemorate. The 19th century, in the eyes of engineers—and if in the eyes of engineers, then in the eyes of the whole world—was the century of James Watt. There were engineers before James Watt. Happier than the men who lived before Agamemnon, their memory was not lost in obscurity for want of the sacred bard and prophet and historian to commemorate their deeds. Tubal Cain was a great mechanical engineer, whose name was a household word in Scotland in the end of the 19th century. Poets and historians had chronicled the works of Archimedes. Skipping 10 centuries, or rather skipping 20 centuries, we came to Smeaton, the man who led up towards the mechanical developments which Watt perfected. Of all the 60 centuries of recorded human history no century had been so great as the 19th in engineering, in the work of applying the laws of matter, and the principles of science for the benefit of mankind. We almost forgot there was engineering before this century. Steam navigation came into existence at Dalswinton Loch, in the East of Scotland, and Symington's boats, after their first trial in 1798, were placed a few years later on the Forth and Clyde Canal. That was the beginning of marine engineering, and what was marine engineering now? It had covered the whole ocean with the works of English engineers. By England he meant—he always meant—England, Scotland, Ireland, India, Canada, and all the other British colonies. Engineers counted other names along with the name of James Watt as being noteworthy in the annals of the 19th century—the names of Faraday and Carnot and Joule. These had all done great things to make the latter end of the 19th century worthy of its beginning with James Watt. The steam engine of James Watt and of the 19th century, was it to be the engine also of future centuries? The latter part of the 19th century opened up new vistas in the application of the works of science, led up to by Watt, and Carnot, and Regnault, and Joule. No man would have been readier than Watt to see the possibilites of other means of producing power than steam. Steam, electricity, and the means of development on which electricity depended would, he was sure, have engaged his attention and admiration, and he would have worked for the promotion of anything that could improve the steam engine. He (Lord Kelvin) believed that we should have ships driven by steam power for at least 100 years yet. We might safely say, so long as our coal supply lasted—a good many hundred years—steam power would keep alive directly the results of the labours of James Watt. He would not prophesy that in any respect, even for land use, other agents would supersede steam, or that the 20th century would be the century of oil and gas and internal combustion engines. Engineers, however, should be interested in the question—"Was the internal combustion engine going to supersede the steam engine?" Whether it did so or not, for any larger application than we now had the gas engine, we should have no less reason to be grateful to James Watt. At the end of the 20th century his name would, he believed, be received with as much respect and gratitude as it now was. In pure science Watt was a leader. He (Lord Kelvin) remembered that his great master in physical science, Regnault, had "la loi de Watt," the law of Watt, with relation to the latent heat of steam always upon his lips. It was a matter of great joy and perpetual pleasure to the University of Glasgow that it had had the honour of having given Watt encouragement in the early days of his studies, and that in his workshop at the University, the Scientific Society, the Philosophical Society, and the Physical Society came into existence. These had been the parents of many similar societies all over the British dominions, with what tremendous benefits to mankind they all knew. Let them think of living now as compared with living 100 years ago. Some people asked, were we happier or better by reason of these wonderful inventions and discoveries? People, he might reply, were happy and good, and sometimes neither happy nor good, during the 60 centuries that preceded James Watt. But we had social advantages now that no human being had before 1800—the advantage, for one thing, of being kept continually in touch with our friends. Engineers did not look upon the application of their craft merely from a mechanical point of view. They knew that their steamers and railways were of great direct benefit to humanity. He had in his pocket a telegram from

India describing the recent eclipse. It read—"Eclipse well seen, also red flames and Baily's beads. Some very fair photographs. The whole party well satisfied." The message reached him the forenoon of that day. The writer, a man 80 years of age, went all the way to India to see the eclipse, and to try to contribute something to the knowledge to be obtained from it. The telegraph, some might say, was not one of the benefits derived from James Watt's labours. He said it was, because without the marine engine and steam navigation they could never have had the ocean telegraph, which in itself was a great blessing to the world. The world to-day was happier and better in every respect for the work of James Watt, and he asked them all to receive with due honour the toast of his memory.

THE PACIFIC CABLE.

(*Concluded from page* 164.)

The Eastern Extension Company represents a combination of associated companies engaged in telegraph transmission between England and Australasia. The lines of the company comprise those of three amalgamated companies:

1. The "British Indian Extension," from Madras to Singapore, with a share capital of £460,000.

2. The "British Australian," from Singapore to Australia, with a share capital of £540,000.

3. The "China Submarine," from Singapore to Hong Kong and Shanghai, with a share capital of £525,000.

The combined share capital of these three companies amounted to £1,525,000. On their amalgamation the united share capital, by a well-known process of "watering" to the extent of £472,500, was increased nominally to £1,997,500. The united company, since known as the Eastern Extension Australasia and China Telegraph Company, Limited, has been exceedingly prosperous; it has paid 7 per cent. on the enlarged capital, equal to 9 per cent. on the original capital. An examination of the published statement establishes that it has in addition expended out of the profits earned, no less a sum than £1,571,540 on extensions and other productive works, and there remains unexpended and undivided to-day a reserve of surplus profits amounting to £804,193.

These figures establish that the Eastern Extension Company has become a remarkably profitable investment. It regularly pays good dividends, but the dividends are no guide to the profits made. It holds in reserve undivided profits far exceeding in amount the whole value of its cables between Asia and Australia. The accounts of the company for 1896 and the first half of 1897 show that the net profits actually earned during these periods amounted to 13 per cent. on the present capital, and 17 per cent. on the capital prior to its being watered.

The company is unwilling to have this state of affairs changed. They know perfectly well that the telegraphic traffic is steadily increasing, and that as the traffic grows the profits will become still greater. It is easy, therefore, to understand why the company has never viewed with friendly feeling the proposed Pacific cable. Its managers are not willing to divide the business with the new line. They must retain it entirely in their possession. They have secured a rich monopoly, and their desire is to make it even more profitable, and to strengthen and perpetuate it.

The Pacific cable has been projected in no spirit of hostility to any company or to any country. It has been advocated as a means of extending to the whole Empire the advantages derivable from the geographical position of the Dominion. Canada offers the connecting link in an Imperial chain of telegraphs encircling the globe. When the project is completed, it will bring the mother country into direct electrical connection with every one of the great possessions of the crown in both hemispheres, without touching the soil of any foreign power. Thus it cannot fail, in a high degree, to promote Imperial unity. Indeed, it is difficult to conceive how a perfect union, or any union of the whole, is possible without union between the parts. The whole Empire is in strong sympathy with the aims and aspirations which a few years back were limited to a few men of advanced thought. The historical event of last June has shown to the world that "the British people are one people, animated by one spirit." It is recognised that we are approaching the period when new relations may be established between the United Kingdom and those younger British communities beyond the seas, known in past history as colonies, but which are passing from colonial tutelage to a higher national status. In order to promote these closer relations, what is more desirable, what more necessary, than that each and all be connected by the appliances which art and science have devised? Canada stands first among the British communities of the outer Empire. Scarcely second to Canada we look forward, in no long period, to welcome the kindred Dominion of Australia, comprising under one federal government half a dozen colonies, each possessing great potentialities. What more in harmony with the spirit of the British people than that Canada and Australia be brought in close communion? Is it not indispensable to vital public interest that those two great units of the Empire—the island continent in the South Pacific and British North America, should possess the means of instantaneous communication, one with the other?

The proposition of the Eastern Extension Company submitted to the Conference of Premiers has no such purpose in view. Its object is indeed the very opposite. While the consolidation of the Empire *demands that* the Queen's subjects in Canada and Australasia shall *possess all the* advantages which the closest telegraphic connection can effect, the policy which animates that company would cause these communities to remain severed. Is such a policy to be commended? Does not the Eastern Extension Company when persistently exercising its manifold and widely ramified influence to keep Canada and Australia disunited, assume an attitude of hostility to both countries and to Imperial unity?

In the interests of the Eastern Extension Company the Pacific cable has been declared to be impracticable; its cost has been greatly exaggerated; it has been denounced as a work which could not be maintained without burdensome subsidies; it has been stigmatised as inimical to telegraphy and trade; and it has been decried and misrepresented in every possible manner. The explanation is to be found in the fact that the company is unwilling to relinquish its monopoly and to rest satisfied in the future with a reasonable return for capital invested. On this point the writer is tempted to quote a single paragraph from his address at the Colonial Conference of 1894 as given in the proceedings (page 85).

"The progress and well-being of Canada, Australasia, and the Empire cannot be retarded in order that the lucrative business of a private company may remain without change. Even if the chairman of the Eastern Extension Company succeeded in converting us to his commercial ethics, that the profits of the monopoly he represents must be maintained inviolate, it does not follow that the project of a Pacific cable would not be carried out in some form, even if Canada and Australasia abandon it. There are indeed unmistakable signs that a Pacific cable may shortly be carried out by France and the United States. We all know that France has already completed a section of 800 miles at the southern end, and the United States has recently expended $25,000 in making an elaborate survey of about one-third the whole distance from San Francisco (to the Hawaiian Islands.) With a rival line in foreign hands, it is easy to see that the Eastern Extension would gain nothing, while the Empire would lose much."

With respect to the objections raised by the Eastern Extension Company, they have been completely refuted. The very best evidence shows beyond all question that the project is perfectly feasible, that the cable should be established as a State work, that, so established, the revenue from business obtainable will be ample to meet every charge, including working expenses, maintenance, renewal, interest on cost and sinking fund to replace capital; that in fact, the cable can be established in the most satisfactory manner, and that all its advantages can be attained without any cost whatever to the taxpayer. That the prospects are of this character is attributable to these facts, viz.:

1. As a State work, the capital employed would be obtained at the lowest possible rate of interest.

2. The capital would be limited to the necessities of actual expenditure in establishing the work; there would be no possibility of enlarging the capital account by adding "promotion expenses" or by "watering stock" in any form.

3. No dividend would require to be declared, or bonus paid. Revenue would only have to meet ordinary charges, including interest on the actual cost at a low rate, possibly $2\frac{1}{2}$ per cent.

4. Remunerative traffic which would be controlled by the Australasian Government already exists.

5. Such traffic is continually growing, and it is difficult to assign a limit to its growth.

6. The facilities created and the reduced charges would open up a new and profitable business across the Pacific which would be subject to the new line.

Such being the case, the question may be asked, is there any reason other than the opposition of the Eastern Extension Company why the establishment of this important national work should be farther delayed? It must be admitted that the Pacific cable in operation would put an end to the monopoly of the Eastern Extension Company and diminish the immense profits it enjoys. As, however, less than half the whole traffic would prove remunerative to the Pacific cable, there would remain ample business to the company to yield a good return for the capital invested.

In the memorandum laid before the House of Commons last July by the Secretary of State for the Colonies, it is distinctly indicated that, while the Home Government is willing to co-operate with Canada and the Australian Colonies, the Imperial authorities are unable to see the way to take the initiative, and that they "now await definite proposals from the Colonies interested before proceeding further in the matter." It unfortunately happens that the Australasian Colonies remain under the disadvantage of being disunited politically, and they are not all equally in favour of the Pacific cable, Western Australia and South Australia being somewhat in sympathy with the Eastern Extension Company. New Zealand, New South Wales, Queensland and Victoria desire to have the cable laid on the Canadian route. As the traffic to make it a profitable undertaking would have its source chiefly in these colonies, and, moreover, the land lines within each colony are owned by each respective Government, they have it in their power to control the trans-Pacific telegraphic traffic to the extent required to make the cable a profitable undertaking.

At this distance it is not easy to understand why these four colonies do not agree to take some definite line of action. It is now close on six months since the Premiers met in London, and, as far as known, they have not seen their way to agree on any joint proposal, owing, doubtless, to unexplained local difficulties.

Under these circumstances it is not improper to consider if there be any duty or obligation resting on us in Canada. The Dominion is now looked up to as the elder brother in the British family of kindred nationalities. If, as Canadians, we have faith in our destiny as no inconsiderable element of the great Empire, are we not called upon again to take the initiative? The mother country awaits a proposal. It cannot well come from disunited Australasia. If we are to be brought within speaking distance of the kindred communities in the southern seas, the first impulse must come from ourselves. Shall the opportunity which circumstances have presented be seized, and another proof given to the world that "Canadian Government and people are determined, in all ways, to promote Imperial unity?"

SANDFORD FLEMING.

A SURVEY OF THE POSSIBILITIES OF ELECTRIC HEATING AND COOKING.*

By W. P. ADAMS, A.K.C., A.I.E.E.

(*Concluded from page* 163.)

THERE is one direction in which one might anticipate a large development of electric cooking, and that is in flats. If architects will arrange for a general hot-water supply for the whole building, as I believe is now done in many cases, electric cooking presents such an advantage that an important movement in this direction should take place when the supply companies are convinced of the advantage of charging such prices as will be generally acceptable. I think I have said sufficient to indicate that even with electricity at 3d. per unit, electric cooking is not extravagantly expensive, and if its other great advantages are taken into consideration, particularly the economical results from the perfection of the cooking, it ought to be received with prompt favour.

I am hoping that before long those responsible for electricity supply will begin to make a definite move in the development of electric heating and cooking. It is not sufficient to merely reduce the price of electricity to a reasonable figure, as many of the Corporations have already done, but steps should be taken to induce people to become users of electricity for other purposes than lighting. The hire system, which the gas companies are much in favour of, should be adopted where possible. One of the difficulties which has been met with in the attempt to develop electric heating is the high first cost of the apparatus. This is largely owing to the comparatively small output of heating apparatus at the present time, and is also owing in no small degree to the many different voltages which the goods have to be made up for. You will probably be surprised to learn that there are no less than 14 different voltages in general use at the present time, and you will quite appreciate that this does not tend towards the cheapening of the appliances.

I have little doubt, if supply companies are prepared to give this matter their careful attention, that mutually satisfactory arrangements might be come to between themselves and manufacturing firms so as to meet these difficulties.

I have now to consider the practicability of using cooking and heating plant in connection with plant installed for lighting residences and factories.

In very few and well-arranged and properly-managed private installations does the cost exceed 4d. per unit, and in residences where accumulators are used it would simply mean running the plant a few hours a day extra if electric cooking apparatus were adopted.

In factories where large electric lighting plants are in use, the same argument holds good. The probability is that the generating engines are supplied with steam from the main boiler system, and the man in attendance on the general machinery is expected to look after the electric lighting plant. The cost of generating electricity during the daytime for cooking meals for the staff of this establishment, and perhaps for the employés, is, in such a case, almost a negligible quantity.

I must here make a small digression to call your attention to the curious ideas some people hold with regard to electric cooking. An establishment in Liverpool has just installed a large and economical plant for electric lighting purposes, and it had been proposed to the owners that they should use it during the daytime for cooking purposes. I was asked by the electric light contractors to loan some apparatus for testing, and the conditions being distinctly favourable, this was done. A little later I was informed that the committee would not adopt electric cooking. I was anxious that the test should have been made under my supervision, but it was not thought necessary for me to be present. Inquiries were made, and I found that the committee itself had superintended the experiments, and had insisted upon the food being placed on the appliances before current was turned on. As one of the elementary rules of cooking is that the apparatus should be heated up to the proper temperature before the food is placed upon it, you will understand that such an experiment was foredoomed to failure. I relate this instance as an illustration of the common idea that electric cooking apparatus is capable of doing things which no one would think of expecting from ordinary cooking apparatus, and simply for the reason that the word "electric" is used in connection therewith. Every electrical engineer, at one time or another, has met with peculiar ideas of this sort.

There is nothing, of course, nothing magic about electric heating and cooking appliances. The advantages which we claim for them are: (1) That they are more economical in point of heat utilised than any other appliances; (2) that they are quite without equal in point of cleanliness and general convenience; (3) that there is practically no waste of material in the cooking; (4) that by their means cooking is reduced to a simple science, and absolutely uniform results can be obtained, this being due to the ease with which the heating effect is controlled by switching. In the oven it is usual to fix a thermometer, indicating on a dial on the front of the door, and given temperatures can be maintained within a few degrees. I might further claim that such appliances are perfectly free from such dangers as attend the use of gas cookers. Explosions are impossible, and the risk of fire is nil.

I must now beg of you to spare me a few minutes for the consideration of electric heating by radiators.

I have already indicated at the commencement of this paper that this subject requires consideration from quite a different point of view to electric cooking. Assuming for the moment that there is likely to be any large development, you will at once observe that this will bring no load to the stations during the summer time, and, owing to the large amount of current the radiators consume, they will make the winter load heavy. It may be that persons who adopt electric cooking may be inclined to use the apparatus during the summer time only, on account of its coolness, in the same way as people now adopt gas ovens, returning to the use of the kitchen range in winter. If this were done to any large extent it would probably meet the difficulty, and it might even be desirable for supply companies to give special terms for the use of electric cooking appliances in summer, and increase these charges during the winter. Whether such a plan is feasible or not will have to be ascertained as the problem develops.

When estimating roughly what current radiators are to be wound for, for a given space, I generally assume that 500 watts will be necessary per 1,000 cubic feet of space, in the coldest weather. This, of course, is only a very rough guide, and in every case the general conditions must be taken into consideration. In my office in the City, which has a capacity of 2,000 cubic feet, with one outside wall almost entirely consisting of window space, I rarely use a larger radiator than one absorbing 600 watts. In very sharp weather I have found it necessary to put two of these on for the earlier part of the morning, and sometimes on Mondays, after a continued frost extending over Saturday and Sunday. In this instance it will be seen that a less quantity is required than 500 watts per 1,000 cubic feet of space. In the case of a building with several thin outside walls, and other unfavourable conditions, probably more than the 500 watts would have to be provided for.

With radiators consuming this amount of energy you will appreciate that electric heating is not likely to receive much support when such charges as 8d. per unit are made. At the beginning of last year I was requested by an architect to fit nine radiators in a spacious office in the city. The firm was a wealthy one, and expense was not considered an important matter owing to the convenience of the electric radiators. I pointed out before the order was placed that the cost of current would probably be very high; but, notwithstanding my warning, it was decided to have the radiators fixed. After they had been running for three or four months I was informed that the cost was so excessive that their use would have to be discontinued. With one or two small exceptions these are the only radiators ever installed in the city of London; and, while the prices are maintained at the present figure, little development is likely to take place; and yet the City is an almost ideal place for the use of electric radiators, owing to the fact that the bulk of the offices close at an early hour, and that the occupiers are willing to pay a good price for so convenient and sanitary means of heating as electric radiators provide.

Experience shows that even at so high a figure as 3d. or 4d. there is considerable demand for electric radiators, and this is not surprising when one considers that the heat produced is of exactly the quality that one could desire. It is not sufficiently high to deprive the air of its moisture. There are no products of combustion to vitiate the atmosphere, and the radiators are turned on and off with the same ease as the electric light.

I cannot now make detailed mention of the smaller heating appliances, but I think that their employment is one worthy of some consideration by supply companies. If they are at all largely adopted, they would be of value in increasing the day load, and it is likely that they would be employed at times when the cooking apparatus would not be in use. Take, for instance, the electric kettle. Each kettle takes from 300 to 500 watts, and they are mainly used for preparing tea in the afternoon. It is conceivable that, if used in large numbers, they would help to fill up the somewhat awkward dip in the curve occurring about 3 or 4 o'clock in the afternoon, after the hot cupboards and plates had gone out of use.

In conclusion, I will ask you to be as lenient as possible when passing judgment upon this paper. I am well aware that I have been guilty of some temerity in venturing to read a paper upon a subject about which there is so little practical knowledge. My excuse for doing so is, that I believe there is a reasonable probability of considerable development in this direction in the near future; and I hope that the figures which I have placed before you may help electrical engineers and others interested to understand better the claims that this branch of electrical engineering has upon them. I have attempted to deal with the problem as widely as possible, and I hope that the aspect of affairs from the central station engineers' point of view may receive some consideration during the discussion.

* Abstract of paper read before the Northern Society of Electrical Engineers.

ELECTRICITY IN THE MACHINE SHOP.

THE severity of misfortunes is often mitigated by subsequent benefits arising, which are the better available because of the very conditions caused by misfortune. As an example of this, which the near future is placing to the hand of English manufacturing engineers, we may name the engineers' strike, and the tactics which led up to it. We have pointed out that the restrictive action of trades unionism has been responsible for the continuance in use of thousands of old-fashioned tools, which their owners are perfectly well aware could be economically replaced by new and improved tools of greater output *capacity*, and doubtless this would be done if only such new tools were allowed to work at their proper speeds. American visitors, never at a loss to cast a sneer at English shops, have not failed to note the slow speeds at which tools are driven in union-ridden shops, while perhaps themselves subscribers to the American fund which is being raised to maintain restricted output. As we may hope the near future will see an entire change in English shop management and tool using, it is reasonable to anticipate that there will be a very large demand for new machine tools, and it seems opportune that we should endeavour at this probable crisis to draw attention to the very great economy of electrical driving of machine tools, and to the extreme desirableness of entirely changing the practice as regards machine tools. To some extent in this country, but to a much greater extent in America, the driving of tools electrically has made rapid progress since the year 1894. Modern American shops fitted with new tools have found to some extent that the application of the new motive power transmission has not been possible to be carried to its most economical extent, and to the larger tools there has been required a good deal of extra fittings, while smaller tools have been banked, as it were, upon an electrically-driven shaft, that would have been better driven independently. In fine, electricity has been rather a graft upon an already grown tree than a naturally grown branch. Could we see 20 years ahead, it is probable that a continuance along the lines now opening out would carry us to the time when the demand for small motors would have been met by their supply, and that machines driven by shafting will be almost, or wholly, superseded by machines with their own motor, just as large machines have now their own separate motor. Further, we think the future will see a very great change in tools themselves. There will be more portable tools carried about by overhead cranes and attached to the work, in place of, as now, work being taken to fixed tools. One of the complaints against trade unionism is, that under its rules one man must attend to one tool only. Machine tools seem to be now working under parallel conditions. One piece of work can only be operated upon by one tool at a time. An example of how electricity will change this is to be seen in an illustration of the drilling of a large casting in the shops of the General Electric Company, at Schenectady. The cumbersome casting is hung up in chains to be drilled by a radial drill, which is perhaps about the first step in the carrying of a machine tool to its work, and has made the radial drill so popular and successful. On another page (*Cassier's Magazine*) the same casting is shown lying safely on the floor and being operated on by two portable slotters and a portable drill, all electrically operated. In present practice, or shall we say old practice, huge machines are required even to drill small holes if the piece drilled is large. The size of machine tools has in fact been measured by the bulkiness of the things being made. There is no reason whatever that a ½-inch drill should be carried by a 2-ton frame. Carry the drilling machine to the work and at once the tool is reduced to what is necessary to drive the ½-inch drill. Machine tools will be small and portable. They can be attached by the half-dozen to a big casting, and work in future will be dumped down at a convenient place in the shop, where it will remain till finished. The lathe and the large planing machine may perhaps still remain fixtures, and have work brought to them, but drills, cylinder boring bars, slotters and shapers will be smaller than of old, and will be portable, and as, perforce, they will require to be separately driven, the small motor is bound to make its appearance.

How does all this bear upon our prefatorial remarks? Simply that the impending change of practice with its consequential demand for new tools will or should be made coincident with the new system of driving, and the new tools ought to be fitted to serve the new driving arrangements.

The economy of electrical driving arises largely from the abolition of shafting, steam piping, &c., and the concentration of steam plant at a centre. It does not necessarily follow that the total abolition of all intermediate gearing between the motor and the actual tool can be effected economically, and, in drawing attention to this point we might quote Mr. Mullin, to whose article we have referred, to the effect that two notable instances of direct-driving have signally failed, and been replaced by gearing, in one case, at least, of a comparatively discredited variety. One is that of the geared trolley motor which replaced the direct torque armatured axle. The other case is the bicycle, the high direct-driven machine being entirely displaced by the chain-geared safety, the serious disadvantages of the chain being partially eliminated by the dust-proof case and partially overlooked in the desire to bring the C.G. of the loaded machine further behind the point of support than possible in the high machine. But the use of gearing is essential to small and light motors, and is likely to continue.

It would be well that our manufacturing engineers should very seriously consider the system of electric driving, and the various changes it makes possible before re-organising their shops. Machine tool makers also should be prepared to meet the new demand which is likely to be made upon them. If our views be correct we may say that the harassing tactics of trades unionism have delayed the improvement of our workshops until the improvement can be made wholesale and thoroughly—men, methods, machines and motors all moving together. There has got to be a change, and when it does come it will be thorough, as customary in England, where we are apt to stick a long time in our grooves, but when we do leave them we are thorough.

In America, to judge from Mr. Mullin's illustrations, electrical driving has been largely adopted to old machines as well as applied to new ones, and the result is very mixed, the motors often having a temporary appearance; but there is apparently a strong desire to secure the new driving at any cost, so great are its advantages, and in one large shop it is said that 4,000 hands are now doing the work of 6,000, and with an increased output of 60 per cent. This is a rail rolling mill which has utilised mechanical power to the utmost. Need we wonder that America is now sending rails abroad, and, no doubt, finding such work as will more than provide for the 2,000 hands above thrown out.

We need hardly point out that the saving effected in the size of the bulk of tools, and the reduced dimensions of the buildings necessary to contain them, as well as the lighter construction possible will, in the case of a new works, probably outweigh the cost of the electric motors, and all this saving would be additional to that of the motive power, of oil, belting, and attendance. The modern engineers' shop should, in fact, be simply an area commanded by a traveller arranged to convey the pieces of work to the heavy tools, and to carry the lighter tools to the work. The motive power would be placed anywhere most convenient. In fact, the motive power would usually be placed near the forge, so as to be convenient for supplying steam to the hammer. All driving would be electrical, and warming would be done by steam. When not in use, the portable machine tools would be stacked in close array, not filling much space. Machine tools would be much more saleable than they are to-day, and it would be possible to borrow tools to tide over any special push of work. This cannot be done where tools are bedded down and belt driven.

TECHNICAL LITIGATION AND THE QUESTION OF GOOD WORK IN HOUSE WIRING.

By V. ZINGLER, A.I.E.E.

(*Concluded from page* 103.)

We may now turn to the second subject of the title, which has only been introduced here because, in the case referred to, it was made a position of by the defendants; but, owing to a weak point in their defence, they were driven out of it, and the battle was decided on lower ground. It is, of course, almost impossible to standardise the quality of work that is done in house wiring; fire insurance offices have attempted it; the Institution of Electrical Engineers have drawn up rules to be observed; every supply company has regulations which must be complied with; consulting engineers draw up elaborate specifications; and even wiring firms themselves make out their own specifications, without which the average customer forms a poor opinion of them. And what does it all come to? Can each and every one of these bodies have a representative continually on the spot to see that their rules are observed? If not, with whom does it primarily rest to carry out, if not every rule that has been made, at least such an average standard of work as shall meet the requirements of all the parties concerned? There is no doubt it lies with the firm itself; it is a question of commercial morality and nothing further. The quality of material supplied, the honesty of the foreman, the training of efficient workmen, and the adoption of a proper system of work and of superintendence are all factors in the respectability and standing of the firm; and indicate whether their policy is to be one of getting work at all costs, or of combining the making of a fair profit with work which is a credit to themselves, and studies their customers. It is impossible for the foreman to be honest if he sees that his firm is supplying inferior material, and deceiving the customer; it is still less possible for the workman, who takes his cue from his foreman and the general style of the firm, to avoid scamping his work. He wants looking after enough in most cases, but he is also only human, and endeavours to do his best to please his present masters. And so, when he finds that it is a "nigger driving" concern, and that he is expected to get through the work quickly, with no question as to what lies underneath, why he does it. Firms of this sort are unfortunately very common; it is only necessary to look at the comparative list of tenders often appearing in this Journal to see the great and perfectly unintelligible variations in estimates; these show the electrical trade parasites, the firms whose life may be described as a constant harmonic motion between business or partnership notices and liquidation notices. At the end of each period there is a re-incarnation consisting of a new combination of sells (the pun may be pardoned), and during their short life they manage to do a certain amount of bad work, which also lies dormant for a time, but which, on the application of 220 volts or a little moisture, comes forth from all corners to annoy the customer. Turning to the estimates above referred to, it may be asked why it is that these differ so very much. We have said that this is unintelligible, but this is really only so on the face of it. Let us analyse an estimate. It consists of three parts: material, labour, and contingencies. Now, when quoting to a specification with schedule of lights, the material is a fixed quantity, and its cost may be said not to vary more than about 10 per cent.—speaking only of wiring material, and not plant. It is, of course, possible that some firms do not take as much trouble as others in measuring up for wire and casing, but even this does not make a large difference. It is on the question of labour and contingencies that firms go wrong. Only those who have had plenty of experience in all kinds of wiring work, and lived through it, know how great the uncertainty of time and labour is; building not finished, fittings not ready, unexpected surprises in the way of girders, floors, and walls. These and many other things have to be allowed for if the firm is going to make a profit, or if they are not going to scamp the work. And if these things have not been allowed for in the desire to obtain an order, and are met with when the job is under way, the temptation to try and make the cost keep below the tendered price is no doubt very great. In confirmation of these views, it may always be observed in reading through a list of wiring tenders, that the best-known (and, of course, most experienced) firms are at the top. And it will be found that the firms who do the best work are those who, to begin with, have a conscience; who set about a job with the idea of providing the best material and labour at a fair profit; who do not persuade their customers to take what will not be necessary for their requirements; who have honest foremen and a good system of superintendence; and who have a standard of wiring work from which they refuse to deviate, and to which they have trained a few good wiremen whom they keep. These may be said to be the ethics of the wiring question, and they may be summed up in a remark frequently made by a firm (who conforms to them) when a customer asks, "What will it cost?" "My dear Sir, you can get it done for anything you like!"

It may now not be inappropriate to discuss the various details of wiring work in which the question of good work arises, and especially those which came before the Court in the case we have in view. On this occasion a great deal of nonsense was talked about the "tree" and the "sub-circuit" systems. Because one witness had said that the latter system was the most recent of the two, counsel fell upon it, and dubbed it the "new" system; and this was so insisted on, that there is no doubt that in the mind of the jury it was clear that the plaintiff had not put in this system because he had only himself just heard of it. As a matter of fact, it may be said to be many years old and to be the result of the excellent fire insurance rules which tended to put electrical wiring into something like shape. The "tree" system is certainly antiquated, but there are occasions when it must be used, such as in the wiring of long, straggling sheds with few lights in each. It is even then necessary to fuse each main at every point where it is reduced in section, and also to fuse each light separately. Any failure to comply with this is not only bad work but gross negligence and carelessness. As regards the "sub-circuit" system, this is the only system now used for good house wiring, and on the double-wire system it cannot be said to be complete, safe, or good work unless it consists of D.P. fuse and switch for mains, distributing board with D.P. fuse and switch on each circuit, and fuse board at the end of each circuit provided with D.P. fuse for every sub-circuit, to consist of not more than seven 16-C.P. lamps on each. It is not the object of this article to draw up a specification; but it may be added, without going into the question of material of floor boards, that the poles should be kept apart by an air-space, and that all holes for fixing screws should be well bushed. The failure to do this is a frequent cause of leakage, which leads to other things.

Another point discussed in the case was that of "dry joints." How such a term has ever arisen it is impossible to say, as it cannot be too strongly pointed out that such a thing as is understood by "dry joint" should never have existed, not even on temporary work. It may be said to be an aggravated form of *the* only danger of fire in electric wiring, namely, increase of resistance, and consequently of heat, due to the interposition of a section of lower conductivity, without a fuse to protect it. How any man calling himself an electrician, much less an expert, can go into the witness box and say that there is no harm in a dry joint, passeth understanding. He might, with equal assurance, describe himself as a truthful man.

We next come to the question of casing and bunching of wires. Here experts may even be allowed to differ, as the arguments *pro* and *con* have equal reason. In pipes, where wires must be bunched, the only dangers are caused by bad work; *i.e.*, burrs which may tear the wire, or bad wire which may break down. In either case an arc may be formed, but if the general insulation from earth is good, and the circuits are properly fused, this will not occur. The remedy is to avoid these causes. But as regards wood casing, there are dangers from other causes; *i.e.*, rodents, water and mechanical injury. The use of wood casing is only a temporary remedy against all three. The best remedy against water is to use good wire, and the only remedy against all three is not to use the casing but iron pipe. It may, however, be said that if casing has to be used, it must be used everywhere, if only for the sake of tidiness, and if it is omitted under the floor boards it may also be omitted on the walls. But in the latter case the customer sees it, and in the former case he does not. The conclusion is obvious if good work has to be done.

The only remaining important point is the wiring and fixing of fittings. More bad work may be done at this point than anywhere else on the installation. There is a common belief amongst careless wiremen that there should be a joint for every fitting. Every joint is an increased weakness to the system, and may be likened to the weakest link of a chain—the strength of the chain. But two bad joints are worse than one weak link, as they double the leakage and the source of danger.

In the case of most ordinary plain fittings, such as brackets, tube-pendants, &c., the wires should be left long enough to run right into the lampholder, with a little to spare; this should be coiled up in the back-plate or in the floor above. There are, however, some fittings, designed by artists, and not engineers, where no proper provision is made for wiring. In these cases flexible wire has to be used—that is, while people will buy such fittings—and not only is it customary to make joints here, but the flexible wire is twisted about outside the fittings and bound round by wire without any regard for possible consequences. What is more, the wire used is frequently not vulcanised, also to economise space. The dangers are self-apparent. The remedies are—not to buy badly designed fittings, or to have them altered if necessary; if the fittings must be wired with flexible wire, let it be vulcanised, and fix a small china cut-out in the wall behind or above (as the case may be) the fitting back-plate.

If even this is impossible, and it is necessary to make a joint, the flexible wire at the point of jointing should be strengthened by winding the fine wires round a piece of copper wire of equal section to the circuit wire; the whole should then be soldered together, and well protected.

No flexible wires should pass through metallic back-plates or other metal parts without an insulating bush. In fact, such a thing can only be the result of accident or ignorance. The question of wiring of fittings was fully dealt with by the writer in this Journal some time back.

It is, however, clear that the trouble of fitting joints will always exist more or less until some manufacturer of fittings, more energetic than the rest, will devise and standardise a complete system of male and female sockets for fittings; the male to be in the back-plate and to be wired to the lampholder; the female socket to be fixed as a "point" on the wall or ceiling, and wired back to the fuseboard. The fitting would then make electrical contact just like an ordinary plug and shoe, and it would be secured to the wall by the usual method now employed.

The slight extra cost of these sockets would be met by a more than corresponding reduction in labour of fixing and making joints, not to speak of the convenience of being able to change the fitting if desired. Such a system should commend itself to ladies, who, according to the plaintiffs' experience in this case (and the experience of most other electricians) are never satisfied with a fitting when it is fixed up. The best way to deal with such people is not to make dry joints, so as to lessen the trouble of taking down the fitting next time, but to provide the wireman with a book of order forms to be signed by their customer or his wife whenever an extra of this sort is required, and to charge these up at the end. It will be found an excellent method for suppressing the lady's enthusiasm for changing fittings.

Finally, it is of no use abusing Fire Insurance and Supply Companies' Rules unless something better can be suggested, and if both are adhered to as far as possible, with a due feeling of responsibility and interest in the work, and a proper look round and inspection afterwards, there should not be reason for such lawsuits or for any accusations of bad work. It can only be urged that the test as made by the Supply Company shows absolutely nothing as to how the work has been performed, and a man who goes round with a boy and an ohmmeter and generator has no means of proving anything else than that the insulation resistance of the installation is not low enough to cause serious loss to his employers. Even then cases have been known where the mains have been disconnected at some point for the test, and joined up before the lamps were put in, to show that there was complete continuity.

It cannot be too strongly urged on the public not to listen to touts who call at their houses and ask to be allowed to estimate for the electric lighting, nor to accept the lowest tender invariably because it is the cheapest. It will, without doubt, cost them more in the end than if they accepted the dearest tender. Far better is it to engage the services of a capable consulting engineer with good references, to pay him, say, 5 per cent. on the cost, and to know then that he will take full responsibility for the choice of a good firm, and for the due carrying out of the contract according to his own advice and experience.

SOME ELECTROLYTIC PROCESSES FOR THE MANUFACTURE OF WHITE LEAD.

By SHERARD COWPER-COLES.

Up to the present the old Dutch process of making carbonate of lead has held its own, and it is still the impression that the lead produced by this process is the best as regards its covering capacity. Such was the finding of the Committee appointed by Government to investigate the dangers attending the manufacture of white lead. Carbonate of lead, manufactured by a wet or electrolytic process is found to be more or less crystalline and hydroscopic, and has not the same covering power as white lead manufactured by a dry process.

The amount of white lead produced on the Tyneside is 16 to 17,000 tons a year; a similar amount is produced in France; Italy producing about 3,500 tons a year.

The old Dutch process consists in subjecting desilverised metallic lead (blue lead) which has been melted and cast in wickets (also called crates) which are sometimes in the form of gratings or plates with two holes and a central flat rib to the vapour of acetic and carbonic acid. The wickets are put into stacks or blue beds for corrosion into white lead. This is done as follows:—The floor of the stack, a large cubicle built of bricks, is first covered with a layer of tan, on this are arranged as closely as possible stoneware pots filled with dilute acetic acid, and on the top of these are placed four or five layers of wickets in close contact with each other. The whole is then covered over with boards, forming a second floor upon which fresh layers of tan, pots and wickets, are arranged as above. This is, in its turn, covered in the same way, and so on until the stack is full; as many as 10 or more layers going into one stack. When the stack is full, the ventilating shafts which have been left at each corner of the stack are closed up, and the stack is left to itself for periods varying from 10 to 15 or more weeks. During this time the conversion of the blue lead into white lead takes place. The tan soon begins to heat and evolves carbonic acid, the heat volatalising the acetic acid. An inter-action then takes place between the lead on the one hand, and the carbonic acid, acetic acid, and air on the other, leading through a series of chemical changes not clearly understood, to the ultimate production of an amorphous basic carbonate of lead (white lead); the action goes on until either all the lead is corroded, or all the acetic acid has been volatalised, or no more carbonic acid is produced. During these changes there is always a small proportion of acetate of lead present in the corrosion, some of which is also left in the final product. At the expiration of the time found necessary by experience the stack is opened, and the corroded lead is wetted and carried away in trays to corrugated rolls over which passes a constant stream of water; in front of these rolls the corroded lead is tipped down. In passing between the rollers the wickets are crushed, thereby detaching the white lead from any remaining blue lead. The crushed material next passes into a shallow tank having a perforated bottom, in which it is raked about, separating the blue from the white lead. The blue lead is raked out; the white lead passes with a current of water to grinding mills, where it is ground up and run into a series of tanks; in these the finely divided white lead settles to the bottom, the water is then drawn off, the white lead is removed, put into earthenware or copper pans, and placed in drying ovens. When the white lead is thoroughly dried, which takes from three to five days, the pans are taken from the ovens by hand labour, or mechanical means, and the dry white lead is placed either into casks, or thrown into bins for subsequent conversion into paint.

White lead (carbonate of lead) has two faults, as it is both poisonous to the makers and to the users. The perspiration on the hands has an acid reaction, and tends to dissolve some of the white lead, and this passing into the system, gives rise to lead poisoning. Lead has the property of accumulating in the system, and when a certain amount has got in the system, it is very difficult to eliminate. The other defect alluded to is that of discolouring on exposure to air and sulphurous gases, with which it forms black sulphide of lead.

From the foregoing description it will be seen that the Dutch process is a very slow and tedious one. To overcome these difficulties the following system has been devised. The lead is cast into thin sheets about 20 inches by 15 inches, weighing between 2 and 3 lbs. each. These sheets are then corrugated and packed in crates with plates of coke or carbon which form the negative electrodes. Strips of tin make the connection between the lead or electro-positive plate and the carbon electrode, the object being that when subjected to warm vapours of acetic acid, carbonic acid, and atmospheric air, electrical action is set up between the two, which hastens the corrosion and reduces the time required to convert the plates into carbonate of lead from 10 to 15 weeks (the time required by the old Dutch process) to five weeks. The corroded plates are subjected to a similar process as that already described under the head of the Dutch process.

Another electrolytic process consists in electrolysing a 10 per cent. solution of sodium nitrate in a wooden cell provided with a porous diaphragm, the anode being made of pig lead, and the cathode of copper. In the former compartments the lead dissolves as nitrate, whilst round the cathode caustic soda is produced. The two solutions being drawn off and mixed, the alkaline nitrate is regenerated, and the lead precipitated as hydrate. The hydrate is finally treated with sodium carbonate or bicarbonate to convert it into white lead. The caustic soda formed as a bye-product in the latter operation has only to be recarbonated to be available again.

A somewhat similar process, patented by Mr. Browne, is carried out by placing metallic lead in a suitable vessel in electric connection with the positive pole in the presence of a solution of an acetate or a nitrate of an alkali base. A soluble salt of lead is formed on the anode and a solution of caustic alkali at the cathode. In consequence of the flow of the electrolyte against the cathode these two solutions intermix, with the result that lead hydrate is precipitated, the original alkaline salt being regenerated. The solution containing the lead hydroxide in suspension is then run into a settling tank, from which the clear solution is subsequently drawn off when it is used again as the electrolyte, and the lead hydrate is finally exposed to the air or to an atmosphere of carbonic acid to convert it into hydrated carbonate of lead.

It is to be observed that in reality electrolysis plays but little part in these processes, but the mixture of lead carbonate and hydrate of which white lead consists is purely by chemical means.

Another process patented in America consists in passing an electric current from an anode of metallic lead through an alkaline electrolyte consisting of a solution of a salt of ammonia in combination with any acid which will produce a soluble lead salt (including sulphuric acid) and of a bicarbonate of an alkali to a cathode of lead, carbon or other suitable material, thereby causing a decomposition of the salts in the electrolyte, and a formation of a soluble compound of lead, which is transformed into the hydrated carbonate of lead by the simultaneous generation of free carbonic acid at the anode by the presence of caustic alkali (ammonia) generated at the cathode, passing a current of carbonic acid gas through the electrolyte to regenerate the spent alkaline carbonate until the anode is completely dissolved. Both the acetate and bicarbonate of soda are continuously regenerated, the process consuming only lead, carbonic acid and water.

An English process, which has lately been protected, consists in decomposing acetate of ammonia by electrolysis, lead anodes being used, which are separated by porous diaphragms which are made preferably of stout Willesden paper, which are insulated from the bottom to prevent irregular electrolytic action in the electrolyser. A lead solution is produced, and caustic alkali, when on mixing the two solutions white lead is precipitated. When a series of cells are used, the exit openings at the bottom are closed by elastic bags, which are distended by the fluid within.

In another process patented in Germany, lead anodes 3 mm. in thickness are employed for the electrolysis of a solution containing 300 cc. nitric acid and 2,000 cc. of water. The lead salt formed is precipitated as white lead, and gives off a stream of carbonic acid gas. Any silver contained in the lead is deposited on the cathodes, and can be recovered.

NEW PATENTS.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents*, 322, *High Holborn, London, W.C., to whom all inquiries should be addressed.*]

1,835. "An improved telegraph cable grip." A. Gray. Dated January 24th.

1,869. "Improvements in insulators." E. Renault. Dated January 24th. (*Complete.*)

1,872. "Curve tracer of electrical measurements." W. Douglas. (E. Ross, United States.) Dated January 24th. (*Complete.*)

1,880. "Improvements in electric pendulum indicators." F. Jones. Dated January 24th.

1,887. "Method of and means for enabling code or cypher printing or signalling to be effected by means of the ordinary keyboards of type-writing machines, telegraphic apparatus, type-composing machines, or the like." J. Ballot. Dated January 24th.

1,912. "Improvements in telephones." J. D. F. Andrews. Dated January 24th.

1,923. "Improvements in dynamo-electric machinery." J. S. Lewis and F. J. Howitt. Dated January 24th.

1,970. "An improved electric switch or contact maker." J. G. Dixon. Dated January 25th.

1,994. "Improvements in safety fuses for electrical conductors." L. A. Ferguson. Dated January 25th. (*Complete.*)

2,007. "Improvements in or relating to transmitting electrical impulses and signals." E. Wilson and C. J. Evans. Dated January 25th.

2,021. "Electrical log recording instrument for the cabin." P. Jensen. (Patentaktiebolaget Svea, Sweden.) Dated January 25th.

2,024. "Improvements in and relating to primary batteries." C. Koenig. Dated January 25th. (*Complete.*)

2,025. "Improvements in rheostats for regulating the current used in electro-plating and other processes." W. P. Thompson. (The Zucker & Levett and Loeb Company, United States.) Dated January 25th.

2,030. "Improvements in primary batteries." E. Giglio. Dated January 25th.

2,039. "An improved relay switch." T. B. Browne and J. M. James. Dated January 26th.

2,040. "An electrical fire call telegraph." W. Blenheim. Dated January 26th.

2,063. "Improvements in switches for electric light service." A. E. Tanner. Dated January 26th.

2,106. "An improvement in, and connected with, electric arc lamps." J. O. Girdlestone and C. F. G. Thorkelin. Dated January 26th.

2,167. "Improvements in, and connected with, electric generators for cycles and other vehicles." J. Moores and H. O. Farrell. Dated January 27th.

2,171. "An electric bell piano." S. J. Godwin. Dated January 27th.

2,172. "Improvements in attachments to electric incandescence lamps." C. H. Stearn. Dated January 27th.

2,215. "Improvements in, and connected with, the generating of electricity through the motion of the rolling stock and the like." M. Clark and J. B. de Atzugaray. Dated January 27th.

2,266. "Improvements relating to electric plating." J. Matthews and T. Vann. Dated January 28th.

2,284. "A new application of the electric incandescent lamp." J. R. Payne. Dated January 28th.

2,292. "Improved insulator for telegraph wires and the like." H. Peters. Dated January 28th.

2,299. "Improvements in joints between the glass globes of electric arc lamps and the supports by which they are carried." P. H. Guerin. Dated January 28th.

2,308. "Improvements in electrical advertising apparatus." P. C. Pope and J. F. Simpson. Dated January 28th.

2,375. "A teletypograph for transmitting, receiving, and recording messages through a telegraph wire electrically." J. Campbell. Dated January 29th.

2,382. "Improvements in, or relating to, electric telegraphy." P. Picard. Dated January 29th.

2,389. "Improvements in secondary batteries." J. V. Sherrin. Dated January 29th.

2,415. "Improvements in methods or processes for electro-thermally treating materials, and particularly with reference to the manufacture of calcium carbide and apparatus therefor." H. Maxim and W. H. Graham. Dated January 29th.

2,417. "Automatic electric circuit breakers." M. Bouchet. (Date applied for under Patents, &c., Act, 1883, Sec. 103, July 2nd, 1897, being date of application in France.) Dated January 29th.

2,420. "Improved means for controlling the working of lifts, motors and other appliances operated by electric energy." W. A. Kerr. Dated January 29th.

2,423. "Improvements in the manufacture of filaments for incandescent electric lamps." R. Mullard. Dated January 29th.

2,426. "An improved method of and means for facilitating the starting of single or polyphase alternating current motors and the like apparatus." M. Deri. Dated January 29th. (*Complete.*)

2,427. "Improvements in variable electric resistances or rheostats." R. Waygood & Co., Ltd., and P. I. Unwin. Dated January 29th.

2,428. "An improved electrical transformer for currents of high potential and variable frequency." A. Wydts and O. M. Rochefort. Dated January 29th.

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CONTENTS:

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ELECTRICITY SUPPLY CONSIDERATIONS.

ANOTHER year has come and gone, and the counting of units generated, units sold, and units not accounted for, is no doubt proceeding apace with the enthusiasm one finds at the counting of the votes at election times. The time is fast approaching, if it has not actually arrived, when we shall be in possession of the returns of the many electricity works spread about the country. The older stations have reached a standard in low cost of production, as concerns coal, oil, &c., which it will be difficult, in many cases, to improve upon. In the more recent stations we expect a general improvement in these items, and we confidently expect to find a marked lowering in the case of the "two and three-year-olds."

That the supplying of electricity from a central station is a financial success is undisputed, and although some of the balances of the youngest concerns last year were on the wrong side, we shall no doubt find the majority of these, if not all, transferred to their proper side, where permanency is assured.

It is not our intention in this article to deal with the financial side of the question, but to give voice to some points which have occurred to us from time to time, and which, at this period, may not be uninteresting.

The first question which suggests itself is: What is the proper amount to put aside for depreciation? How long will it be before our engines, boilers, machines, &c., wear out? The answer may be that although the percentage put aside at present is small, it will be increased year by year as the machinery gets older, until ultimately things will be right. This may be approximately correct as regards the buildings, switch gear, and running plant, but who can tell us the life of the mains? A very large proportion of the capital expenditure is spent in mains. These are being continually added to; a short extension here and another there adds unconsciously as it were, until the aggregate amount at the year's end is enormous. We may select what appears to us the best main, and exercise great care in the handling and laying of the same, and by repeated tests made at regular intervals keep as watchful an eye upon this part of the installation as it is possible to do, and yet we cannot even guess how long it will be before they have to be taken up and replaced by others.

This is a most serious question. Because the mains are out of sight, they should not be out of mind.

Bare copper strips supported on porcelain insulators laid in stoneware conduits seem to have the best prospect of longevity. It is not always practicable to adopt this system, owing to the shallowness between the pavement and the cellar tops, also the presence of gas and water pipes which cross the pavements at varying depths render a capacious straight conduit an impossibility. This system has never been carried out in its entirety for these reasons, and also in consequence of the difficulties met with in crossing the roadways, when India-rubber cables drawn into cast-iron pipes are most generally resorted to.

Cheapness in cost and laying seems to be the principal factor, at present, which governs the selection of a system of mains. Will the cable which costs so much per yard less than another, last as long? We know that steel armouring will not last for ever, neither will lead sheathing, nor the dielectric whatever it may be. The soil in which the cable is laid will materially affect its life. Instances of this kind are common, and heavy expenditure, quite unexpected, has been the result. Every precaution is taken by cable makers to supply mains which will last as long as possible, but can they guarantee even an approximate life, taking into consideration all the local circumstances? If not, why not?

We constantly have our moving machinery under observance, and we rectify before it can develop into a serious complaint any little irregularity that may be found. As we said before, we test our mains as often as practicable, for insulation leakage, but not for actual depreciation in the steel armouring, lead sheathing, or dielectric. We test our engines for efficiency with an engine indicator, but does it tell us when to put new brasses in the main bearings? We test our dynamos with suitable instruments for insulation, but do these instruments tell us when a new commutator is required?

It would be just as absurd to expect such information from these sources, as it is to assume that our mains are as good as when laid, because the insulation is high and the leakage low.

It would be well if directors of companies would carefully weigh these questions before declaring dividends, and allowing the depreciation to remain at "nil." Now is the time to prepare, and not wait till the calamity comes, and then be unprepared. Municipal authorities are not so likely to err in this respect, owing to the conditions under which their respective loans were granted. It would be well, however, for them to ask themselves this question—Are we allowing enough for depreciation on our mains? May the day be far distant when the mains of the country have to be replaced by others; but if no other item than the natural decay of all material had to be considered, it would only be a matter of time, and let us hope to see the word "nil" under the heading of depreciation removed from all the balance-sheets of all the electrical supply companies this year; if not all, at least those who cannot lay claim to being infants.

SUBSIDISED CABLE COMPANIES.

In the half-yearly report which the directors of the Cuba Submarine Telegraph Company have just issued to the shareholders, we notice a significant fact, indicating the policy of the Treasury and Colonial Office Departments of the Government in dealing with telegraph companies. The point to which we wish to draw attention is comprised in one of the paragraphs of the report, where it is said: "In consequence of the establishment of the new line between Bermuda and Jamaica, subsidised by the British Government on the basis of a charge of 3s. per word between the United Kingdom and Jamaica, the Cuba Company have been compelled to accept reduced rates, which will result in a considerable loss of income."

We have here a company—one of the pioneers—which doubtless had many a severe struggle to maintain, unaided, its existence in the early days, threatened, in its prosperity, by a competing line.

To ordinary competition every company is liable, unless they hold exclusive rights, and shareholders take their risks; but when, as it appears in this case, the Government comes forward and subsidises the new competitor, without giving an equal subsidy to the existing line, one would think that some injustice is being done. No one can contend that the new line is not an admirable one; it connects Halifax with Bermuda, Bermuda with Turk's Island, and Turk's Island with Jamaica—all British possessions. It may have been highly desirable, from an Imperial point of view, that such a line should be established, even if the private interests of certain British subjects should be damaged, on account of the necessity of it for the commonweal, and in that case we agree that these minor interests should be overridden. This has, apparently, been the view taken by our governors.

We sympathise with the shareholders of the Cuba Company, as, besides fighting a subsidised competitor, they will lose the receipts from the official traffic, which will surely pass by the all-British line, and there is also a lowering of rate to face which must, at least for a year or two, seriously affect their company's revenue.

May we not suggest that a partial remedy for their condition may be found in the Cuba Company approaching the British Government, not with the view of asking for complete compensation for damage sustained by the laying of the new Imperial cable, but with the object of obtaining from the Imperial Parliament monetary assistance equivalent to that granted to the new competitor. In this the company may succeed, as the British Government, representing the general community, may think it proper to grant some compensation for the damage this Government has caused to the company while acting in the public interest. The Cuba Company's case would appear all the stronger, in that the new line affords only a single means of communication, while the Cuba Company's route is duplicated throughout, and would appear to be necessary for the security of communication between the Home Government and the West Indian Colonies.

As precedents in electrical matters, where the Government has dealt with compensations, we have the purchase of the land telegraphs by the State, the arrangements with the Submarine Telegraph Company, and with the National Telephone Company. There are doubtless many other instances of compensations in the experience of the War Office, Admiralty, Colonial Office and Treasury, which resemble the case of the Cuba Submarine Company.

Tesla's Latest Advances in Vacuum Tube Lighting.

In a letter to the *Electrical Review*, N.Y., Tesla describes the results of some recent experiments he has made in vacuum tube lamps, and in their application to photography and other purposes. Along with the letter are published copies of photographs taken with Tesla's new vacuum. One is a portrait taken by the light of a single vacuum lamp at a distance of 5 feet with an exposure of five seconds. Another is a page of letterpress taken by a single vacuum tube at a distance of 4 feet with an exposure of two seconds. The photographs are not equal to sunlight photographs, but resemble more those taken with a single magnesium flash light, the shadows being very harsh, but the amount of detail is considerable. It is difficult to say from Tesla's letter in what his improvements exactly consist. He appears to have reduced the size of the vacuum tube, and thereby, as he says, considerably reduced the dissipation of energy from its surface. The illuminating power of the lamp with which the photographs were taken he estimates at 1,000 candles. The great superiority in efficiency of his system over earlier attempts at vacuum tube lighting he considers is principally due to the use of his improved apparatus for "producing economically harmonical electrical vibrations of extreme rapidity," referring, no doubt, to his oscillator recently described in the Electrical Review. Tesla promises soon to give further details of his system. The well known originality of nearly all Tesla's investigations leads us to look forward to the publication of the full description of his new system.

DEATH BY ELECTRICITY.

By W. S. HEDLEY, M.D.

It is not always so easy as might be supposed to kill an animal by electricity. The experiments of Brown-Séquard and D'Arsonval long ago * showed this, and many physiologists have since confirmed it. Kratter found that one short application of an alternating current at 1,500 volts sometimes did not kill either rabbits or guinea-pigs. Yet much lower voltages have often proved fatal to man. Indeed, it seems not improbable, as the present writer has elsewhere † stated, that all commercial forms of electric lighting currents, varying as they do from 80 volts upwards, may be dangerous to human life under certain conditions. It is, of course, true to say, that, other things being equal, risk increases in direct proportion to the electromotive force; but absolute equality of "other conditions" can never be secured. The duration of the application, the nature of the contact, its superficial area and position, the condition of the skin, the periodicity of the current, the species of animal, its weight, age and perhaps even its state of health, are all factors in the result. That duration of contact has a most important bearing on the question, is nothing more than might be expected, for reasons both physical and physiological, and all experiment proves it. It has been shown ‡ that currents, easily borne by an animal when momentarily applied, were fatal when the application was prolonged to 5—10 seconds. On the other hand, short but repeated applications of strong currents were almost invariably fatal. When other conditions are the same, the larger the area of contact, the greater the intensity of the current; but the less its density, and the latter can never be left out of consideration in dealing with physiological effects. The condition of the skin, with reference to moisture, or any breach in its continuity, is also a point of the first importance, inasmuch as the epidermis is the great insulator of the body. But, at the same time, it is to be remembered that the degree of skin injury is not always proportional to the gravity of the accident. Frequency of alternation must also be considered. It may be that fatal effects are in inverse ratio to the periodicity, although not perhaps according to a strictly "straight line law." Animals present differences in their resistance to the effects of electric currents according to their species, and even according to their individual peculiarities. Every animal seems in this respect to be a law only unto itself. It was found in the experiments already alluded to that rabbits often survived currents which proved fatal to dogs ten times bigger. In the original electrocution experiments in America, experiments were made upon a horse, three calves, and a number of dogs. The mean fatal current thus obtained was brought to bear upon the man to be executed, and the result proved a painful *fiasco*. Yet many experiences since then, some of them within recent months, have proved that a low as well as a high electromotive force may kill a man.

It is very generally admitted that in the case of animals killed by strong currents, there is a tolerable uniformity in the *post-mortem* appearances: (1) the latter in many respects resemble those seen after death by asphyxia (apnœa); that is to say, the left side of the heart is comparatively empty, whilst its right side and the larger veins near it are distended and filled with dark fluid blood. The absence of hæmoglobin from the blood is also a fact common to death by electricity and to death by apnœa. (2) The nervous system does not seem to present any very characteristic appearances, at least there is no "gross lesion" which can be said to be constantly present; but slight hæmorrhages in the walls of the fourth ventricle and in the meningeal coverings are not rare. Yet there may be many finer molecular changes in the nervous tissues of which present methods of investigation are not able to make us cognizant. (3) The points of penetration of the current are always evidenced by burns of various degrees. Less constantly the place of exit is similarly marked. These burns of entrance have considerable diagnostic value in cases when the cause of death may be in doubt. They may vary in severity from simple redness to complete destruction of the whole thickness of the skin; but, as already said, their severity has no close relationship with the gravity of the accident.

When a strong current is brought to bear upon a living animal, there is immediately a strong tetanic contraction of the entire striated muscular system; and on the circuit being broken there is often a deep inspiration, perhaps followed by an "expiratory cry." It is often this cry which first calls attention to the accident. In cases which are not fatal there is often loss of consciousness, which may be regarded as the clinical manifestation of the severe shock, or rather shaking, to which the whole central nervous system has been subjected. This is very different from what is surgically known as "shock." In the latter, the longer the condition of shock lasts the greater the danger. In electric accidents, danger of death *diminishes*, the longer the duration of loss of consciousness. It may be said that, if not immediately killed, the person usually recovers. This loss of consciousness soon disappears, perhaps, even, in a few minutes, but for days or weeks there may remain "head symptoms," such as vertigo and severe headache, or there may be palpitations or other such consequences. Neither sensory nor motor paralysis appear to be common.

Death, as the result of electricity, must occur in one of two ways—(1) by mechanical lesions of vital structures, or (2) by arrest of organic functions essential to life; that is to say, by arrest of respiration, heart action, or nutritive exchanges. It is in persons killed by lightning that the first-named mechanical or "disruptive" effects are usually seen. Industrial currents kill in the second way. But even here the difference is quantitative rather than qualitative. Most of the foregoing points have been put in evidence by Kratter and others, and, as already said, are generally accepted. The first class of cases need not be considered. It is self-evident that mechanical disintegration of vital parts must cause death. But, approaching the second class of cases, where death occurs by arrest of organic functions essential to life, the question broadens out, and it becomes necessary to inquire which of such functions is struck first. Where does death begin? What is the "mechanism" of death by electricity? At this point physiologists are no longer in accord.

Is it as D'Arsonval considers, that, acting on nervous centres, the electric current produces a variety of effects known as "inhibitory," viz., suspension of respiration, arrest of heart action, &c., and that it is the first of these that is primarily affected, inasmuch as cardiac action persists after the arrest of respiration. According to this view, there occurs, in fact, "a central paralysis of respiration, constituting a special form of asphyxia," * due to exhaustion of the medulla and functional death of the ganglion cells. If this be correct, artificial respiration affords a hopeful means of restoring animation. This condition of suspended respiration must not be mistaken for death, and a *post-mortem* examination at once proceeded with. "Nécropsiés vivants" is the sensational term which, it may be remembered, was used in connection with the autopsy of the first electrocuted criminals in America.

Dr. Tatum, of New York, experimenting in 1890, came to the conclusion that strong currents kill by acting chiefly or entirely on the actual substance of the heart itself.

In 1895, Dr. L. Jones, having witnessed some experiments undertaken by Mr. Bokenham with reference to the amount of current required to kill anæsthetised cats, considered, from an inspection of the respiration and blood pressure tracings, that death began at the heart, and that the action of the current is "upon the heart muscle rather than upon any of its nervous mechanisms." In the *British Medical Journal* of January 15th, 1898, there appears a paper by Drs. Oliver and Bolam on the same subject, arriving at the same conclusion, and by the same methods, but not giving such details of amperage and voltage as would enable the experiments to be repeated by others.

Against these latter views it has been urged that were the heart's action suddenly arrested by the electric shock, there would not be the great disproportion in the amount of blood on the two sides of the heart that is present in death by electric shock. After sudden arrest of the heart's action, the amount of blood on the two sides of the heart is nearly equal.

* 1884.
† Electrical Review, January 28th, 1898.
‡ Kratter.

* Kratter.

Further, the heart theory rests chiefly on blood pressure tracings, and it is to be remembered that blood pressure is the result of other factors, in addition to the action of the heart.

This leads to another hypothesis. Dr. Bleile, of the Ohio State University, suggests, as the result of carefully conducted physiological experiments, that death by electric shock is entirely due to the fact that the current produces a contraction of the arteries through an influence on the nervous system; that is to say, through an effect on those nervous centres which control the diameter of the arteries, and that a constriction of the arteries so produced throws in such an impediment to the flow of blood as the heart is unable to overcome. This last-named hypothesis no doubt contains an important truth, recognising, as it does, the fact of peripheral obstruction as influencing blood pressure.

It is, however, contended* that the fatal obstruction is not in the systemic arterioles, but is owing to a constriction of the pulmonary arterioles, the latter being excited to contract by the entirely deoxygenised blood. Such a theory obviously falls into line with the *post-mortem* conditions, which, as has been seen, resemble those seen in apnœa.

It would, therefore, appear, not, perhaps, that each of these hypotheses are at hopeless variance, but that death from electricity may be accomplished by various physiological mechanisms. First, and perhaps oftenest, it may be by sudden arrest of respiration; at another time it may be brought about by sudden and primary stoppage of heart action; in either case, the result being not improbably due to physiological death of the centres of respiration or circulation from chemical and morphological changes therein, which present methods of observation do not enable us to recognise. Further, it is certain that these two centres act in unison, and it need not be surprising that the incidence of the damage done by the current may not always be distributed in the same way. But in accepting the foregoing, it is not to be overlooked that the view that fatal results from electric currents are due to damage inflicted within the actual structure of the heart itself is very influentially held, it has never been disproved, and may ultimately turn out to be a cause, if not *the* cause, of death from electricity. Thirdly, mechanical or disruptive lesions, such as tearing of blood-vessels and contusions of of the surface of the brain, are not limited exclusively to accidents by lightning, but have also been observed in a modified form in cases of death from industrial currents.

A short code of rules for guidance in such accidents has been ably formulated by the ELECTRICAL REVIEW, and the present writer has dealt with the subject of "first aid in electric accidents" in an article under that name in the *Lancet*, August, 1894. It is sufficient to say that, notwithstanding the experiments of physiologists, and a growing experience of such cases, all that medical treatment can do is still to be summed up in the original formula of D'Arsonval, "Un foudroyé doit être traité comme un noyé;" in other words, by artificial respiration commenced early and continued long. But there is one further point with reference to this to which brief allusion may be made. It is known to physiologists that animals to whom nitrite of amyl has been administered are more difficult to kill by electric currents than are animals not under the influence of that drug. It acts by paralysing the walls of the small blood vessels, and so doing away with both arterial constriction and pulmonary obstruction. Now, without advocating that capsules of amyl nitrite should form part of the equipment of every "first-aider," it may be suggested that the use of this drug in cases such as drowning and electric shock would in safe hands prove a valuable adjunct to artificial respiration.

* *Lancet*, October, 1895.

THE ELECTRIC LIGHTING OF WASHINGTON.

THE new plant of the United States Electric Lighting Company at Washington, D.C., is very fully described in detail in the *Electrical Review* of New York by Mr. Geo. H. Draper. On reading this excellent description of the new station supplanting the old, it is forcibly brought before us the rapid progress which electrical generation and distribution is making, when we find a comparatively recent works being replaced by a more modern plant and buildings.

It follows that the demand for electricity must also be increasing in proportion to warrant this enormous expense. A section of land has been secured which will allow of plant installed to supply ultimately a very large proportion of the lighting of the city.

The present plant can with ease be quadrupled when necessary, affording an output of 500,000 16-C.P. incandescent lamps or its equivalent in other forms of electrical application. To compare this capacity with that of our largest stations, we must reduce the figures to a common denomination. We count our capacity in 8-C.P. lamps, therefore the Washington station will have a capacity of no less than 1,000,000 of these lamps.

If the American proportion of plant capacity to lamps installed is the same as ours, then nearly 2,000,000 8-candle-power incandescent lamps or their equivalent can be connected to their supply mains before a further extension of their works becomes necessary.

There are two companies supplying electricity in the city, and this no doubt engenders healthy competition. Whether each company vies with the other to give a little extra voltage, and consequently a better light, we do not know; but this we do know, that the people of Washington, D.C., are reported to be complaining of the quality and price of the illuminating gas supplied to them. The street lighting of the national capital is also claimed to be inferior. Added to these facts the assertion that not 2 per cent. of the residences in Washington are lighted by electricity, we begin to realise why the United States Electric Lighting Company is making such elaborate preparations for a much more extensive supply.

Unfortunately, there are restrictions surrounding the extension of the subway system in Washington so severe as to be in some cases almost prohibitory. This is a serious drawback, for no matter how cheaply current may be generated, it cannot be sold to consumers at a low figure unless an economical means of distribution is available. Notwithstanding the retarding influence of these restrictions, the new plant referred to above, and which will soon be in operation, will enable current to be generated at reasonable and distributed at profitable rates.

Barriers of this kind cannot exist for ever, and with the opportunity of building or using sufficient subways for its purpose, the company should be able, in the near future, to remove any complaints as to service and prices.

In England we are striving to eliminate belt driving, for economic reasons, and it is therefore a little surprising to find that belt driving enters somewhat largely into the composition of the new plant under consideration.

The local circumstances may differ, yet where the size of the units are large, one generator, one engine, seems to us to be the rule.

In Washington, however, we find a combination which, on the face of it, seems economical, to say the least of it, although there are objections, which we will immediately point out.

Two large horizontal compound condensing engines in the basement operate a long length of shafting also in the basement, which in turn drives eight Brush 125-light multicircuit arc dynamos by means of belting passing through the floor. Each of these large engines operates a direct-coupled low tension generator, either of which is capable of carrying the entire load. The arc machines may be thrown in or out of service as required by means of the shafting, by steel clutches, 5 feet in diameter. Although this arrangement provides for an economical operation of both the three-wire low tension and the arc light systems from one engine during the period of light load, we, in England, have learned our lesson, and profited thereby. Our opinion of this arrangement is that it savours too much of putting one's eggs all in one basket.

A slight accident to either dynamo, engine, or shafting would probably result in an entire dislocation of supply, and after all, the first consideration of the central station engineer should be continuity and regularity of supply, and economy of production and distribution afterwards.

In addition to the eight Brush arc lighting machines before mentioned, are two General Electric Company's alternators, one A-70 1,040 volts, 125 cycle, one A-30 1,040 volt, 125 cycle, also driven by belting off the common shafting. A third alternator is to be run by a motor.

The interruption in supply is somewhat provided for by the employment of a large relay of storage batteries. The function of this battery is to help over the "peak" at time of heavy load. The battery comprises 150 cells, and has a capacity of 2,000 amperes on a side for three hours, and is so arranged that it can be connected with either the main bus bars or all feeders, and thus can always be used to best advantage. This battery is charged at times of lightest load in the small hours of the morning, and from 9 a.m. till 3 p.m.

The boilers are the well-known Babcock & Wilcox type, so largely used in our own stations, working at a pressure of 160 lbs. There is also a very large economiser, containing the feedwater, and affording upwards of 10,000 square feet of heating surface, thus heating the water from its ordinary temperature to the highest possible degree.

The switch-gear, one of the most important apparatus in a station, has received special attention. It extends the whole width of the engine room wall, operating the entire service of the company, comprising the low tension three-wire systems arc and alternating systems and the accumulators.

The whole of the apparatus is mounted on panels made of blue Rutland marble, highly finished, the instruments and appliances being the latest and finest instruments known to the electrical art.

We generally associate with America overhead distribution, but in Washington, at least, the underground system of mains is almost entirely used, very few overhead mains existing.

As previously mentioned, certain restrictions are in existence which greatly hinder the progress of electricity supply. No additional conduits can be laid, except by direct act of Congress; this does not, however, prohibit the repairing of the existing conduits. Owing to lack of experience, some of the original conduits, which were among the first to be laid in the country, are now in poor condition; moreover, the duct capacity is too small for the increased business. Owing to these defects, the company is at present engaged in rebuilding and modernising over 50 miles of conduit and cable system. Cost has been a second consideration in regard to efficiency. The conduits are simple in construction, and should prove efficient and durable.

What is known as the Lynch-Lake four-way glazed terra-cotta pipe is used, and also the camp glazed terra-cotta single duct, each having round holes 3 inches in diameter. This is laid at a depth of 30 inches from the top of the top duct to the surface of the street, on a base of 4 inches of Portland cement concrete, with 1 inch of the same material laid between each layer of conduit, and 4 inches of concrete is placed on the top and both sides. The joints are butt joints, and over each seam a strip of cotton is laid, which is then plastered over with Portland cement mortar before any concrete is put upon it. A mandril is used to ensure a perfectly clean joint before another length is laid. These joints are clean and perfectly water-tight. Large manholes, 5 feet square by 6 feet deep, fitted with cast-iron covers 5 feet × 5 feet, are built up in two or more pieces. All manholes are drained either to the nearest sewer or to the next manhole, and iron back water valves are used.

Throughout the whole plant, simplicity and durability of arrangement and design seems to have been aimed at, together with the best types of mechanical and electrical service to be had, and the prospects of the company now should be very bright, and we hope its progress will not long be hampered by irritating restrictions which seem to be unnecessary.

A DEPARTMENT OF ELECTRICITY FOR CHICAGO.

Judging from appearances and results, America has not in the past been noted for its restrictive legislation or protective supervision where the generation and distribution of electrical energy has been concerned, as the crowds of bare overhead conductors carrying high-tension currents, and the numerous fatal accidents thereby occasioned from time to time, bear witness. Chicago, however, appears to be waking up in this direction, and, according to the *Western Electrician*, the City Council propose creating a Municipal "Department of Electricity," with officers and staff consisting of: "A city electrician, an assistant city electrician, a superintendent of construction, a chief clerk, two book-keepers, two stenographers, one chief inspector, and nine assistant inspectors, and such other assistants and employés as the City Council may by ordinance establish." The creation of the department, duties and salaries of officials, regulations, fees, and penalties, are to be included in paragraphs 589 to 598, inclusive of Chapter XXV. of the "Revised Code of Chicago, 1897."

Paragraph 589 embodies the name of the proposed department and enumerates the staff.

Paragraph 590 creates the office of city electrician, states that he shall be a practical and skilled electrician, shall not engage in any other business, shall be appointed by the Mayor, and shall hold his office for two years. So far, good.

Paragraph 591 provides that the said city electrician, before taking office, shall execute a bond to the City of Chicago, with approved sureties (number not mentioned) in the sum of $20,000! "conditioned for the faithful performance of the duties of his office." As shown in the next paragraph, the salary is to be $4,000, the bond being equal to five years' salary! Evidently the Council anticipate a heavy revenue to the department from fees and penalties, and it is not a very cheerful prospect for the producers and consumers of electrical energy. We presume the bond is intended to cover possible defalcations as negligence or other similar offences could surely be adequately met by requiring his resignation.

Paragraph 592 deals with powers, subordinate officers' bonds, and salary. The duties of city electrician include "the management and control of the fire alarm, telegraph, and police telephone system, of all municipal electric lighting, of the inspection of all electrical wiring within the City limits, both inside of buildings and above, beneath, and upon the surface of the streets, and of all electrical matters in which the city is interested." Salary, as stated above, $4,000 per annum.

Paragraph 593.—Assistant city electrician, qualifications, duty, salary. The assistant to be capable of taking the duties of his chief in his absence. Salary, $3,250 per annum.

Paragraph 594.—Superintendent of construction, duty, &c. To put in new circuits and instal all new work of the city, under the chief. Salary, $1,800 per annum.

Paragraph 595.—Other officers, powers, duties, salaries. All other officers with their powers, duties, and salaries engaged and fixed by the city electrician.

Paragraph 596 provides that "no electric current shall be used for illumination, decoration power or heating, except as hereinafter provided."

Paragraph 597 requires that "all persons, firms, or corporations," desiring to use electric currents for purposes set out in paragraph 596, shall, before commencing any electrical construction whatever, "either installing new electrical apparatus, *or repairing apparatus already in use*" (italics are ours), "file an application for a permit therefore in the office of the city electrician," describing in detail the work to be done, and "upon receipt of which application, if found proper, such permit shall be given."

While reasonable supervision of wiring and other work on consumers' premises is proper and necessary, both in the interests of consumer and undertaker, we cannot help thinking that this is carrying supervision to the point of absurdity, if not prohibition. As the paragraph reads, and in the absence of further explanation, the unfortunate consumer has to be deprived of his light, power, or heat for hours, or it may be days, if the city electrician chooses to be obstinate, because, forsooth, a switch goes wrong, or some trivial matter, which may be classed as "repairs," requires doing. How, in the name of common sense, can repairs to "apparatus already in use" concern the City Council?

But there is more to follow:—

Paragraph 598 empowers the city electrician, and it becomes his duty, to inspect installations both before and after its completion, and may remove laths, plaster, boards and partitions, in order to inspect current carrying conductors; should he find that the work has been done in accordance with the rules and requirements of the fire department, he shall issue a certificate—after receiving a fee—and the use of the current is unlawful until such fee is paid and certificate given. He may, however, issue a temporary permit before completion.

Paragraph 598A.—"A preliminary certificate may be issued by the city electrician in the case of completed installation, but upon which no current will be used in the immediate future." This certificate is to state that, at the time of inspection, the work was in order, and the fee shall be one-half the regular rates; before current is put on, another inspection is required, and, if still in order, the remainder of the fee is to be paid and final certificate given. The object of the preliminary certificate is not apparent, unless it is to fill up the time of the officials, as no current can be laid on until a further inspection and certificate is granted; and it is no consolation to the unfortunate householder, who wants the current, to know that three months ago his wiring was in perfect order, when a "dead earth," or other defect, prevents his being connected.

Paragraph 598B.—"The city electrician is hereby empowered to inspect or re-inspect all overhead, underground, and interior wires and apparatus conducting electric current for light, heat, or power," and if found unsafe to either life or property he can order them to be put right within 48 hours; failing which, a penalty of $10 may be imposed for each and every day they continue in an unsafe condition.

Paragraph 596C provides that all poles and manhole covers, now in existence or hereafter fixed, shall be stamped with the owner's name, and all services shall be labelled with the owner's name, and such a full description of the conductors as shall meet with the approval of the said city electrician.

Paragraph 598D prescribes the fees for permits and certificates as follows:

For each arc light	$1.00
For each 16-C.P. incandescent or equivalent ...	.10
For each E H.P. of 746 watts used for power or other purpose than above	1.00
Minimum charge for inspection	1.00
Inspection of temporary installations, show windows, exhibitions, &c., at the rate, per hour, of	.50
For re-inspections, half the above fees.	

Paragraph 598E requires the city electrician to issue a yearly report, giving a full and accurate account of all inspections made and moneys received!

Paragraph 598F.—No alterations to be made to any installation without the previous sanction of the city electrician.

Paragraph 598G.—Any violation of these provisions entails a penalty of not less than $50 nor more than $100, and a further penalty of $10 per day as long as it continues. The city electrician may also order and compel the cutting off of the supply until the provisions are fully complied with.

Against reasonable supervision on the part of the local authority of all work affecting the public safety, particularly that executed and maintained by private enterprise, we have nothing to say, indeed, it is necessary and right, but when it comes to the infliction of corporation inspectors into private premises we draw the line.

Imagine what this means. A private citizen requires or desires the current for lighting his dwelling house. He is generally perfectly ignorant of all rules and regulations, and relies upon his wiring contractor (poor man) to do all that is needful. Such contractor, if unscrupulous, and we presume that even in America there may be some, does everything he can to evade inspection. The city electrician gets to know, and a $50 fine is the result. Suppose, however, that the contractor gives the required notice, and the city electrician cannot immediately attend, or does not deem it necessary, the work proceeds. The Fire Insurance Company require their rules to be obeyed; the Supply Company also has rules and inspectors. The fire department of the city has rules, and lastly comes the city electrician, whose ideas of good work may far transcend those of all the others. At his orders down comes lath and plaster, partitions, or other obstructions, to enable him to inspect, and then it may be condemned, and have to be re-done; but if passed, a fee of 10 cents per lamp is demanded. Again, the city electrician's standard of excellence may be much lower than that of the supply company's engineer, and after the City Council's fee is paid, and permit given, the supply may be refused. We should think that such espionage would become intolerable, and that if would-be consumers knew the facts, they would leave electric lighting severely alone, and use candles.

Municipal supervision of this kind would never find favour in England, and we should think it would cause trouble in America.

We should be glad to welcome in England any reasonable measures which would effectually drive bad wiring out of the field; but we think it may be safely left to the fire offices and the supply undertakers' engineers, provided they are properly backed up by legislation—whether compulsory or permissive only.

The imposition of fees for inspection of private premises on the part of the municipality, when such inspection is rendered by it compulsory, is bad in principle. If the wiring is bad the consumer alone suffers, unless it is so utterly bad that all precautions have been neglected—such as an entire absence of cut-outs and other defects almost inconceivable in the 19th century—when, in case of fire, it may of course spread to other premises.

In any case, if the present condition of house wiring in Chicago has necessitated inspection, fees and penalties as above set forth, it must be pretty bad, and we may congratulate ourselves that it is at any rate not necessary in England.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

At the meeting of the Institution of Electrical Engineers held at the Institution of Civil Engineers, on Wednesday, the 9th inst., the discussion on Major-General Webber's paper, "Notes on the Electro-Chemical Treatment of Ores Containing the Precious Metals" was resumed, and on completion of the discussion Mr. Sherard Cowper-Coles read a paper describing "An Electrolytic Process for the Manufacture of Parabolic Reflectors."

Mr. Sulman had evidently not exhausted his offensive ammunition in the speech he made at the previous meeting, and the first contribution to the discussion on Major Webber's paper—after the routine business had been got through—was a categorical list of questions submitted in writing by Mr. Sulman, wherein he returned to the attack on the Pelatan-Clerici process with renewed ardour. In a series of 12 elaborate questions he sought to demolish M. Pelatan completely, and although his rival made out a very good case in his replies, we cannot but thank Mr. Sulman as being the agent by whom a very valuable appendix to the paper was obtained.

The more important items of information were, that the capital cost per tank of a plant for the treatment of 100 tons of ore per 24-hour cycle is: Treatment tank, 9 feet diameter, capable of dealing with 5 tons per day, costs £60; 20 such tanks are required, and the whole plant costs, say, £5,000, exclusive of crushing apparatus. Respecting a statement in the second question that with a sludge containing only 60 per cent. of water, one horse-power is usually found necessary for agitation, M. Pelatan replied that the power depended upon the nature and density of the ore; as little as one-fifth of a horse-power had been found sufficient, while the figure in the paper was ample. If one horse-power were required it probably included that necessary to revolve the containing vat or barrel.

Coming to the cost of treatment per ton with a plant capable of dealing with 100 tons per 24 hours, M. Pelatan gave the following figures in reply to Mr. Sulman:—

	s.	d.		s.	d.
Chemicals	2	6	to	4	0
Power	1	0	„	1	6
Labour	0	6	„	1	0
	4	0	„	6	6

600 lbs. of mercury were used in each tank, the loss being due to mechanical causes and amounting as a maximum to 2 ozs. per ton of ore. No attempt is made to recover the

cyanide. It was claimed for the process that it was exceptionally suitable for ores which yielded very poor or no results by ordinary methods, and as it can deal with ores crushed to pass through a very fine mesh, it evidently can deal with slimes.

The catechism ended, Mr. McMillan then read a communication from Mr. D. A. Louis, in which this gentleman—well known to many as a chemical expert who has paid special attention to metallurgical questions—expressed his feeling that the paper was admirably conceived, commented upon the general data offered, stated he thought the mill illustrated prodigious, and made some remarks upon the lack of particulars as to profit obtained, the cost of labour, &c. Apparently his desire for further information would have been satisfied to some degree had Mr. Louis been aware of the answers given by the inventor to Mr. Sulman. Mr. Cooper spoke briefly on the term "nascent chlorine," as used in the paper, and was afterwards answered by General Webber, who explained that sodium chloride was essential to the process for reducing the resistance of the electrolyte.

General Webber was then called upon to reply, and he did so, commencing by remarking that there was no reservation to the pleasure offered him by the observations of all the speakers. The paper was intended to consider the scientific, and not the commercial side of his subject, and chiefly was he concerned with the electrical side of the question. The fact that what he had dealt with was an electro-chemical process, was his reason for laying his paper before electrical engineers. If electricity were of no use, his paper was one to be brought only before mining engineers; but in bringing it under the notice of the members of the Institution, he desired to direct attention to the assistance that electricity afforded to an industry, the immense extent of which was perhaps not generally or fully realised. He thought that the younger members would do well to study the question as it fell to them to carry it on.

The replies to the criticisms in the discussion were complete and interesting. Briefly summarising what was said in a few lines, the author pointed out that the MacArthur-Forrest and Siemens-Halske processes were for the treatment of tailings; the methods for dealing with slimes had only quite recently approached practical solution. Three processes had generally to be employed:—Concentration, treatment over amalgamating plates, and finally with cyanide and deposition of the tailings. The descriptions of many processes failed to give any idea of the time occupied or the space required by the plant. The costs were difficult to give where labour is a factor that varies everywhere, and this factor alone may range from 2s. a day in one case, where a given plant is considered, with Kaffir hand labour up to 10s. or 12s., where white labour is employed. Messrs. Sulman and Teed were twitted with not giving any costs or scientific details of their own processes, which is a percolation one pure and simple. The cost of the Pelatan-Clerici process is governed by local questions; the variations for different classes of ore are effected by altering the length of time and quantity of chemicals.

Turbidity must be absent in the Siemens and Halske process, and the same condition is essential to success in all circulation processes: a great many more than those mentioned have been invented, and even put to work.

The president, Mr. J. W. Swan, followed General Webber with a few remarks that were useful in giving those present who were not metallurgists, a clear idea of the difference in processes. Thus the one before the meeting was intended for the amalgamation of gold that had not been brought into solution, its main object being to put the gold in a condition favourable for being taken up by the mercury. On the other hand, the Siemens-Halske process was one for the simple deposition of gold from a clear solution of gold already dissolved by cyanide.

Mr. Sherard Cowper-Coles then gave the description of his process for the production of projector mirrors, which was rendered all the more interesting by the use of the projection lantern, whereby a number of instructive slides were thrown upon the screen and explained to the audience by the author. In brief, the method consisted in depositing copper electrolytically on the back of a silver coating thrown down chemically on the surface of a glass mould of the desired form, the silver being afterwards covered by a coating of palladium to protect the silver from tarnishing. The silver and copper reflector is separated from the glass mould by heating in water to 120° F.

Mr. Grove thought the method was of particular value, as it enabled a projector mirror to be produced which did not require the excessive care in handling of an ordinary mirror, while it would probably be less effected by the bluish-white soot thrown off by the arc, and would, perhaps, be applied with advantage to the manufacture of the opaque screens used in projectors to maintain the parallelism of the beam by cutting off the direct rays coming from the front of the arc. General Webber conceived that this field of improvement might be of immense benefit to those who had to conduct the defence of our coasts in times of danger or under threat of invasion.

Mr. Mordey rose to protest against the assumption, implied in the observations of some speakers, that the Institution was not concerned with the "cost," or questions of cost. He thought that articles should be produced as cheaply as possible, and humorously remarked that while engineers are those who direct the forces of nature to the benefit of mankind, if the expense of any process is so great that man has nothing to eat, it is not much good to direct the forces of nature to his advantage. Mr. J. W. Swan congratulated Mr. Cowper-Coles very warmly upon his success in devising the process described, as he had considered the question years ago at the suggestion of Major Bagnold; but, foreseeing many objections to an electrolytic method, he had never ventured to combat them, and was pleased to find that such methods had proved so successful in the hands of the author.

The meeting adjourned with the interesting notification ringing in their ears that the next paper would be one by Mr. Binswanger-Byng on 200-volt fittings. The Institution has done well to procure papers on such "live" subjects as accumulator traction, electro-chemistry and now electric lighting. No doubt our friends—the station and contracting fraternity—will be glad to get back to a subject about which they have more to say than the extraction of gold—from ores.

THE "ALLAN" ACCUMULATOR.

THIS accumulator, manufactured by Allan & Adamson, Limited, has now been on the market for nearly three years, having undergone many severe and searching tests, not only at the company's works, but at the hands of others. The battery has quietly and steadily pushed its way forward, but the company decided not to court publicity in any special way until the most efficient methods of manufacture had been decided upon, and the battery had given satisfactory evidence of its durability.

These matters having now been firmly established, the company has no reason for further delay in bringing the accumulator more prominently before the electrical world; the more so, that recently a very important and valuable improvement has been made upon the plate, affecting its mechanical strength, and its efficiency as a support for the active material.

The plate is (as suggested by the last remark) of the pasted form, the paste or active material being supported in a hollow frame, both + and — elements being of similar construction. The hollow frame has lattices extending from edge to edge on both its sides, whilst the edges are perforated, and the paste is forced into these perforations to insure its more perfect support. Until recently the frame, cast in one piece, had the bevelled edge of its lattices on the outside, bevelled sufficiently to enable the frame to easily leave the mould, whilst the inner surface of the lattices were cast flat against the core; this form of lattice was deemed defective, as not securely locking the active material within the frame, and the attention of the management was directed towards *reversing* the lattices, whilst still casting the frame in one piece. This difficulty was ultimately overcome by a very ingenious method of casting (devised by Mr. Allan), which we are not at liberty on the present occasion to describe. The advantage of this improvement, however, must be at once apparent, as, by the new method of construction, the active material is preserved in one unbroken mass throughout the frame; that is, the frame supports the active material wholly from the *outside*. It is this peculiarity which confers upon this plate its freedom from *buckling*.

The composition of the paste is of such a nature as permits it to be made of almost any degree of hardness during formation without in any way lessening its power to discharge at very high rates; indeed, in this respect, it is claimed that the "Allan" accumulator is unusual, as its rate of discharge for three hours is said to be 1·5 amperes per pound weight of complete cell, whilst its average capacity in watt-hours, at a similar discharge rate, is equal to 9·0 per pound weight, the total ampere-hour capacity being equal to 6 amperes per pound weight, *also* of complete cell. A further idea of its capacity, weight, and size of a battery, may be gained by giving the following quotation from a tender which has just been submitted for use on a new electrically-driven cab:—

"Forty cells of 210 ampere-hours *guaranteed* capacity. The weight of these cells, complete, will not exceed 1,300 lbs., and they will measure outside 35 inches × 34 inches × 12 inches high."

The "Allan" accumulator makes strongly for traction. Its high capacity and discharging rate for its weight, its lightness, strength, durability, and immunity from buckling, all render it peculiarly adapted to this class of work.

Light and small, it can be more easily handled, and we all know that batteries, as a rule, suffer more in handling than they do in the actual work done by them. Aiming at perfecting their accumulator for traction work, the company is convinced that all other uses are being met at the same time.

The manufacturers consider the batteries admirably suited for every class of work, and having given them a thorough test for durability, are prepared to guarantee them and to substantiate the figures given.

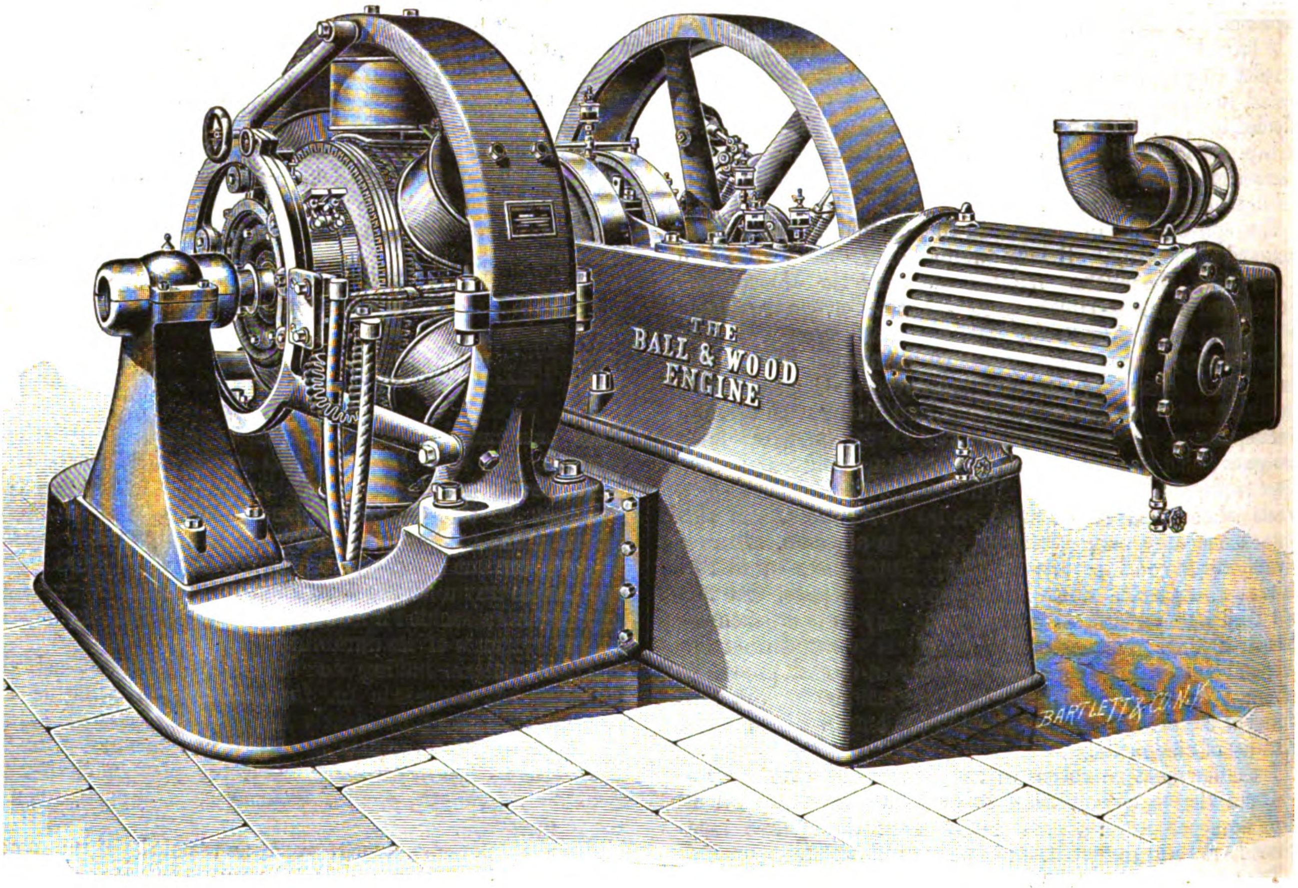
Several test sheets have been sent to us, all of which make out a remarkably good case for the "Allan" cell, but we have not space at our disposal to publish these.

We have, however, had an opportunity of seeing the process of manufacturing the plates, and of seeing several of the cells in operation, and there seems to be no reason why the merits claimed for this type of secondary battery should not be fully borne out in practical operations on a large scale. In any case electric traction experts will do well to fully investigate the claims made for this battery before deciding upon a choice of accumulator either for tramcars or other electrically-driven vehicles.

The North Metropolitan Tramway Company has had at least two sad experiences of the uses of secondary batteries on certain sections of its lines. Is it too much to hope that its enterprising and far-seeing managing director may see his way to yet another, and we trust commercially successful, venture?

THE BALL AND WOOD ENGINE.

One of the examples of the high speed American horizontal engine being introduced into this country by Mr. F. Nell (already so well known as a supplier of turbines), of 97, Queen Victoria Street, is that known as the Ball and Wood Engine. It is one of a box frame type, with over-hung cylinder and two fly-wheels with fly-wheel governor, and is claimed to regulate to 1 per cent. between abrupt changes of no load and full load. In this engine there is a peculiar slide valve which works between top and bottom faces. The ports are on the lower face, the steam entrance is in the upper face. The valve is in two parts, kept apart by the steam which is inside the valve, the two parts being joined by a telescopic sleeve. Exhaust takes place into the valve



chest. The face pressure is thus moderate and constant, and the wear even. The system of lubrication adopted is that of the oil pipe, clean oil from a reservoir being led to the parts through a filter and adjustable sight feed.

The Ball and Wood engine is one of those developed to its present perfection by the electrical industry, and in our illustration we show one of these engines directly coupled to a dynamo.

The sub-division of units has made the demand for economical engines of small power very large. Before the days of electric light, small-powered engines could not be obtained of economical type. The same tendency to use several units has spread to ordinary factories, where several small engines of good type are better than one large engine, probably owing to the great convenience they offer in running a department overtime when other departments are stopped.

In these engines there are double-disc counter-balanced cranks, the balance of the moving parts being thus direct and equally distributed on each side of the centre line. The two fly-wheels are outside the frame, and are made with a split boss, the split being radial only, and not diametral. When placed on the shaft, the boss is tightened by a stout through bolt, and opposite the bolt are two keys held tight by set screws. To put the wheels on their shaft it is only needful to use a small wedge to slightly open the boss so as to enable it to slip easily in its place. The governor, of fly-wheel type has the inertia weight and spring, and the inertia aids the centrifugal force. The weight arm is hollow, and has pockets for weights to vary the normal speed. The governor acts by moving the eccentric across the end of the shaft in such a way as to give a lead varying with the cut-off from a maximum at the latest point to zero, when the weights are in their extreme out position. Some idea of the powers of these engine may be gathered when we say that the 10 inches by 11 inches single cylinder engine run at 300 revolutions, will give 54 H.P. at 80 lbs. initial pressure.

The 16 inches by 16 inches engine at 250 revolutions, gives 211 H.P. at 100 lbs. initial.

Where an engine is wanted for direct connection, the bed or frame is made to suit the dynamo frame desired so as to obtain a harmonious combination.

In the catalogue before us, diagrams are shown from a 9 inches × 10 inches at 325 revolutions, which show a reduction of load from 300 to 75 amperes in 10 seconds. The diagram of each revolution is fairly closely traced as the load was taken off, and the governor action is made very plain.

The Ball and Wood Company do not confine themselves to small horizontal engines, or even to horizontal engines. They make also engines of vertical type and large size, for either direct connection, belt, or rope driving.

THE MEASUREMENT OF INSULATION RESISTANCE BY ALTERNATING CURRENTS.

For some time past, a rule has been in force in Germany which requires that the insulation resistance of any electric installation which is to be connected to the supply mains, shall be at least equal to $\frac{1,000,000}{n}$ ohms, when n is the number of lamps fixed; and, further, that the test shall be made with a pressure equal to that at which the circuit will be worked. In order to avoid the necessity of carrying about a battery capable of giving a testing pressure equal to the working pressure of the circuit, various methods have been suggested of making the test by means of current taken from the supply mains; and these methods, particularly in the case of alternating current supply, have lately formed the subject of articles in both German and French technical journals.

One of the methods proposed consists of connecting one pole of the supply mains through an alternating current voltmeter to the circuit to be tested, whilst the other pole of the supply mains is earthed; the insulation resistance being calculated, as in the case of direct currents, from the formula, $R = G.\frac{V - V'}{V'}$, where G is the resistance of the voltmeter, and V and V′ respectively the readings of the voltmeter when connected between the two poles of the supply mains, and between one pole and the circuit under test. Objection is taken to this method, because the resistance of the ordinary electro-magnetic voltmeter for alternating currents is so low that the instrument cannot be used to measure the insulation resistance of a circuit where the number of lamps fixed is small. This objection is, of course, an important one, but we do not think that accurate results would be obtained by this method, even on circuits of which the insulation resistance came well within the range of the voltmeter, unless this latter was specially arranged so that the non-inductive resistance in series with the working coils formed a very large percentage of the total resistance of the instrument. Again, although one pole of the mains might be earthed if each installation was fed by a separate transformer, there would be very great objections to the earthing of one pole of a low tension distributing network.

To get over the first-named difficulty of want of sensitiveness, an instrument has been devised by the Allgemeine Electricitäts Gesellschaft, in which the fixed coil is connected across the terminals of the supply mains, and is arranged to take a current of 1 ampere or more so as to produce a very strong field, whilst the circuit of the moving coil, which is of high resistance, is connected between one pole of the supply mains and the circuit to be tested. This type of instrument should certainly give much better results than the ordinary voltmeter, but the objection to earthing one pole of the supply mains still remains, and renders this particular method of testing inadmissible in many cases. A slight modification of the method of testing would render the earthing of one pole unnecessary, but it would at the same time reduce the testing pressure from that between the supply mains to the pressure between one pole and earth; and this might be anything between the full working pressure and half that amount, according to the condition of the distributing network. Of course, the objection to earthing might be removed by using a small equal ratio transformer to supply the testing current, but this would be nearly as cumbersome to carry round as the testing battery.

A bridge method has also been proposed and tried, the galvanometer being replaced by a telephone, and the battery by a connection to the supply mains, whilst the terminals to which the unknown resistance is usually connected, are joined up, one to the circuit under test and the other to earth. This method has been tried with a working pressure of 120 volts and a frequency of 50, but was not found sensitive enough to give satisfactory results, and although it is stated that accurate measurements could be made when the testing current was supplied by an induction coil instead of from the supply mains, the method does not appear to us to have any advantages likely to bring it into general use.

If any method is to be used in which the testing current is taken from the mains, we would suggest that the circuit to be tested should be connected to one pole of the supply mains through a non-inductive resistance, and that the potential differences between the terminals of this resistance, and between the supply conductor and earth should be measured by an electrostatic voltmeter. The insulation resistance of the circuit would be given by $R = r.\frac{V - V'}{V'}$ when r is the value of the non-inductive resistance, and V and V′ respectively the readings of the voltmeter when connected to earth and across the terminals of the resistance. The value of the resistance, r, must, of course, be such that it is at least equal to $\frac{R}{x - 1}$ if R is the highest insulation resistance to be measured, and x the ratio of the highest and lowest readings of the voltmeter.

ENCLOSED ARC LAMPS.

Since the introduction of the commercial arc lamp, says the *Electrical World*, in 1878 no improvement has been made in its development that can compare in commercial value with the enclosed arc principle. The use of the enclosed arc has practically revolutionised the arc light industry, and, says our contemporary, one of the earliest and most successful lamps of this character placed upon the market was the Jandus double enclosed arc lamp. This lamp, which is manufactured by the Jandus Electric Company, Cleveland, Ohio, has been before the public for the past three years, both in Europe and America. The Jandus lamp burns directly across the terminals of a potential circuit without waste of energy. This makes it desirable for a street lighting system where multiple circuits are used, and for an underground system it is particularly adapted, because lamps can be connected wherever necessary without the inconvenience of running connecting wires between pairs of lamps or installing two lamps where only one is needed, or wasting the energy of one lamp, as was necessary under the old system of connecting two lamps in series. For interior lighting, the economy and convenience of burning lamps singly cannot be over-estimated. The Jandus lamp has been highly endorsed by the Board of Fire Underwriters generally. Mechanically and electrically it differs greatly from any other lamp. The action of the lamp is extremely simple. There is only a single winding which forms the solenoid. The armature is held suspended in a strong magnetic field formed by the iron frame of the lamp, which surrounds the winding. The regulation of the lamp is maintained by the weight of the armature, which is considerable, opposing the pull of the magnet. When the arc becomes too long, from the consumption of the carbon, the magnet will weaken, owing to the decrease in the current flowing through it, caused by the increased resistance of the arc, and the armature will fall a little until the arc has regained its normal strength, and the current consequently restored, when the magnet will again hold the armature stationary. The armature is the plunger for its own dash pot, formed in a brass tube inside the coil. The carbon, extended by a tube or sheath, is inserted directly into the clutch, consisting of a pan-shaped piece, carrying four clutch rings, which fall by gravity and grip the carbon between the inclined side of the pan and the carbon. The clutch releases this and allows the carbon to feed when the armature has descended, until the clutch rings rest upon the releasing tube. This form of clutch allows the unequal sizes of the carbons and sheath to be fed through it with equal accuracy. The current is conducted to the carbon through a series of 16 contact rings, which are arranged in a circle and make a flexible contact with the carbon. One of the great advantages of the absence of the carbon rod is that the current is conducted from the mechanism directly to the carbon. The upper carbon is held concentric with the lower by the globe cap, which is centred by the guides on the bottom of the box enclosing the contact rings. The armature carrying the clutch is therefore the only movable part in the entire mechanism of the lamp, the absence of springs or adjustments being one of the most notable features. The yoke supports the inner globe and the lower carbon holder at its bottom end, where a ring admits the arms of the spider carried on the lower holder. This spider, by a turn to the right, locks the holder in position, and closes the electrical circuit through the lamps. The outer globe is secured to the yoke by a circular nut, and is closed, air-tight, at this point by means of asbestos gaskets. The Jandus standard lamp for outdoor service is provided with a waterproof case, and the terminal wires are led through water-tight rubber bushings, no hood being required. The rheostat is placed below the lower carbon holder inside the outer globe in a position where it will cast no shadow, and is thoroughly protected from the weather and readily accessible. In the lamp for inside service the rheostat is placed in a canopy at the top, where it can be readily adjusted by dropping the top half of the canopy. A cut-off switch is provided in the canopy. The Jandus lamp is claimed to embody the following advantages: Long life (the lamps burning 150 hours on a single half-inch carbon); lamps burn singly with economy on 110-volt circuit; perfect diffusion and uniform distribution of light; absence of flickering; practically noiseless in operation; fewness of working parts; decrease in cost of repairs, and small size.

THE PROTECTION OF ELECTRIC POWER TRANSMISSION CIRCUITS FROM LIGHTNING.*

By JOHN T. MORRIS, Stud.Inst.C.E.

The importance of efficiently protecting electric power transmission circuits from lightning is shown by the fact that in some of the earlier installations it was found more economical to shut down the generating plant than to run the risk of an armature being burnt out, or other similar mishap, during a severe thunderstorm. The danger lies not so much in the conduction of the discharge to earth as in the arc, started by the lightning, being maintained by the current. After demonstrating in a curve the relation between the sparking distance and voltage, the author shows that the discharges from which the line must be protected are of three kinds: (1) Those due to lightning actually striking the line; (2) the rush and surgings of electricity induced in the line; and (3) those due to slow accumulation of the charge. Discharges of the first kind are extremely rare, those of the third are occasional, while those of the second are the most frequent. The methods of preventing discharges from entering the circuit are described: at Niagara and Grünberg an earthed wire is stretched along the circuit a short distance above the conductors; and the means of providing opportunities for the discharge, after having entered the circuit, from passing to earth, are detailed. Lightning arresters may be divided into two classes: those in which the line is permanently connected to earth through a high resistance, and those consisting of a short spark-gap, one terminal being connected to earth and the other to the line. Examples of both types are explained, and the various methods of extinguishing the arc are dwelt with, typical instances of each being described. After dealing with the non-arcing properties of some metals, such as zinc, cadmium, antimony, bismuth, &c., the author proceeds to detail arrangements for good earths, and the methods, such as by choking-coils, of preventing discharges passing along the line to the power-house; the best positions of arresters in power transmission and tramway work are shown, and a description is given of a 15,000-volt 3-phase arrester and choking-coil rack. The author concludes by considering the number of arresters required upon a circuit: recent experience has shown that one per mile in sheltered places, and as many as twleve in exposed positions are necessary to ensure a reasonable degree of safety. The principles employed in some arresters were illustrated by experiments. Numerous specimens of different arresters used in power transmission work were exhibited.

* Abstract of paper read before the Institution of Civil Engineer Students, February 11th, 1898.

SOAMES'S MOTOR-TESTING BRAKE.

This brake, which is being introduced by the Davies Motor Company, is of extremely simple construction, and gives perfectly definite weighing of the torque on the pulley under test against ordinary dead weights. It consists of a steel lever working on knife edges, which can be raised or lowered by the hand-wheel at the top of the brake. Holes are drilled in the lever at equal distances from the centre, corresponding to the ordinary sizes of pulley in use. The centre of the brake is placed over the centre of the pulley, and from the two holes corresponding to the diameter of the pulley under test is suspended a piece of webbing, which passes round the pulley, as in the

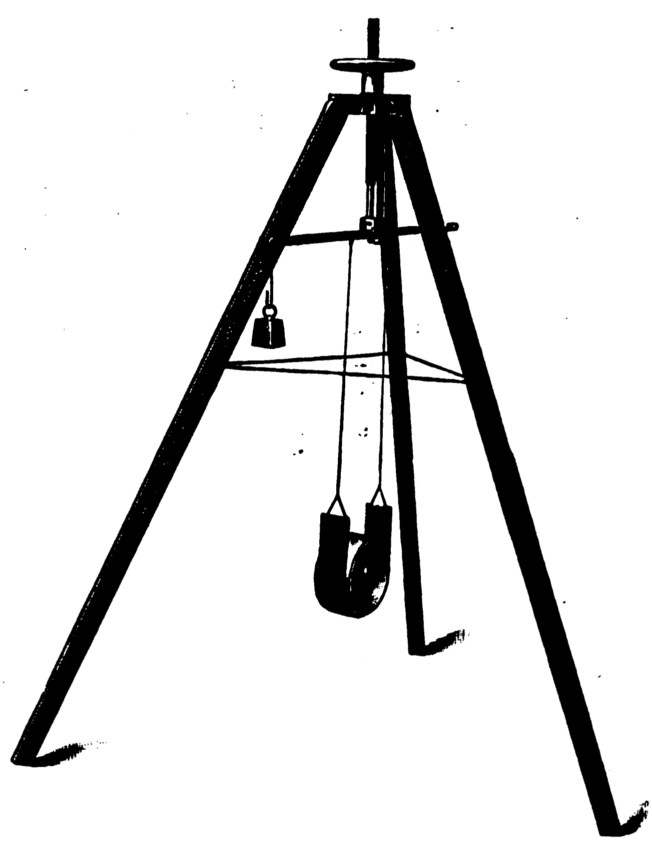


diagram. When the pulley is running, a weight, say, from ¼ to 30 lbs., is suspended on the end of the arm, as shown. The whole is then raised by turning the hand-wheel, tightening the belt on the pulley until sufficient friction is put on the belt to raise the arm to a horizontal position and keep it floating there; the speed of the pulley being taken at the same time. The usual constant, viz., $2 \pi L \div 33{,}000$, L being the distance of the weight from the centre, multiplied by the speed and the weight, gives H.P. direct. The size of the pulley, which should be perfectly smooth and flat, does not enter into the equation, so long as the distance between the holes in the arm is equal to its diameter; the band *must*, in all cases, be hung from two holes equidistant from the centre. It is stated that every reading can be repeated with absolute certainty, and that each one does not take more than 10 seconds at the outside.

HORSE-DRAWN CABS v. ELECTRIC CABS.*

The actual expenses of operating vehicles are very difficult to obtain in this country, both the costermonger and the railway director displaying a suspicious reticence when asked for information, which is not a little amusing. Our French contemporary, *La France Automobile*, has, however, succeeded in obtaining such information as is applicable to Paris, and we reproduce it here as being an eminently instructive comparison. Moreover, we think that the prices do not differ greatly from those ruling in London:—

Daily Cost of a Horse and Cab.

	Francs.
General expenses	0 53
Financial expenses	0.30
Tickets (cabman's)	0.01
Apprenticeship and sundries	0 05
Provident fund	0.07
Fire insurance	0 02
Lighting of carriages and depôts	0.11
Heating " "	0.02
Water	0.03
Syndicate expenses	0.05
Accidents and damage	0.35
Rent of depôts	1.05
Depôt staff and employés	0.99
Rates and taxes	2.26
Food, shoeing, and wear and tear of horses	6.65
Renewing and wear and tear of rolling stock	2.74
Wear and tear of property	0.21
12s. 4d. =	15.44

Daily Cost of an Electric Cab
(The number of carriages being equal in the two cases).

	Francs.
General expenses	0.17
Financial expenses	0.08
Tickets (cabman's)	0 01
Apprenticeship and sundries	0 05
Provident fund	0.04
Fire insurance	0 01
Lighting of carriages and depôts	0.05
Heating " "	0.01
Water	0.06
Syndicate expenses	0.05
Accidents and damage	0.24
Rent of depôts	0.35
Depôt staff and employés	0.50
Rates and taxes	1.50
Electrical energy and accumulators	2.20
Renewing and wear and tear of stock	2 74
Wear and tear of property	1.07
7s. 4d. =	9.13

Allowing for an under-estimate there is still a large balance in favour of the electrical cab.

BUSINESS NOTICES, &c.

Announcement.—Mr. S. Harrison, of Wigan, informs us that the delay in the execution of orders, occasioned by the recent fire is at an end, and that he is now in a position to give prompt delivery. He has, moreover, secured larger premises at 73, Wallgate, Wigan, to which the workshops and showroom will be transferred as soon as the necessary alterations are completed.

Business Announcement.—Messrs. Reed & Jenkins have opened a showroom at High Street, Bristol, and are generating their own current by means of a Silvertown dynamo driven by a Crossley gas engine. They are agents for the Stewart enclosed arc lamp.

Dissolution of Partnership.—Messrs. J. McLellan and G. J. Wells (John McLellan & Co., electrical engineers, 19, Station Road, Blackburn), have dissolved partnership from May 31st, 1897. Debts to be attended to by J. McLellan, who continues the business under the old name.

Liquidation Notices.—Mr. J. H. Thornton, of 2, Warwick Street, Regent Street, London, W., liquidator of the National Company for the Distribution of Electricity by Secondary Generators, Limited, gives notice to creditors that they must send notes of their debts or claims, and the usual particulars, to him on or before Tuesday, March 15th.

Mr. R. H. Marsh, of Ethelburga House, Bishopsgate Street Within, E.C., also gives notice that creditors of the Crompton-Howell Electrical Storage Company, Limited, must send to him as the liquidator, particulars of debts or claims, on or before March 25th.

Creditors of the Electrical Traffic Syndicate should send particulars of their debts or claims and the usual information to Mr. Maurice Jenks, 6, Old Jewry, E.C., liquidator, by March 26th.

* *The Automotor and Horseless Vehicle Journal.*

Electrical Wares Exported.

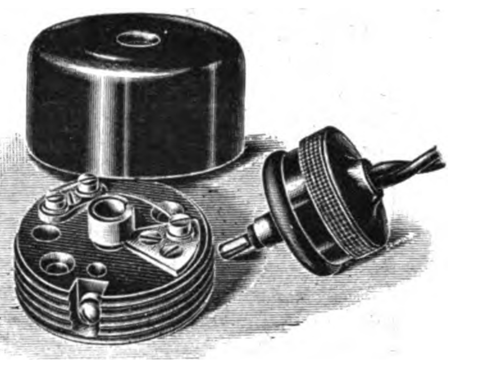
Week Ending Feb. 15th, 1897.

	£	s.
Albany	158	0
Alexandria. Teleg. mat.	140	0
Amsterdam	50	0
Auckland	328	0
Brisbane. Teleg. poles...	526	0
Bombay. Teleg. mat. ...	59	0
Brussels...	10	0
Calcutta	790	0
Cape Town	321	0
Corfu. Teleg. mat. ...	23	0
Durban	408	0
East London	340	0
Gothenburg	8	0
Hamburg. Teleg. mat.	225	0
Hobart	31	0
Malaga	155	0
Port Elizabeth	161	0
Rotterdam	276	0
Shanghai	527	0
Sydney	1,181	0
Trinidad. Telep. mat.	48	0
Wellington	560	0
" Telep. mat.	2,320	0
Total	£8,644	0

Week Ending Feb. 15th, 1898.

	£	s.
Aden. Teleg. mat. ...	22	0
Amsterdam	80	0
Antwerp...	244	0
Auckland	27	0
Bangkok...	229	0
Barcelona	210	0
" Teleg. wire	98	0
Boulogne	20	0
Buenos Ayres. Teleg. mat.	478	0
Calcutta...	851	0
Cape Town	25	0
Olinde	156	0
Colombo...	60	0
Delagoa Bay	1,832	0
Durban	3,001	0
Flushing	60	0
Gibraltar	538	0
Gothenburg	123	0
Hong Kong	150	0
Leghorn...	122	0
Lisbon	48	0
Madras	5	0
Melbourne	762	0
Napier	10	0
Ostend	50	0
Port Elizabeth. Teleg. mat.	450	0
Shanghai	115	0
Singapore	178	0
" Teleg. wire...	61	0
Sydney	335	0
Trinidad	22	0
Wellington	77	0
Yokohama	935	0
Total	£11,374	0

Concentric Wall Connections.—Mr. A. P. Lundberg sends us a sample of the "Gem" concentric wall connection, which he is just putting on the market. It is claimed to be simple in construction, small in size, and neat in appearance. Safety is claimed as one of its good points, as the brass parts of opposite polarity are well separated, and on this account wilful short-circuiting is made a



more difficult matter; the small hole in the cover (the plug being only $\frac{1}{4}$-inch diameter) is also an advantage. In outside appearance it closely resembles the "Dot" two-pin wall connection, which is in great demand, and can be fitted with similar varieties of covers and plugs as that pattern. It is only $1\frac{3}{4}$-inch diameter, and $1\frac{11}{16}$-inch height over all when plug is in connection with socket part. A long fuse is provided for, if such is required, and all plugs and sockets are made interchangeable.

Electric Clock-Switch.—A patent automatic electric clock-switch (Wheatley, James & Browne's patent) is being placed upon the market by Messrs. James & Browne, 39, Victoria Street, S.W. The instrument is specially designed for shop window lights, street lamps, advertising signs, &c. Its object is to automatically switch "on" and "off" at any desired time, the weekly winding of the clock being the only attention necessary. It is fitted with a quick make-and-break mercury switch, which has been found to work thoroughly satisfactorily both on arc and incandescent circuits. The mechanism involving the patent is very simple, though reliable. A single transmission wheel connects this mechanism with the clock, which is a pendulum movement. The instrument is enclosed in a painted iron case, and the dials are covered by a circular bevel glass in polished glass rim. For outdoor use it is enclosed in a dust-tight, damp-proof case, which can be fixed either in the base or attached to any lamp standard.

Electro-Chemistry and Water-Power Utilisation in Switzerland.—A company is in course of formation at Berne, with a capital of £80,000, to be known as the Electro-Chemische Industrie Gesellschaft, to put down plant to utilise certain available water-power, and to erect an electro-chemical factory near Thusis.

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Electric Lamp Carbons in Canada.—It is reported that new works for the manufacture of arc lamp carbons by a special process are about to be established at Brockville, Ont.

Fire Alarms.—The houses of the members of the fire brigade are to be connected by means of electric alarms.

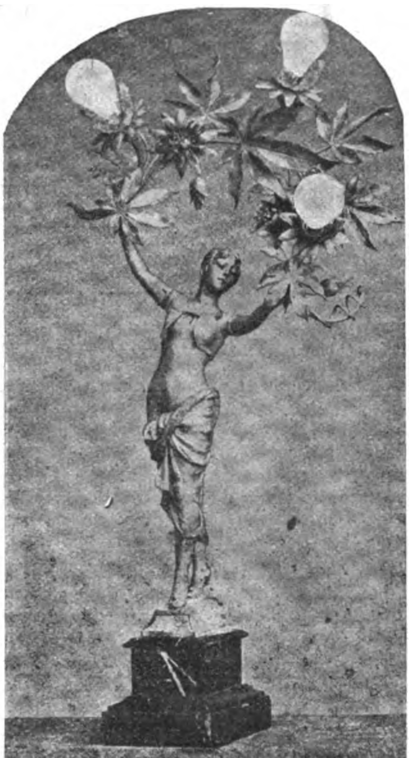
Foreign Cable Agency.—A first-class London firm, well connected with the electrical trades, is required to represent a foreign cable factory in England and British Colonies. Applications are to be addressed to K. E., 763, care of Rudolf Mosse, Cologne, Germany.

Harrison Coles & Co. v. Radford.—At Wandsworth County Court on Monday, Messrs. Harrison Coles & Co., sued Mr. Joyce Radford, of the Station Hotel, Richmond, for the cost of installing the electric light. The case was settled by defendant agreeing to pay £18 provided the work was done satisfactorily.

Institution of German Electrical Engineers.—The annual report of the Berlin Elektrotechnische Verein states that the number of members in January was 2,444, of whom 555 were resident in Berlin. As compared with January, 1897, this shows an increase of 371 members.

King's College Engineering Society.—At a general meeting held on Friday, February 11th, Mr. J. D. L. Bradwell read a paper on the "Manufacture of Incandescent Lamps." The author, commencing with an account of the parchmentising process of making filaments, went on to describe the different processes of mounting, and the uses of flashing; he then concluded with a short description of the method of making the bulbs, and sealing in the filaments.

Krupka & Jacoby.—We have received from Messrs. Krupka & Jacoby a set of illustrations of figures and wall decorations for electric lighting, of which we give an example, as the showrooms



of the firm at 62, Watling Street, are now stocked with a great variety of this special class of goods; those who need fittings of an ornamental character should not omit to pay them a visit, for the designs are extremely beautiful and artistic.

Lists.—The Phœnix Glass Company, of New York (London representative, Mr. A. L. Gibson, 4, Queen Victoria Street, E.C.) sends us a list of the Davis Indicating Globe. This is a globe in the shape of a hand, with a finger pointing to "office," "exit," &c., these words being on the back of the hand in black. The globes are made in opal, ruby, or flesh tint.

Messrs. Green & Boulding, of Featherstone Street, City Road, are sending out a list dated February 1st, 1898, giving full details of the Buffalo automatic injector, also some notes of the "Shipman" engine, Tripp metallic packing, &c.

Messrs. Price & Cornell, of 15, Victoria Street, S.W., have issued a list giving an illustrated description of the Westminster gas engine ("Otto" principle). Prices and particulars of single cylinder horizontal engines, from 2 to 30 H.P., are given, also of small horizontal motors ½ and 1 H.P., and vertical motors ¼ and ⅜-H.P.

Lloyd & Lloyd v. D. and W. Henderson & Co.—In this action, which has already been briefly reported in the Electrical Review, Sheriff Strachan has issued an interlocutor ordering an opinion of English counsel to be taken on the question. It will be remembered that plaintiffs sought to recover from defendants £600 as patent royalties for years 1895, 1896, and 1897. Pursuers hold letters patent in the United Kingdom for the Benardos system of electric welding, and at pursuers' request, they allege they had prepared a license to use the invention. Defenders delivered license again to pursuers signed by A. P. Henderson, for self and partners. The pursuers contend that by the law of England there is continuing liability for the total royalties to the end of the patents amounting to £2,600, less £400, already paid by the defenders. The defenders refuse to pay further royalty on the ground that there was no completed agreement, and that they had ceased using the invention.

Lyell v. Davies.—Judge Lumley Smith, Q.C., delivered judgment in this case at the Westminster County Court last Saturday. The plaintiffs, Messrs. Lyell & Co., electrical engineers, had an order for a frame in which the portraits of King Oscar and the Queen of Sweden were to be enclosed. They were fitted for the electric light, and were to be used in the decorations in Stockholm on the occasion of King Oscar's Jubilee. The frame was handed to the defendants with instructions to ship it by a certain boat for delivery at Gothenburg. They missed the boat, and on its arrival no artists could be obtained to paint the portraits, and the frame was therefore refused. Had it gone by the boat arranged for, it would have gone through all right. His Honour found that defendant undertook the risk knowing all the circumstances, and there would be judgment for the plaintiff for £18 with costs. Leave to appeal was given.

Packing Export Goods.—In connection with our recent comments on the necessity for more careful packing of machinery for foreign parts, we note from a paragraph in the *Times* that Germany attributes a good deal of its success abroad to the care which is given by manufacturers to packing and transport. The latest report from the British Legation in Munich contains some observations on the great importance of packing goods in such a way as to set them off to the best advantage, and of the improvements made in Germany in this respect during the past few years. Ten years ago German consular reports contained numerous complaints of defective packing and arrangement; but this has now been altered, and the Germans are said to surpass the French in the tasteful and suitable manner in which they present their wares to foreign buyers. The requirements of distant countries in regard to packing are carefully studied. The various methods of transport after arriving at the ports of discharge are known and provided for, as well as the provisions of the different tariffs, so that goods may be packed in such a way as to pay as little duty as possible.

Rochefort-sur-Mer Exhibition.—An international and colonial exhibition will be held at Rochefort-sur-Mer from June 1st to October 1st, 1898. The exhibition will be established on the Esplanade and the Roz-Bry Square. All the products of commerce industry, marine, and the fine arts will be admitted, and metallurgy, mechanics, and electricity will be special features. For all further particulars, apply to La Mairie de Rochefort-sur-Mer.

"Scientific American" Catalogue.—We have received from the publishers of the *Scientific American* (361, Broadway, New York), a cloth bound copy of their new *Scientific American Supplement* catalogue, giving, in carefully arranged form, titles of articles which have appeared in that paper on variety of subjects of scientific interest. The list is a good index, reference being made to 10,000 of the more important articles.

Scottish Cyanide Company.—We reproduce the following from the *North British Daily Mail*:—"The Scottish Cyanide Company will begin operations in a fortnight at their works at Leven. The process patented by Mr. Reymond, of Edinburgh, is purely electrical, the clay thereby being heated in its entirety, whereas by the old method this could not be secured. The electric plant is the best and most valuable laid down in the kingdom, and its cyanide of potassium will be put on the market at a much lower rate than presently secured. The capital of the new company is £200,000."

Smoking Concerts.—On Friday last, at the Grosvenor Hall, Buckingham Palace Road, between 300 and 350 employés of Messrs. Drake & Gorham, and their friends, attended a smoking concert, and a very pleasant evening was spent. Mr. Drake stated that 1897 had been the firm's record year in turnover, in spite of increasing competition, and that during the past 12 months £1,000 had been distributed among the employés in the form of bonuses.

A smoking concert of the drawing office staff and others employed at the Electric Construction Works, at Bushbury, was held at the Swan and Peacock Hotel, on 5th inst.

Water-Power.—The subject of water-power utilisation for electric lighting installations is an attractive one, and it will interest our readers to know that Mr. Alph. Steiger has just supplied and erected a new turbine plant which utilises a fall of only 2 feet, and develops 40 brake horse-power, for Mr. A. J. Taylor, of Strensham Mills, near Tewkesbury. The plant has just been most successfully started. There are probably not a dozen turbine plants in the world utilising such a low fall; but the success claimed in this instance shows that even low falls, of which there are plenty in this country, can be turned to good account.

Workshop Lighting.—Messrs. Robey & Co. have put down the necessary plant for lighting the workshops, offices, and other buildings, of Messrs. Wm. Pattinson & Sons, builders and contractors, at Ruskington.

ELECTRIC LIGHTING NOTES.

Aberdeen.—Prof. Kennedy was in Aberdeen on Saturday, and conferred with the Gas and Electric Lighting Committee *re* extensions of electric lighting to the West End, the utilisation of dust, and the proposed electric tramways. The professor will report. It is proposed to light the West Church by electricity.

Adenshaw.—The District Council recently conferred with the Manchester City Council *re* electric lighting, and the latter body offered to lay cables to supply such places as Adenshaw at the same price as Manchester residents pay.

Ashton.—The Council has approved of a design of arc lamp pillar, with incandescent lamp brackets, submitted by Mr Clirehugh. A tender has been accepted.

Ballymena.—Immediate steps are to be taken to have the town lighted electrically. The clerk to the Commissioners is to get information from English towns as to the systems.

Bermondsey.—The Electric Lighting Committee has been empowered to obtain a further report from Mr. Manville, dealing with the proposal to combine dust destruction with the electric lighting scheme.

Blockley.—On Tuesday last the small plant for street lighting was inaugurated. Messrs. T. Parker, Limited, supplied the dynamos (one for the public, and one for private supply), one being worked by a 13-H.P. turbine, and the other by a 10-H.P. vertical engine. There are 28 lamps in the streets. The cost has been defrayed by public subscriptions. Major Spencer (whose wife switched on the current) replying on her behalf, said that nine years ago the village adopted electric street lighting, and it continued until the Blockley Electric Light and Manufacturing Company dissolved three years ago, since when oil lamps had been used. Mr. H. N. Warburton was the electrical engineer for the work.

Cheltenham.—The electrical engineer has reported that the two new boilers had been erected and tested with satisfactory results, and that the first 220-kilowatt steam alternator would be ready for steam trials on February 9th. Mr. Waghorne stated that the electrical engineer estimated that the delay in the supply of machinery caused by the engineering dispute had involved the loss of something like £1,000 to the electric light revenue.

Cordoba.—From an article in a Buenos Ayres paper, we gather that the electric light and power works for Cordoba, Argentine Republic, are in so advanced a state, that in the course of a few weeks supply may be commenced. Turbines and dynamos are in position at Casa Bamba. The cables are completed to Cordoba, 22 kilometres in length, and some of the mains in the city as well. The company utilises the power of the river fall between Dique de San Roque and Mal Paso, on the Rio Primero. At Casa Bamba a tunnel, 90 metres long, and 3½ metres diameter, has been made through the hill, connecting the two extremities of a great bend in the river. Water is conveyed from the tunnel to the turbines by a 2-metre iron tube. When further plant is put down to the extent provided for, there will be 5,000 H.P. available. Current is conveyed by overhead conductors at 10,000 volts. From Casa to Cordoba there is a line of posts bearing three 9-mm. copper wires, and three wires for protection from lightning. At the Casa Bamba station transformers raise the voltage, and near the Observatory it is reduced to 2,000 volts, and subsequently to 210 and 115 volts respectively for power and lighting of consumers' premises. The general manager of the Electric Light and Power Company at Cordoba is Mr. Theophilus Greenwood. The company has numerous applications for current.

Country House Lighting.—The Grove, Witham, has been lighted by electricity for Mr. Percy Laurence. Messrs. Laurence, Scott & Co. supplied the plant, and Messrs. Strode & Co. carried out the work. There are 200 lights in the mansion and other buildings.

Lord Wantage has given the order to the National Electric Free Wiring Company, Limited, for supplying and erecting a complete installation for electrically lighting "Downs" House, near Wantage. The installation comprises steam engine, boiler, dynamo, storage batteries, switchboards, mains, house wiring and fittings. The wiring is all to be on the "patent Twin system," owned by the National Electric Free Wiring Company, Limited.

Coventry.—The monthly return of the electric light department shows an increase over the corresponding period last year. For the past few months the returns have shown a steady increase.

Crieff.—On 7th inst. the Town Council met in private to consult with Mr. R. Frederick Yorke, A.I.E.E., as to the proposals he has made in regard to electric lighting for the burgh. Mr. Yorke thinks though £8,000 would, in his opinion, be necessary to carry out the scheme he proposes by water power, the working expenses would be nothing approaching the outlay if steam power were to be used. He would propose to convey the current from the Turret or Barvick Falls to Crieff by overhead wires. He is of the opinion, if a local company could be formed for carrying out the scheme, the town would be relieved of all responsibility in the way of raising capital, &c.

Greenock.—Last week we stated that Mr. Tighe, of Paisley, was being consulted by the Commissioners on the electric lighting question. This should, of course, be Mr. Teague, of Paisley.

Hartlepool.—In connection with the proposal to combine dust destructors with electric lighting here, a Corporation deputation visited Leyton last week to inspect the destructor there.

Hyde.—The Council is to apply to the Local Government Board for a further loan of £1,000 on the Technical School account for electric lighting and other purposes.

Ipswich.—The electric lighting order having been obtained, various proposals were before the Town Council recently, as to what should be done next. One motion was, that the Electric Lighting Committee be re-appointed, with instructions to proceed with the necessary works at a cost of £36,200; but ultimately an amendment, requesting the committee to carefully consider the offers received by private parties for the purchase of the order, was carried.

Kettering.—Letters have been received from the Municipal Electric Supply Company and the Electric Extension Company *re* electric lighting. Further consideration has been deferred by the Council for three months until the new Council is in office.

Kingston.—The fourth annual report of Mr. J. E. Edgcome, borough electrical engineer, shows that after payment of all the works' cost for generation of electricity, maintenance, and repair of machinery and mains, &c., there remains a balance of £867 19s. 9d., as compared with £301 3s. 1d. for 1896. This sum is sufficient to pay the interest for the year on the capital expended on the undertaking, leaving a balance of £43 12s. 1d. towards the repayment of the principal.

Leeds.—The Yorkshire House-to-House Company, and representatives of the Corporation, conferred together on 8th inst. respecting the proposed purchase of the undertaking by the municipality. It is probable that the whole matter will be thrashed out before the Local Government Board inquiry, to be held in a week or two.

Liverpool.—The Much Woolton Urban Council is proceeding against the Liverpool and District Electric Lighting Company for having caused a smoke nuisance at the generating station at Gateacre.

London.—Mr. T. W. E. Higgens, surveyor to the Chelsea Vestry, has drawn up a report with regard to the Metropolitan Electric Supply Company's Bill before Parliament, in so far as it affects the parish of Chelsea. He states that the company are supplying electricity in various areas, and, being unable to acquire land for larger generating stations within the areas supplied by them, have purchased a site in Willesden and Acton, upon which they are erecting a generating station, and they seek Parliamentary sanction to convey electricity from this station to Amberley Road, Paddington, by means of two lines of cables, one laid under the towing path of the Grand Junction Canal, and the other under the roadway of Harrow Road. The Chelsea surveyor thinks that the Vestry should oppose the laying of any mains in Harrow Road, unless the company will undertake to supply electricity for public and private purposes at Kensal Town at a cost of not more than 4½d. per unit.

Lowestoft.—At the last Council meeting Mr. Fry, chairman of a Special Committee, reported in favour of the Horsfall destructor, of high temperature and forced draught. A rough estimate of the cost was £3,000, which would effect considerable saving on the present system. Smith's Marsh had been practically decided on as the site of the electric station, and there would be plenty of room there for the destructor. The question was referred to the Sanitary Committee to obtain tenders and apply for a loan for the combined scheme.

Lynn.—After receiving a note of the terms of several consulting engineers for reporting and advising *re* electric lighting, the Corporation has appointed Prof. Kennedy.

Newmarket.—A local company has been formed to take over the electric lighting order which Messrs. Edmundson, Limited had agreed to purchase from the Council.

Pembroke.—Mr. Robt. Hammond explained his electric lighting scheme to the Commissioners on 7th inst., and the Electric Lighting Committee was afterwards instructed to proceed with the scheme, the estimated cost of which is £32,500. The proposed compulsory area includes four miles of lamps, and the scheme provides for 7,500 lamps, though the station chimney and buildings will be large enough for plant for 15,000 lamps.

Peterborough.—The Local Government Board inquiry into the application for a £15,000 electric lighting loan for the Council was held at the Guildhall last week. The inquiry lasted three years.

Plymouth.—An electric lighting plant, comprising a Taunton dynamo and Crossley gas engine, has been put down for a new *café* at 45, George Street. An electric motor is to be employed for coffee grinding and roasting machinery.

Poplar.—We learn that at an expenditure of about £50,000, the District Board of Works have resolved to adopt electric lighting.

Portsmouth.—Owing to the collapse of the engineers' strike, Alderman G. Ellis, J.P., estimates that within six weeks or two months there will be sufficient current available to supply 10,000 extra lights. A member advocated dust destruction in connection with the installation.

Sheffield.—The *Sheffield Independent* for February 10th gives a complete copy of the terms of the agreement entered into by the Corporation and the Electric Light Company for the purchase of the undertaking, to which we briefly referred last week. The company receives £213 8s. for every £100 share originally invested, and in addition £70,000 for stock and stores in hand and recent capital expenditure.

It is stated that the solicitor acting in the interests of the Electric Light Company has forwarded a letter to the Town Clerk, stating that, having regard to the insinuations and untrue statements made at the last Council meeting, the directors have decided that the terms of purchase under discussion between the parties shall remain in abeyance for the present. The directors invite the Parliamentary Committee to inspect the minute books from beginning to end, and offer to supply all information with regard to the contracts, engagements, and liabilities of the company, in addition to full investigation of the figures mentioned in the terms of purchase.

The Parliamentary Committee, after considering the company's communication, expressed its opinion that the directors were fully acquitted of any improper secrecy or conduct in connection with the negotiations, and trusted that the terms would be accepted by the company.

Shrewsbury.—The provisional order has passed the standing orders of the Board of Trade, but a memorial has been lodged by six persons (all, or nearly all, large gas shareholders) against the purchase of the Shropshire Electric Light and Power Company's undertaking.

South Australia.—During the last session of Parliament in the colony of South Australia, an Act was passed in favour of the South Australian Electric Light and Motive Power Company, which gives to this company practically a monopoly of the electric light and motive power business throughout the colony. One of the promoters of the Bill was Mr. W. W. Crawford, M.I.M.E., C.H.E., A.I.E.E., the representative in Australia of Messrs. Johnson & Phillips, to whom orders for the Port Adelaide plant have already been transmitted. Mr. Crawford is a large stock holder, as well as a director of, and consulting engineer to the company. Messrs. Johnson & Phillips have now depôts at 91, Pitt Street, Sydney, and Brookman's Buildings, Adelaide.

Southampton.—The Electric Lighting Committee is to consider the subject of lighting the parks by electricity, in conjunction with the public thoroughfares. The plant is working to its full capacity, and no more consumers can be taken on until the end of May.

Taunton.—The Town Council will apply for a £10,000 loan for electric lighting extensions. Mains are to be extended in various parts, and a sub-station is to be erected at Rowbarton. The increased demand necessitates these extensions.

Mr. E. B. Thornhill, electrical engineer, reports that the lamp connections during the past quarter increased by the equivalent of 364 8-C.P. lamps, and orders were in hand for 480 8-C.P. lamps.

Torquay.—Trials are this week being made of the plant at the electricity works.

Wakefield.—The chairman of the Electric Light Committee visited Messrs. Fowler's Works at Leeds last week, and reported himself satisfied with the progress being made with the engines and dynamos, &c.

West Ham.—The Town Council has altered the rates of current from 6d. per unit for the first two hours and 4d. after, to 7d. per unit for the first two hours and 3d. after.

West Hartlepool.—The total amount of the electric lighting contracts given out, as stated under "Contracts Closed" last week, was £12,000. When the matter was before the Council, some members thought that the borough surveyor had not been consulted sufficiently in the matter, and that the recommendations of Prof. Kennedy should first have been submitted to him. However, the acceptance of the tenders was confirmed by the majority.

Weston-super-Mare.—The District Council is desirous of keeping the electric lighting business in its own hands, and the Weston-super-Mare Electric Light and Power Syndicate is also wishful in the same direction. The syndicate applied for an order annulling the powers granted under the 1891 municipal order, which had not been carried into effect. The Council drew up its objections to such a course, and expressed its intention of carrying out a scheme itself. Both parties have been in communication with the Board of Trade on the matter.

Wigan.—The Gas and Electric Lighting Committee is again going into the subject of electric lighting. At a recent Council meeting, Mr. Fyans made a long statement as to the progress being made in other towns.

Withington.—A sub-committee of the District Council has been appointed to enter into negotiations with the Manchester Corporation for a supply of electricity to the district.

Woking.—The Council complains that many of the electric lamps of the Woking Electric Supply Company give a light of less than 25 candle-power. A list has been sent to the company at its request.

Wood Green.—A letter from the Municipal Electric Supply Company, suggesting a supply of electricity for Wood Green, is in the hands of the District Council.

Worcester.—Statements were made at the City Council meeting recently, to the effect that the cost of electric lighting at the Market Hall was double what it was formerly for gas. In 1895 and 1896 the cost was £45 and £54 respectively for gas; but in 1897, for electric lighting, the cost was £112. It was stated to be the same at the Guildhall and Public Hall.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Airdrie-Coatbridge.—The Coatbridge Council has discussed the arrangements come to with the representatives of the British Electric Traction Company to lay this line of tramways, and has decided to withhold opposition provided certain concessions are granted by the company.

Australian Electric Power Scheme.—The *Times* correspondent at Melbourne telegraphed on 12th inst. saying that Messrs. Horn and Bakewell, two leading colonists of South Australia, had left by the *Orizaba* for London, to place the Great Western Railway and Electric Power Company before English capitalists. The company possesses valuable concessions of land, together with the right to construct a railway connecting Hobart with the Mount Lyell and Zeehan district, in Tasmania.

Bristol.—The Town Council has referred back to the Sanitary Committee its report upon the electric traction proposals of the Bristol Tramway Company. This report approved in principle the extensions of the company's system proposed, but suggested that certain routes might be altered with advantage. It, however, pointed out that the new lines were 7½ miles in length, and for half the distance there was not the requisite width of carriage way, 9 feet 6 inches, between the rail and kerb, and many frontagers had objected. The point, however, to which the report took special objection was the endeavour of the company under their Electrical Power Bill to arrange the mode of traction with the Board of Trade without consultation with the Council. The report proposed that the Committee oppose both Bills, although meanwhile negotiating with the company. Opposition to this view was expressed in an amendment which, after much debate was carried by 36 votes to 29. "That the report of the Sanitary Committee and the two Bills of the Tramway Company, be referred back to the Sanitary Committee for negotiations; that meanwhile a petition be presented against the Electrical Power Bill, but that the consent of the Corporation be given to the promotion of the Extension Bill conditionally."

Canterbury—Herne Bay.—A Dover paper says that a movement is on foot in Canterbury for establishing an electric tramway service between there and Herne Bay. The two towns are at present connected by a 'bus service.

Cardiff.—The Electrical and Lighting Committee propose sending a deputation to the Continent to inquire as to what is the best system of electric tramways for Cardiff. The proposal was only carried by three votes to two, and we suppose the matter has yet to come before the Council.

Dublin.—Before Mr. Justice Murphy and a special jury in the Dublin Nisi Prius Court, on 7th inst., Mr. Robert Forrester claimed from the Dublin United Tramways Company £500 damages for personal injuries sustained. When the plaintiff got on the platform of a car it gave a sudden lurch and he fell off, sustaining a cut and becoming unconscious. Defendant company declared that the car was at a standstill when plaintiff fell off. Judgment for defendants.

A special meeting of the Corporation was held on Wednesday, for the purpose of dealing with the report of the sub-committee appointed to deal with the plans of the Tramways Company for the introduction of electric traction within the city.

Edinburgh.—It has been referred to a Committee to report upon the advisability of constructing an electric tramway from Preston Street *viâ* Dalkeith Road and Niddrie Road, to Joppa and Portobello, returning by Meadowbank and Waterloo Place. As Prof. Kennedy is being consulted on various other matters this, too, is to be laid before him.

Electric Power Distribution Schemes.—Several of the other municipal authorities whose districts are affected by the two electric power schemes which have been occupying a good deal of attention of late, have resolved to oppose the proposals.

Electric Railway between Frankfort, Homburg, and Saalburg.—The Light Railway Company, Lenz & Co., of Stettin, has submitted to the municipal authorities at Homburg a project for constructing an electric railway, running from Frankfort-on-the-Main, through Homburg and Dornholzhausen to Saalburg. It is proposed in this scheme to run the line along the highways wherever possible.—*Elec. Tech. Zeit.*

Electric Railway between Glauchau, Meerane, and Crimmitschau.—The preliminary work for the construction of this electric railway has been commenced. The main line will run through the streets and highways to Crimmitschau; a branch line going from an intermediate station (Dennherits) to Meerane.

Electric Tramways at Frankfort-on-the-Oder.—The electric street railway, built by the Allgemeine Elektricitäts-Gesellschaft at Frankfort-on-the-Oder, was opened on January 22nd.

Electric Tramways at Liegnitz.—These tramways, constructed by Felix Singer & Co., were taken over by the local authorities on January 18th, and were opened a few days later with 14 motor tramcars running on the line.

Egypt.—The Compagnie des Tramways d'Alexandrie has just secured a concession for another electric tramway in Alexandria, which will bring up the length of the electric tramways in that city to 25 kilometres.

Halifax.—Owing to the difficulty experienced in obtaining prompt delivery of materials, it is said to be very doubtful whether the whole of the system will be ready to be opened, as desired, on Easter Monday. The Electric Supply Association, however, have promised to supply sufficient plant and rolling stock to enable the Corporation to have at least one section of the tramways in operation by that date.

Hounslow.—Mr. Clifton Robinson appeared before the Hounslow District Council on 8th inst. and explained the details of the proposed electric tramway scheme which would touch this district. The Council, after discussion, gave its consent to the scheme, subject to certain conditions being fulfilled.

Introduction of Electric Traction in Berlin.—After the Berlin Horse Tramway Company received permission from the authorities to introduce electric traction, they set about the work immediately. In the first week of January the erection of the overhead conductor was begun, and by the middle of February the electric system will be working on lines from Alexander Platz to Schöneberg, and from Demminer Strasse to Kreuzberg. On these lines the mixed system of overhead conductors and accumulators will be employed. The overhead system on the first mentioned line will extend from Alexander Platz to Spittelmarkt at one end, and from Potsdamer Platz to the terminus at the other end. On the second mentioned line it will extend over the Demminer Strasse-Kreuzberg section, and the Bärwaldstrasse-Kreuzberg section. Electric traction will next be introduced on the Ringbahn, the conversion taking place early this year. On the lines from Lützow Platz and from Moabit to Charlottenburg, horse traction will be retained until October 1st this year. Permission has been given to the street tramway company to introduce electric traction before October 1st, 1898, an extension to January 1st, 1899, being granted if necessary. The company will not, however, be able to introduce as many accumulator cars as they require before October 1st, 1898.—*Elec. Tech. Zeit.*, January 6th, 1898.

Leeds.—The Leeds Tramways Company have, says *Daily Tenders*, adjourned for one month the question of providing the Headingley, Chapletown and Hunslet sections with a system of electric traction similar to that at Roundhay Park and Kirkstall.

Thirteen out of the twenty-two cars ordered for the Kirkstall-Roundhay electrical tramway are now running. This number of cars permits of a 10 minutes' through service. When the whole 22 cars are ready, there will be a 5 minutes service between Harehills Lane and the Cardigan Arms.

River Plate.—In December last "La Capital" electric tramway was inaugurated at Buenos Ayres. The length of line opened, says the *Review of the River Plate*, was 14½ kilometres, which will bring the suburbs of Flores and Caballito into direct communication with the southern and central districts of the city. The electric cars start from the Plaza at Flores, running to the temporary terminus at the corner of San Juan and Entre Rios, from which point passengers are conveyed in horse cars to the Plaza de Mayo, Boca and Darsena, combination tickets of the Capital Company being issued for the whole journey. The conversion to electricity of the existing line, between Entre Rios and Plaza de Mayo, is being actively carried on and will in a short time be completed, when a direct electric service from the Plaza de Flores to the Plaza de Mayo, and *vice-versa*, will be definitely established. The electric service from the Plaza de Mayo to the Boca will be opened early this year. The central terminus of the system is in the Plaza de Mayo, between Congress and the Government Houses, opposite the Bolsa, from which point the cars will proceed down Calle Victoria. The power station is at the corner of Comercio. The building covers 1,400 square metres, and is equipped with three vertical compound Ball and Wood engines of 450 H.P. each, directly coupled to 300 kilowatt Walker generators. Two of these units will be sufficient to supply current to all the cars that will be in operation on the line at one time, so that one unit can be kept in reserve. The engines have 30 inches × 14½ inches cylinders × 18 inches stroke, running at 175 revolutions per minute. They are fitted with Corliss valves placed in the cylinder heads. The admission valves are controlled by a Ball & Wood governor. There are four Stirling water-tube boilers of 250 H.P. each working at 140 lbs. pressure. Green's economisers and Conover's condensers with compound pumps are employed. The water system is very completely arranged. There are two Worthington pumps, either of which can supply all the water required by the four boilers. By means of a special system of piping either or both of the pumps may do the following service:—(1) Draw water from the city water service, (2) from a semi-artesian well, (3) from a large reserve water deposit, (4) from a waste water well. The water can be discharged (1) into the boilers direct, (2) into the boilers through the economiser, (3) the waste water into the sewer, (4) through a fire hose conveniently located in the boiler room. The power house is of steel, and is designed for an ultimate capacity of 20,000 H.P. Current from the power station is carried by an underground cable to Entre Rios, and then by trolley wires and a feeder cable overhead carried on poles. The return current from Entre Rios is also by underground cable, temporarily. The rolling stock will consist at first of 41 cars; and workshops for mechanical repairs, &c., have been erected. The cars will carry 52 passengers, 30 outside, 22 inside. They are equipped with two "General Electric 1,000" motors each. The entire rolling-stock has been built by the J. G. Brill Co., and mounted on Brill trucks, having been put together and painted in the tramway company's workshops. The track construction is most substantial. Johnson 9-inch 90-lb. grooved girder rails have been used, the rails being bonded with two classes of bonds, the Edison-Brown plastic bond, and the Syracuse soldered bond, and cross-bonded with copper wire every 100 metres. The feeders in the business districts are all underground. The poles are both wooden and iron, the latter being supplied by Morris, Tasker & Co., the H. W. Johns Company supplying the overhead appliances. Mr. Charles R. Thursby, managing director, superintended the construction of the line, and Mr. J. W. McCrosky is the chief engineer.

Staffordshire.—The Brierley Hill Council has approved the design submitted by the British Electric Traction Company for the trolley pillars for the electric tramways, subjected to the satisfaction of the surveyor.

Storage Batteries as Station Auxiliaries.—The Consolidated Traction Company, of Pittsburg, has recently installed two sets of storage batteries as station auxiliaries, one in one of its power stations, and the other at a point midway between the other three power stations; each set has a capacity of 500 ampere-hours. The result has been a considerable increase in the output of the stations; in a particular instance one set of accumulators in parallel with a 800-kw. generator, has enabled the company to obtain from this generator continuously for 24 hours an output of 1,100 kw. The total output of the four stations can be easily adjusted by means of accumulators, so that any one can be made to carry any portion of the load up to its capacity, the four stations are tied together by feeders; the actual economy in the resistance loss in the feeders by maintaining the voltage constant is very large. The results secured on this line have been so important that the United Traction Company has decided to abandon its present McKeesport station and substitute for it a storage battery station; the maintenance of this station has cost the company, on an average, about $7,200 per annum, most of which, it is thought, will be saved by the installation proposed.—*Electrical World*, New York.

Storage Battery Traction.—The equipment of the Ostend railway is on the electric accumulator system, the plant being established in the depôt of the local railway. The line, which was recently described in *L'Electricien*, is 3·1 kilometres long, and is virtually a circular road connecting the Kursal Boulevard, Rogier Station, and the Harbour. The plant includes one compound engine direct-connected to a Westinghouse dynamo, generating 135 amperes at 280 volts, and operating at 650 revolutions. The switchboard is of three white marble sections, with the usual instruments, and commands four accumulator-charging circuits with pressures varying between 240 and 270 volts. The charging of the accumulators is done upon a central track, so that the handling, both loading and unloading, is extremely easy of accomplishment. The complement of each car comprises 12 boxes of nine elements, having a capacity of 140 ampere-hours, at a 50-ampere rate. The charge lasts from three-quarters of an hour to two hours, according to the demand made upon the battery. As constant use gradually disintegrates the active matter of the positive plates, this is carefully saved in a tank, and eventually used for renewing the battery. This process is several times repeated before the frame finally becomes worthless, when it is recast. Each element is contained in an ebonite vessel, the nine elements being inclosed in a wooden trough, having two bands of copper for contacts. The carriages weigh 7,500 kilogrammes without accumulators or passengers, and have a capacity of 24 seats and 26 standing places. They have no imperial or deck seats. The carriages are lighted by six 16-candle-power lamps each, and are provided with two 18-kilowatt Westinghouse motors, each connected to an axle by reducing gears of one to five. The motors are regulated by a series-parallel controller with spark extinguisher. According to data obtained for three months of active service, the management claims that the expense of this line will be very much below anything so far known in this form of traction, the consumption of coal being shown to be but 1·45 kilogrammes per kilometer-car.

Stourbridge and Kinver Electric Railway Scheme.—On Tuesday, the Earl of Jersey and Col. Boughey, the Light Railway Commissioners, held an inquiry at Stourbridge respecting the proposal of the British Electric Traction Company to construct an electric tram line between Coalbournbrook and Kinver. Mr. Foley, one of the principal landowners had intended to oppose the railway, but he withdrew his opposition during the inquiry. In the result, Lord Jersey said that as regarded the preamble there was a case, and the Commissioners would be happy to recommend to the Board of Trade that the order should go forward. He, however, pointed out that many difficulties might have arisen had Mr. Foley not withdrawn his opposition so handsomely.

Sydney.—Mr. G. Fischer, an officer of the Works Department, recently returned from the United States, where he had been superintending the construction of some electric material for the George Street tramway. A Sydney paper says that the material that has been ordered for the department from the States is for the power-house at Ultimo. The department is also getting from the States 2,000 tons of steel rails. An effort was made to obtain the rails from England, but manufacturers there found it impossible to supply them with the higher proportion of carbon that was required. American firms, however, promptly agreed to provide the material of the desired quality, and the order was placed accordingly.

Swansea.—The Swansea Tramway Company, which has been negotiating for some years with the Swansea Corporation, have, says the *Western Mail*, now practically come to terms with another customer for the undertaking. A meeting of shareholders is to be held in London on February 25th for the purpose of considering the terms of an agreement, dated February 9th, 1898, between the Swansea Improvements and Tramways Company, and the British Electric Traction Company, for the sale of the undertaking, property and assets of the Swansea Company to the Traction Company.

Switzerland.—The Authorities of the Zurich Municipal Electric Tramways have just invited tenders for the supply of additional plant, including 24 motor tramcars, required in connection with the extension of the tramway system.

TELEGRAPH AND TELEPHONE NOTES.

A Bright Outlook.—We make the following extract from the *Outlook*, to which new periodical we offer our best wishes for a successful career:—"The commercial battles of the future will beyond a doubt be waged in the Pacific. England, the United States, Canada, Australia, Japan, Russia, and now Germany and France—in a word, all the great trading nations—are preparing for the struggle. What is England doing to meet the future? What, indeed! She has in the Canadian Pacific Railway an Imperial highway of the highest strategic and commercial importance; but that thread of empire Canada herself provided, without one cent of cost to the British taxpayer. Canada, too, has spanned the Pacific with mail and trade services to China and Japan on the one hand, and Australasia on the other, some of the Australasian colonies helping in the latter case. Is it too much to ask that England should follow up this spirited colonial lead by really doing something in the matter of the Pacific cable? Why allow it to be any longer the sport of committees and sub-committees in Downing Street? It is a great and pressing need in the interests of England, Canada and Australia alike, and in view of all that is happening in the Pacific, should be dallied over no further."

The Telephone Service.—The National Telephone Company has communicated with the Corporation, asking for a conference on the telephone question. This is in consequence of the City's decision to hold an inquiry. It is stated that the late Commission of Sewers many times invited the company to confer on the matter, but no notice was taken of the application.

The difference existing between the General Post Office and the Commission of Sewers, in respect of the laying of lines of underground telegraphs under certain City streets, came before the Railway and Canal Commission (Mr. Justice Wright, Sir F. Peel, and Viscount Cobham) on Thursday last week. The case was before the City of London Court in December (see ELECTRICAL REVIEW, December 3rd), when Mr. Commissioner Kerr decided the case in favour of the Post Office. The City Corporation appealed to the Railway Commissioners, contending that the order was not reasonable or just. After the speeches of counsel, Mr. Justice Wright said that the Corporation, in seeking to restrict the consent given to the Post Office, had no doubt been actuated by no captious or unfriendly spirit, but had striven to give effect to their view that when companies were making a profit by using public streets for private purposes, they should be compelled to give good value in return for concessions allowed to them. The question, however, arose as to whether they had the right of control which they claimed. Even if it were open to them to seek to impose such conditions as were in question in this case, the Court were of opinion that they were not reasonable, and would, according to the terms of the Act, "consent" that the streets should be opened by the Post Office authorised under the conditions usually imposed in such cases. Judgment was accordingly given for the Postmaster-General, without costs.

The Boston Town Council wishes the Post Office to bring its trunk lines to Boston, and also has in mind a scheme for a municipal local service.

In the House of Commons last week, Mr. Provand asked the Secretary to the Treasury what were the working expenses of the intertown telephones, and how much the intertown wires had earned since the date on which they were taken over from the National Telephone Company to December 31st, 1897. Mr. Hanbury replying, said that the capital expenditure—partly estimated—to December 31st, 1897, was £1,190,000. This sum includes the amount paid to the National Telephone Company. The gross earnings up to the same date amounted to £200,832. The working expenses, being included in those of the telegraph service, cannot be separately stated.

French Telegraph Extension.—The French Minister for the Colonies states that telegraphic communication is established between Senegal and Waguadougo, and will soon be extended to Fada-n-gourand.

German Telephones.—The German Imperial Post Office authorities have resolved to henceforth supply only single-receiver instruments for business or house telephone connections. A second receiver may, however, be obtained for 10s. from the post office authorities, who will maintain it for a certain sum. An annual payment of 5s. will be required from those subscribers already having double receivers, but the latter instruments will not again be issued for public use.

The Glasgow Telephone Inquiry.—The *Scotsman* learns that a demand is to be made on the Treasury for the production of Sheriff Jameson's report on the Glasgow telephone service. Mr. Hanbury will in the first place be privately approached, and, in the event of a refusal, the matter will be brought forward in the House.

Huddersfield Telephones.—The Postmaster-General has refused the application for a municipal telephone license, and the Council has dropped the proposal. A sub-committee is to consider terms of agreement with the National Telephone Company with regard to their application to lay wires underground.

Interruptions to Australian Land Lines.—In the formidable list which we published last week of interruptions of the trunk land lines of Australia, on which we rely for communication to the principal centres of that continent, we omitted to note that on December 9th last the West Australian land line, which joins a submarine cable to Java at Roebuck Bay was interrupted, and, as from the 8th till the 12th the South Australian land line, which runs from Adelaide in the south to Port Darwin in the north of Australia, was also broken down, it follows that Australia was completely isolated on December 9th, apart from the general delays on the 8th, 10th, 11th and 12th of that month, owing to the breakdown of the Port Darwin line. In addition to last week's list of interruptions, we have now to add that, on the 9th, current communication with Adelaide ceased, and, we learn from the *Times* of the 11th, that telegrams from Sydney were not received owing to the interruption of South Australian land lines. Since that date there has been a more or less spasmodic supply of telegrams from Australia conscientiously marked "delayed in transmission." Thus altogether, during the last five months, there have been at least 15 or 16 cases in which the trunk land lines in Australia have been broken down. In view of this, we can only admire the temerity with which the Eastern Telegraph Company proposes to land still another cable in West Australia, which of course will, just as much as the existing cables, have to depend on the very intermittent land line service under review for the transmission of telegrams to the principle centres of population on the south-east and east coasts of Australia. Although not affecting the land lines in that country, we learn from the Australian press that on December 1st last "the delay to the outward traffic from London is due to messages being diverted from the Indo-European line."

The Telegraph Wire Export Trade.—January has proved to be a very dull month as regards the exports of telegraph wire and apparatus connected therewith, from this country. In former years the January exports have usually fallen a long way short of those of the preceding month, but this year the decrease is much greater than usual, from £172,140 in December, 1897, to only £37,929 last month, the figures for January, 1897, being £62,120.

Telegraphic Addresses.—In the Commons the other day Mr. Hanbury, replying to Sir C. Cameron, said:—It is the fact that the rule of the Post Office that the first word in an abbreviated address must be a dictionary word containing not more that 10 letters, and that proper names and compound words—*i.e.*, words which appear in a dictionary joined by a hyphen—can only in rare cases be accepted, is intended, as the hon. member supposes, to preclude the registration of arbitrary words consisting of 10 letters, or constructed from the first and last syllable of a firm's name, or spelling the initials of the designation of a club, unless, indeed, these syllables or initials happen to make a real word.

Telegraphic Interruptions and Repairs:—

CABLES.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1898 ...	...
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Curaçao-La Guayra ...	Jan. 5th, 1898 ...	Feb. 15th, 1898.
Paramaribo-Cayenne ...	Jan. 27th, 1898 ...	...
Amason Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Saigon-Hong Kong	Jan. 8th, 1898 ...	...
Bolama-Bissao	Jan. 28th, 1898 ...	Feb. 14th, 1898.
Emden-Vigo	Feb. 7th, 1898 ...	...
Cyprus-Latakia	Feb. 10th, 1898 ...	...
LANDLINES.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Cartagena-Barranquilla ...	July 4th, 1896 ...	...
Nicaragua landlines	Feb. 8th, 1898 ...	Feb. 10th,
Costa Rica "	Feb. 10th, 1898 ...	...

CONTRACTS OPEN AND CLOSED.

OPEN.

Bilbao.—February 28th. The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Consul at Bilbao, reporting that the provisional board appointed in connection with the electric tramway which it is proposed to lay from Zumarraga to Zumaya, in the province of Guipuscoa, invite plans and tenders, to be received by February 28th, for the construction and equipment of the line. Further particulars of the conditions of the tenders for the above-named tram line and branch, which together measure 30 miles, may be inspected at the Commercial Department of the Foreign Office any day between the hours of 11 and 6.

Belfast.—March 8th. The Corporation wants tenders for the wiring of the new police cells, Chichester Street. Electrical engineer, Mr. V. A. H. McCowan. See our "Official Notices."

Berlin.—March 15th. The Municipal Traffic Deputation of the Town Council has opened a competition for the construction of several new electric tramways in that city. Exhaustive details concerning this project are contained in the *Elektrotechnische Zeitschrift* of the 13th inst., which mentions that proposals will be received by the Stadtische Verkehrsdeputation Rathhaus III, Berlin, by March 15th.

Bristol.—February 21st. The Electrical Committee wants tenders for 214 arc lamp posts. Electrical engineer, Mr. H. Faraday Proctor. See our "Official Notices" February 11th.

Canterbury.—February 23rd. Tenders are invited for the electric wiring and fittings for the Beaney Institute for the Town Council. Specifications, &c., to be obtained at the office of the City Surveyor, 28, St. Margaret's Street.

Carlisle.—February 25th. Tenders are being invited for the erection of the central station buildings in James Street. City engineer and surveyor, Mr. H. C. Marks, 36, Fisher Street.

Coventry.—March 8th. The Electric Light Committee wants tenders for the supply and erection of engine house, separate exciting and surface condensing plant, also pipework, switchboards and instruments for extensions of the municipal electricity works, Consulting engineer, Mr. Robert Hammond. See our "Official Notices" this week.

Denmark.—March 12th. Tenders are being invited for the supply of the engines, dynamos, accumulators, &c, required in connection with the new central station at Frederiksberg, near Copenhagen. Tenders to be sent to the Frederiksberg Sporveis-og Electricitets Aktieselskab, Gammel Kongerie, 140, Copenhagen V., from whom particulars may be obtained.

France.—March 31st. Tenders are being invited by the Municipal Authorities of Saint Chamond (Loire) for the concession for the lighting of the public streets of the town, either by gas or electricity. Particulars from, and tenders to be sent to, La Mairie de Saint Chamond (Loire).

Glasgow.—February 28th. The Corporation wants tenders for the hire or purchase of dynamos and engines, direct coupled or belt driven, capable of providing 1,100 break H.P. and spare power equal to 25 per cent. additional, also two rope driven dynamos to run at a speed not exceeding 500 revolutions per minute, and capable of providing 200 H.P. each at a potential of 230 H.P. The plant must be delivered by August 1st. Engineer, Mr. W. A. Chamen. See our "Official Notices."

Glasgow.—February 28th. The Corporation wants tenders for the supply of lead covered cables and accessories for twelve months, accumulators, motor transformers, motor driven boosters and switching apparatus. Mr. W. A. Chamen, engineer. See our "Official Notices."

Harrogate.—February 24th. The Corporation invites tenders for the supply and erection of vertical steam engine, dynamo, switchboard, motor, overhead conductors, &c., for sewage pumping plant. Mr. Geo. Wilkinson, borough electrical engineer. See our "Official Notices" February 11th.

Italy.—March 2nd. Tenders are being invited by the Municipal Authorities of Piacenza for the establishment of a central electricity generating station in the town for lighting and power purposes. Particulars may be had from, and tenders to be sent to, El Municipio di Piacenza, Italy.

Liverpool.—March 8th. The West Derby Board of Guardians wants tenders for supply and erection of boilers, engines, dynamos, batteries, wiring, &c., for the lighting of the Mill Road Infirmary. Consulting engineer, Mr. T. L. Miller. See our "Official Notices" for particulars.

Madrid.—February 22nd. The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Chargé d'Affaires at Madrid, enclosing copy of a Royal decree announcing that a public auction for the contract for repairing the national submarine telegraph cables during the next five years will be held at Madrid on February 22nd. Further particulars as to the cables in question may be inspected at the Commercial Department of the Foreign Office any time between the hours of 11 and 5.

Northwich.—March 5th. The Weaver Navigation Trustees are inviting tenders for the construction and erection of the necessary electric power plant for lighting and working the new swing bridges at Northwich. Current will be supplied by the Northwich Electric Supply Company. Engineer, Mr. J. A. Saner, M.I.E.E. See our "Official Notices" February 11th.

Pembroke (Ireland).—March 5th. The Lighting Committee wants tenders for the supply and erection of various plant, machinery, &c., for electric lighting. See our "Official Notices" this week for full particulars. Consulting engineer, Mr. Robert Hammond.

Plymouth.—February 21st. The Council wants tenders for the erection and completion of a refuse destructor with all necessary flues, fittings, boilers, &c. Borough engineer, Mr. James Paton, Municipal Offices.

Portsmouth.—February 22nd. The Corporation wants tenders for the supply and erection of Lancashire boilers, feed pumps, mechanical stokers, &c. Consulting engineers, Messrs. Kincaid, Waller & Manville. See our "Official Notices" February 11th.

Rochdale.—February 19th. The Corporation wants tenders for steam dynamos, balancer, and boosters, &c. Engineers, Messrs. Lacey, Clirehugh & Sillar. See our "Official Notices" January 14th.

Roumania.—March 15th. Tenders are being invited by the General Direction of the Roumanian Post and Telegraphs in Bucharest for the supply of 56,000 metres of galvanised iron and steel wire.

Shoreditch.—March 8th. The Vestry wants tenders for the supply of electric cables and sundries, also engineers' tools, ironmongery, &c. See our "Official Notices."

St. Helens.—February 21st. The Corporation wants tenders for various plant and machinery, &c., in connection with the proposed electric tramways. See our "Official Notices" January 28th for particulars. Consulting engineer, Dr. J. Hopkinson.

St. Pancras.—February 22nd. The Vestry wants tenders for dry back marine boilers with superheaters and brickwork seatings. See our "Official Notices" February 4th.

Sunderland.—February 25th. Tenders are invited by the Corporation for the supply of various cables, pipes, service boxes and stoneware casings for the year. Borough electrical engineer, Mr. J. F. C. Snell. See our "Official Notices."

The War Office.—April 27th. The Secretary of State for War is prepared to receive offers, competitive designs and specifications for the supply of portable electric search light apparatus. Particulars from the Director of Army Contracts, War Office, Pall Mall, S.W. See our "Official Notices" February 4th.

Victoria.—March 21st. The Telegraph Department of the Victorian Government Railways is inviting tenders for the supply of alternating current transformers and one main switchboard. Tenders to the Telegraph Superintendent's Office, Spencer Street, Melbourne.

Wallasey.—March 17th. The District Council wants tenders for the supply of engine, alternator, exciter, two Lancashire and one water-tube boilers, and condensing apparatus. Engineer, Mr. J. H. Crowther. See "Official Notices" February 11th.

Watford.—March 16th. The District Council wants tenders for the supply and erection of various plant for the electric lighting of the district. For details of the seven sections see our "Official Notices" February 11th. Mr. W. C. C. Hawtayne, consulting engineer.

West Ham.—March 8th. The Council invites tenders for wiring and fitting up various buildings, including the Town Hall, police court, Corporation stables, fire stables, &c. Mr. J. Steinitz, borough electrical engineer. See our "Official Notices" this week.

CLOSED.

Aberdeen.—The contract for the supply of a 650-H.P. engine and dynamo (£4,147) is being given to Messrs. Mather and Platt, Limited, £60 extra being paid for adapting it for traction work

Belfast.—The Harbour Commissioners have accepted the following tenders for the supply of electrical plant for the extension of the electric lighting of the quays at the Harbour:—

Dynamos (two)	Mr. Wilson Hartnell
Switchboard and switches	Williamson & Joseph
Arc lamps	Mr. C. A. Müller
Lamp posts	Mr. T. Scott Anderson
Mains, boxes, &c.	British Insulated Wire Company

Bootle.—The Town Council has accepted the following tenders:—

Contract No. 1.—Boilers and economisers	T. Parker, Limited, at £11,791, less £650 allowance for present engines, dynamos & switchboards.
„ „ 2.—Engines, dynamos, &c.	
„ „ 4.—Feeders, mains, service lines, &c., and maintaining same for 10 years	£10,096.

„ „ 5.—Messrs. T. Parker, Limited, for the running of electricity supply works and supply of current for public and private purposes as follows:—For each 10 ampere arc lamp run from one hour after sunset to one hour before sunrise (3,620 hours per annum), £24 per annum; for each 10 ampere arc lamp run from one hour after sunset to midnight (1,810 hours per annum), £12 per annum; for each lamp hour added or deducted from above, 1·55d.; for each incandescent lamp used for public lighting, 3d. per unit; for remainder of current up to guarantee of 100,000 units per annum for public and private purposes, 3·75d. per unit; for first 25,000 units above guarantee, 1·75d. per unit; for second 25,000 units above guarantee, 1·25d. per unit; for every unit in excess of 150,000 units, 1d. per unit.

The question was raised by some Councillors as to why the tender of a local firm had not been accepted. Councillor Hall replied that the acceptance of the local tender would have meant a loss to the ratepayers of £4,700 in three years.

Bradford.—The City Council has accepted tenders as follows for electric lighting plant:—

Two dynamos.—Siemens Bros. & Co., Limited	£2,800
(Extra armature)	600
Two 600-H.P. steam engines.—Willans & Robinson	4,590

A sub-committee is to inspect combined lighting and traction central stations on the Continent.

Burnley.—The Corporation has accepted the tender of Messrs. G. E. Bellis & Co., for two combined engines and dynamos for electric lighting extensions at £4,888.

St. Pancras.—The Vestry has accepted the tender of the Fowler-Waring Cables Company (£4,196 odd) for cables, &c., for the extension to Queen's Crescent, Malden Road and Prince of Wales Road.

Wimbledon.—The following tenders have been accepted in connection with the Council's electric lighting scheme (Mr. A. H. Preece, consulting engineer):—Buildings, Burgess £3,388. Boilers, Babcock & Wilcox £2,482. Steam engine and dynamo, Crompton and Co. £4,181. Mains, W. T. Henley's Co. £15,792. The switchboard, condenser, and crane contracts have not been finally decided yet.

FORTHCOMING EVENTS.

1898.

Friday, February 18th, at 6.30 p.m.—Institution of Electrical Engineers. Students' visit to the generating stations of the St. Pancras Vestry.

Finsbury Technical College Conversazione. Lecture on "Wireless Telegraphy," by Dr. S. Thompson.

At 7.30 p.m. Staff smoking concert of the City of London, the Metropolitan, and the London Electric Lighting Companies, at the Crown Room, Freemason's Tavern, Great Queen Street, Holborn, W.C. Chairman, Mr. P. W. D'Alton.

Saturday, February 19th.—Latest date for the Rochdale Corporation electric lighting tenders.

Monday, February 21st.—Latest date for Bristol Corporation arc lamp posts tenders.

Latest date for the St. Helen's Corporation electric tramway plant tenders.

Whitehall Rooms of the Hôtel Métropole. Webb Testimonial presentation reception at 9.30 p.m. Presentation at 10 o'clock p.m.

Tuesday, February 22nd.—The Federated Institution of Mining Engineers, 26th general meeting at Newcastle-upon-Tyne. Various papers are to be read, and among those to be open for discussion are the following:—"Light Railways," by Mr. Leslie S. Robinson. "A One-rail or Trestle System of Light Railway," by Mr. Fred. J. Rowan. "On Some Dangers attending the Use of Steam Pipes," by Mr. A. L. Steavenson. "Machine Coal-mining in Iowa, U.S.A.," by Mr. H. Foster Cain. "Latest Developments and the Practical Application of Alternating Multiphase Machinery for Power Transmission," by Mr. Walter Dixon. Visits will be paid to the Telegraph and Telephone Departments at the General Post Office, Mr. A. W. Heaviside, Superintending Engineer.

Latest date for St. Pancras tenders.

At 8 p.m.—Institution of Civil Engineers.—Papers to be read with a view to discussion: (1) "The Theory, Design and Working of Alternate Current Motors," by Mr. Ll. B. Atkinson, Assoc.M.Inst.C.E.; and (2) "The Dublin Electric Tramway," by Mr. H. F. Parshall, M.Inst.C.E.

Latest date for the Portsmouth electricity supply plant tenders.

Wednesday, February 23rd.—Second day of the Federated Institution of Mining Engineers. Various excursions, including visit to the works of Ernest Scott & Mountain, Limited, Newcastle-on-Tyne.

Latest date for the Canterbury Council wiring tenders.

Thursday, February 24th.—Latest date for tenders for Harrogate Corporation electrical plant for sewage pumping.

At 8 p.m.—The Institution of Electrical Engineers. "On the Manufacture of Lamps and other Apparatus for 200 volts Circuits," by G. Binswanger-Byng.

Friday, February 25th, at 6.30 p.m.—The Institution of Electrical Engineers. Students' visit to the Shoreditch electricity supply station. Applications at once to the Students' Hon. Sec. (Mr. S. Grant, 28, St. Mary Abbot's Terrace, W.) as the number will be limited to 20.

At 8 p.m.—The Institution of Civil Engineers.—Students meeting. "The Problem of Train Resistance," by C. E. Wolff, B.Sc., Stud.Inst.C.E.

Saturday, February 26th, at 4 p.m.—Physical Society in the Chemistry Lecture Room, Keate's Lane, Eton College. The Rev. T. C. Porter will describe:—1. A new theory of geysers. 2. A new method of viewing Newton's Rings. 3. Experiments bearing on the sensation of light. 4. A method of viewing lantern projections in stereoscopic relief. 5. Winter observations on the shadow of El Teide, with a new method for measuring approximately the diameter of the earth. 6. Temperature of the water of Niagara.

NOTES.

Correspondence.—We have received, just as we go to press, a letter from Mr. Robert Hammond, regarding the Shoreditch dust destructor, replying to the letters of Messrs. Kershaw and Russell, which appeared last week. We regret being compelled to defer publication until our next issue.

Postal Telegraph Factory Staff Dinner.—The staff of the Postal Telegraph Factory, Mount Pleasant, held their fourth annual dinner at the Inns of Court Hotel on Saturday, February 5th, Mr. Martin F. Roberts, the superintendent of the factory, presiding. Among the guests present were Mr. J. C. Lamb, C.B., C.M.G.; Mr. J. Ardron; Mr. H. C. Fischer, C.M.G.; Lieut.-Colonel P. G. von Donop, R.E.; Prof. W. H. H. Hudson, Dr. Mumford, Dr. Walmesley, Messrs. J. W. Eames, W. Slingo, W. V. Morten, and G. W. Hook. The occasion was the 28th anniversary of the acquisition of the telegraphs by the State, and in responding to the toast of "The Chief Office" (proposed by the chairman), Mr. Lamb dwelt upon the progress made in telegraph engineering, and in the general efficiency of the service to the public during the past 28 years. A hope was also expressed that, as many present had assisted at the transfer of the telegraphs in 1870, so, also, many would live to see complete success attending the efforts now being made to render the telephone service equally efficient. In proposing the toast of "Electrical Engineering," Mr. A. Brooker emphasised the importance of the pioneer work done by telegraph engineers, which rendered possible the rapid progress in other more modern branches of electrical engineering, and mentioned that the running of two properly designed alternators in parallel might be more exciting, but was certainly a far less difficult task than the running of two multiplex motors and distributors for eight hours synchronously. In the absence of Mr. W. H. Preece, Mr. J. Ardron responded. Mr. J. M. G. Trezise proposed "The Guests," and referred to the long and remarkable career of Mr. H. C. Fischer, and to the acknowledged efficiency of the Royal Engineers, especially the Telegraph Battalion—a point upon which those present were well qualified to express an opinion. Mr. Fischer and Lieut.-Col. von Donop replied in felicitous terms, the latter acknowledging the advantages resulting from the close connection between the Engineers and the Postal Telegraphs. A varied vocal and instrumental musical entertainment was given during the evening by members of the staff.

Institution of Mechanical Engineers.—The 51st annual meeting of this Institution was held in the hall of the Institution of Civil Engineers, Great George Street, Westminster, on Thursday and Friday last week. The chair was occupied during the earlier portion of the proceedings by Mr. E. W. Richards, the retiring president, who introduced Mr. Edgar Worthington, the newly-elected secretary, to the meeting. The report stated that at the end of last year the number of names on the roll was 2,496, as compared with 2,359 at the end of the previous year. During 1897 227 names were added, the loss by death being 30, and by resignation or removal 60. The result of the ballot for the election of the council was announced, Mr. S. W. Johnson being elected president, and Mr. Arthur Keene and Sir William White vice-presidents. The discussion was afterwards resumed upon a paper read at the last meeting by Mr. Philip Dawson on "Mechanical Features of Electric Traction."

(*Continued on page* 227.)

THE MAKING OF CHLORIDE ACCUMULATORS.

(*Concluded from page* 188.)

The description of the manufacture of the chloride negative plate may be fittingly concluded by illustrating a complete cell showing plates, and this is given in fig. 6.

Comparatively speaking, the manufacture of the positive plate is a simple operation. Contrary to what occurs in making the negative plate, the positive grids are made first. They are cast in moulds by means of compressed air, as is done in the case of the negative plates. The material is antimonial lead, and the moulds are arranged to leave a series of holes in the frames, and into these apertures are pressed cores of lead. The core takes the form of a pure lead rosette, and the process of making this rosette is exceedingly interesting. First of all, long strips of pure lead, about ½ inch in width, are passed through specially designed machines, which will rib and automatically cut it into short lengths. Fig. 7 gives a fair idea of this operation which is known as gimping; the gimped pieces are then collected and carried to adjoining tables, where the lengths are spun by boys into small rosettes (fig. 8). The rosettes are then pressed by hand into position in the plates, the process being indicated in fig. 9. When the plates are filled they are passed through a hydraulic press, which completes the keying of the rosette mechanically, the plate being then practically ready for forming. The formation is effected by coupling up the plates with a set of dummy negatives and passing the current continuously through the cells, the rosettes becoming finally coated with a fine adherent hard crystalline coating of peroxide.

After the formation process the plates are then cast up into sets in a similar manner to the negative. That practically completes the general outline of the manufacture of chloride plates. There are, of course, many details that could not very well find a place in this article, but probably sufficient has been said to indicate the general nature of the process.

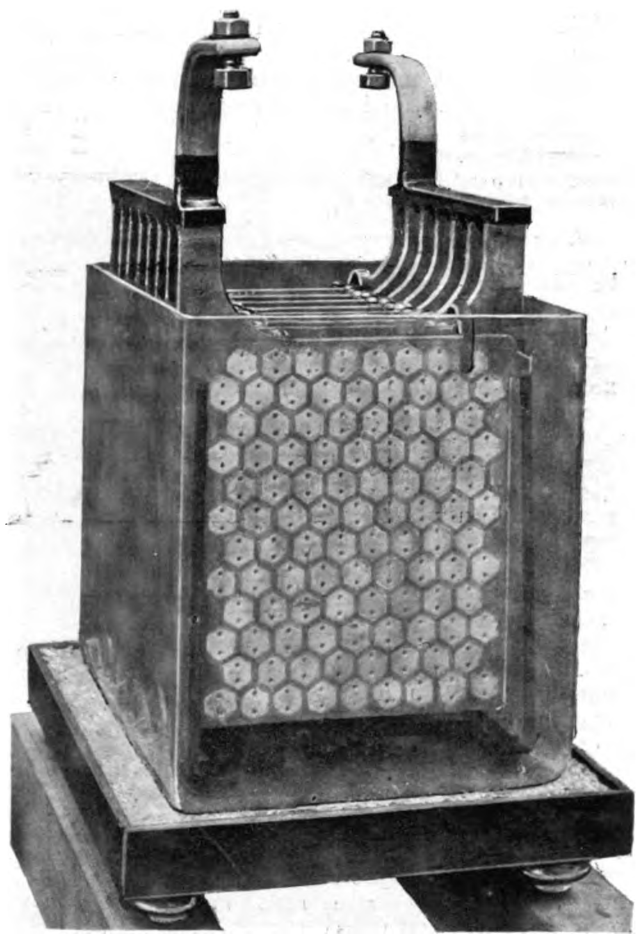


Fig. 6.—Complete Cell Showing Negative Plate.

Fig. 8.—Making the Rosettes.

There are many other things at these accumulator works that one ought to refer to. There is the electrical plant, which, in a way, is interesting, and consists of two 90-H.P. compound condensing engines, each directly coupled to a Mather & Platt multipolar dynamo; then there is a high-speed compound engine, coupled direct to a two-pole dynamo, also of Mather and Platt manufacture. In addition is a motor generator, which is capable of delivering current at 10 volts. The steam raising plant consists at present of two Lancashire boilers, though arrangements are being made for extending it. The generating plant is utilised not only for formation purposes, but serves to light the extensive works and to furnish energy for driving motors, which form quite a distinguishing feature of the place. There is nothing specially interesting about the switchboard. Each unit has a separate panel, and there are separate boards for controlling the energy used in the formation baths and in the lighting and motors. Housed in the same building as the generating plant is a large double-throw pump, which is used for the condensers, a double set of pumps for supplying the hydraulic accumulator, and also two Westinghouse compressors for the supply of compressed air.

There are, of course, the usual workshops necessary in such establishments. There is a large joiners' shop, equipped with modern machinery, and driven by electrical means. There is also a mechanics' shop, fitted with machine tools, and close by are the stores. It is very important that the workmen employed on certain sections of accumulator work should be kept moderately clean, and though we suppose it is not an easy matter to make a man clean by Act of Parliament, little trouble is experienced in this direction at the Chloride Works; moreover, the management insist that every man before he commences or recommences work shall have a substantial meal, and the enforcement of this rule has resulted in a general improvement in the health of the employés.

The testing of accumulators forms a very important part of the work carried on, and a large room is set apart for commercial tests of every description. Moreover, not only is the chloride cell elaborately tested, but all known types of cell are very carefully scrutinised and compared with the home article. With the exception, as we have pointed out before, of purchasing raw materials and the glass boxes, every operation necessary to produce a chloride cell is carried out on these works; there is little doubt that for completeness, for facility and convenience of manufacture, the Chloride Works rank among the best in the country.

Fig. 7.—The Gimping of the Lead Strip.

Some allusion has been made to the directions in which the chloride cell is performing useful work; but perhaps the most interesting of its many applications is the use that is being made of the cell for traction work, both in conjunction with the overhead wire system, and in cases where the accumulator is carried on the car. As an auxiliary to the overhead system, the excellent service of the Chloride cell is not confined to this country. One of the most notable examples is the system of the Union Traction Company, of Philadelphia, which operates some 500 miles of road. In making recent extensions on this line, it was found that it would be necessary either to build a new power house, or instal a battery sub-station, as the required addition to the existing feeder system would necessitate such an enormous outlay for copper, as to render it commercially impossible. It was found that the cost of copper alone to carry out this extension, and double the service on the section, would be four or five times the total cost of a battery installation to fully meet all the requirements, and that a new power house was out of the question, on account of the heavy operating expenses. Before the extension was made, the pressure at the end of the feeder was barely enough to operate cars on schedule time, and the pressure varied as much as 50 per cent.

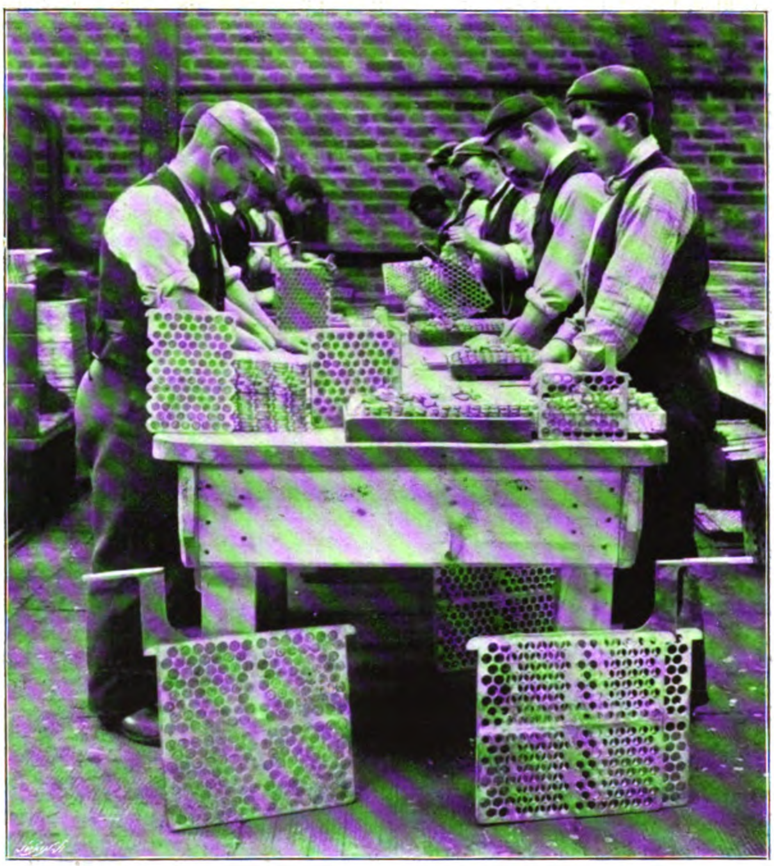


Fig. 9.—Pressing the Rosettes into the Positive Grids.

The load on the section varies from 100 to 700 amperes; the feeder carries a constant load of 400 amperes, the battery discharging or charging to the extent necessary to maintain this condition. The result in actual practice is found to be that the feeder load remains constant at this average current, and is absolutely independent of the fluctuating demand on the line. It is claimed that the battery in these cases enables the generators always to run at full load, and consequently at the highest point of efficiency, and to act as a cushion to the engine in the event of the circuit breaker opening when trouble occurs on the line.

On the Woonsocket line they have been able to show in pounds, shillings and pence what the value of a battery is, and it has been found that the saving in operating expenses amounts to £700 per annum.

In this country it has been already demonstrated on the existing electric tramway systems that one of the most valuable functions of a storage battery is to provide a reserve in case of breakdown.

In accumulator car systems, the Chloride cell has established a good reputation; and is being used on four lines in Paris at the present moment. The working results of one of these systems was published in the Review some months ago. Even on the much maligned Central Tramway system, where these cells have now been used for three years, the record is a good deal better than is generally supposed; indeed, we are not exaggerating when we say that the cost of upkeep of the batteries does not exceed 1⅜d. per car mile.

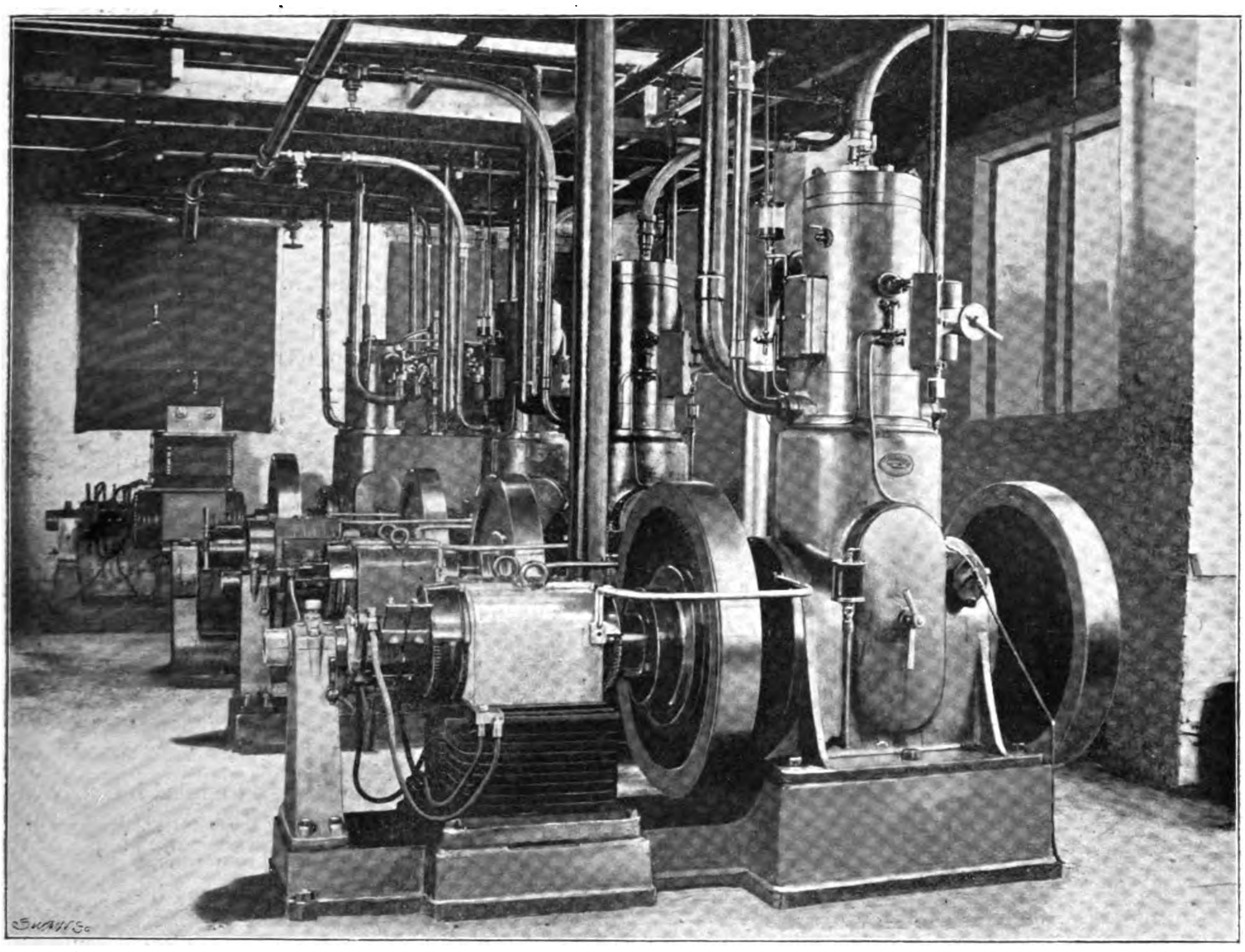
The Americans were always fond of big things, but it was generally supposed in this country that, in the use of storage batteries for lighting, we should not have had to yield the palm to our American friends; yet the Chicago Edison Company are about to put down what is very properly termed the largest storage battery in the world, one that is costing £20,000.

GAS ENGINES FOR ELECTRIC LIGHTING.

It is generally admitted that the internal combustion engine will play a conspicuous part in the cheapening of electricity, but one must be forgiven if at times one thinks the progress made in gas engine construction seems to be a little slow. At the same time, there is abundant evidence that gas engines for electric lighting work have been materially improved during the past few years. They are not only giving less cyclical variation, but the economy of a modern gas engine shows a most marked advance on the performances of, say, four years ago. Compared with steam motors, the size of the gas engine is still insignificant, and the weight of material per effective horse-power is very considerable; but the one great drawback that was urged against gas engines for electrical work, namely, unsteady running, may be said to have completely disappeared.

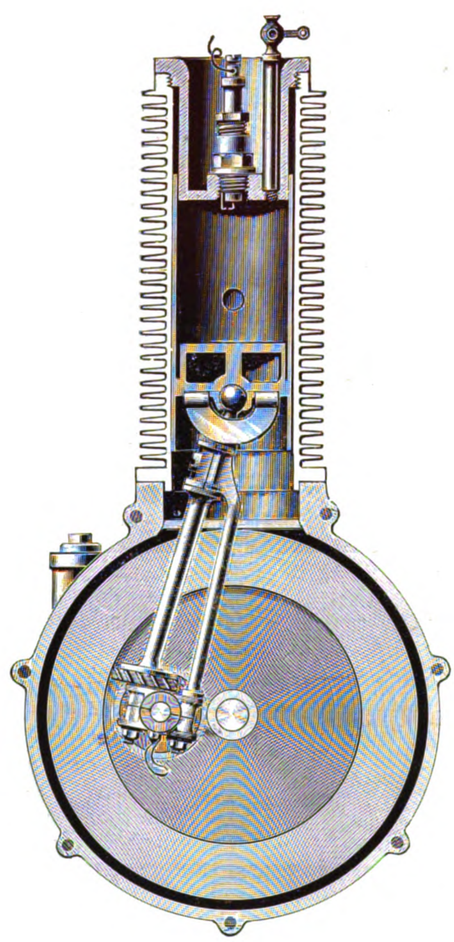
In the use of gas engines for central electricity works, much interest has been recently created by the success that has attended the running of such motors at Leyton, and no doubt we may see an immediate extension of gas engine stations.

It may be a matter of interest to many of our readers to learn that for some two years there has existed at Clapham Road a central station which has attained a distinct measure of success in lighting portions of the surrounding district. The plant comprises gas engines direct-coupled to dynamos, and they vary in size from 17 B.H.P. engines down to 2½ B.H.P. The combined plant is capable of giving 1,000 amperes at 110 volts, the average nightly load being 600 amperes. The works, which are quite of moderate size, were originally started in a small dwelling house, and it may be mentioned here that the lighting plant really forms part of a business that was started by Messrs. Paris Singer & Co., to manufacture the Dawson gas engine. The lighting of a few surrounding shops and houses was attended with so much success, that extensions speedily became necessary, and to meet the ever increasing demand, a small central station was eventually erected. A view is given of the plant erected in this building, though engines of similar capacity are still working in other parts of the works. The most notable feature is that the dynamos are direct-coupled to the engines, and to give an instance as to the smallness of the floor space occupied, three sets of 11 units each only take up a space of 13 feet by 8 feet, and this leaves ample room between the machines. The sets at present in use comprise one 35-B.H.P. double cylinder engine, six sets of 11 units, three of 4 units, and two of 2½ units capacity. There are two batteries of accumulators of the E.P.S. K 66 type, which are run in parallel with the machines at the time of heavy load, and thus become effective in the event of an ignition tube breaking. The battery also takes charge of the night load, and meets the whole of the Sunday demand, the engines being shut down from Saturday night till Monday morning. Water for circulating in the cylinder jackets is pumped from a well adjoining the works to tanks placed above the engine room; after passing round the cylinders the water passes to other tanks, and from thence runs back to the well. Town gas is at present employed for the engines, but we understand that when the load increases, producer gas will be made on the premises, plant for this purpose having been already erected by Messrs. Paisley.



A Gas Engine Station.

Undoubtedly the most interesting feature of the plant is the type of engine, which is extremely simple. It is designated the rotary piston type, and is practically valveless. The cycle adopted is the Otto, and some ideas of the interior mechanism may be obtained from the detailed drawing annexed. It should be explained, however, that this illustration is of the smaller class of engine made by Messrs. Paris Singer & Co., and is designed for motor cars. The action of the engine is practically as follows:—In every two complete revolutions of the engine, the piston is rotated completely round. As the piston is hollow, the work done by the explosive mixture is performed inside the piston. To provide for the admission of the gas, there are two holes in the piston opposite each other, and in the process of rotation, these holes become uncovered at the ports, and thus admit the mixture. During the period occupied by compressing and firing, the piston has been rotated, and at another position of the cylinder the holes become uncovered at the exhaust outlets, and the products of combustion pass out. The two holes in the piston, therefore, serve as a means of taking in the explosive mixture, and of getting rid of the



burnt gases. The rotating action of the piston is obtained in the following manner. For all intents and purposes the connecting rod may be considered as split in two, one portion of which is rigid, and the other portion is free to revolve. A tangent wheel on the front rod is driven by a quick pitch wheel fixed near the end of the crank pin; the piston rod is connected to the piston by means of a universal joint. The explanatory drawing will probably make the action of the mechanism clear.

It would seem as if there might be some gain in permitting the explosion to take place inside the piston, rather than in the cylinder; the cylinder walls are not thereby directly affected by the heated gases, neither is the lubrication of the piston interfered with.

The ordinary ignition tube is employed, the position being altered in the different sizes. A form of inertia governor is used, the regulation of the engine being effected by the hit-and-miss principle.

Probably we shall be able to say something eventually on the cost of producing electric energy at these small works. Our thanks are due to Mr. R. M. Campbell, the works manager to Messrs. Paris Singer & Co., for showing us round the works and explaining the very interesting features of the gas engine, which are now being made in considerable numbers.

ELECTRIC CRANES.

This somewhat well-worn subject has been brought before the Northern Society of Electrical Engineers, Manchester, by Mr. J. G. Statter.

The chief point of interest centres in the description of an electric crane made by the author's firm, which, for some special purposes, seems to have considerable advantages. It is a three-motor crane, in which the motors are connected in series order, and worked by constant current with variable pressure.

The motor brushes are made to rock through nearly half a circle by means of a chain and wheel, and the motors are started, stopped and reversed, simply by moving their brushes. When the brushes are on a diameter at right angles to the pole gaps there is no torque, no counter E.M.F., and no motion; but, moving the brushes to one side or the other causes a torque one way or the other and motion accordingly, so that the commutator and brushes act as their own switches, for stopping, starting, and reversing.

Such a system requires a constant current dynamo, specially designed for the crane, or a motor generator for constant current. The pressure rises and falls in accordance with the load on the motors.

The paper also describes a fanciful method of working a crane by a motor, in which the armature and field magnets both revolve; but as it is admittedly only a toy and of low efficiency, not being completely under control, it is of no interest to describe it here.

The rest of the paper deals with well-known apparatus, three-motor and single-motor cranes, without adding much to the knowledge of these already well-known and common types.

So far as we can gather, the single-motor crane finds most favour with crane makers, as it is the only system which can be readily adapted to existing cranes and to standard designs of mechanically-driven cranes. In fact, many square shaft-driven cranes have been converted, at small cost, and with little alteration, into electric cranes with a single motor. The three-motor system requires a specially constructed crane, and the series system of working with constant current requires not only a specially-made crane, but also a special generator. These, in practice, are serious drawbacks to the two latter systems.

A single motor with an open and crossed belt drive finds much favour with some crane makers, simply on account of its simplicity and effectiveness, and the same simple method is finding considerable favour in applying electro-motors to lifts, as manipulating the lift by belts has been found to be more economical and reliable than working them by purely electrical control, through a most complicated box of cam shafts, bevel wheels, clutches, and switches, all of which require continued attention. Any good motor can be used for crane driving, the details, switches, resistances, and gearing of the motor to its work are the only points in which electrical engineering problems arise.

Royal Institution.—On Friday, the 11th inst., a lecture was delivered at the Royal Institution by Dr. J. H. Gladstone, on the "Metals used by the Great Nations of Antiquity," in which he traced the growth of the metal working arts from the earliest periods of history. In connection with the occasion, a conversazione took place at the Royal Institution the same evening, which was well attended. At this a number of interesting samples of alloys and rare metals was on view, including aluminium from the British Aluminium Company, the well-known Atlas anti-friction metal, Delta metal, and rare metals from the firm of Messrs. Johnson, Matthey & Co., including a specimen of uranium, valued at £7,000.

NOTES.

(*Continued from page* 222.)

Obituary.—Our American exchanges record the death of Mr. O. B. Shallenberger, which occurred on January 24th, at the early age of 38. In 1884 he resigned from the U. S. Naval service, and devoted, from that time forth, his whole attention to electrical science. In the same year he joined the electric light department of the Union Switch and Signal Company of Pittsburg, and in 1885 he took charge of the setting up and operation of the Gaulard & Gibbs apparatus imported from Europe by Mr. Westinghouse. At this time his practical acquaintance with alternating currents began. After Stanley's experiments at Great Barrington, Mass., and other experiments conducted at Pittsburg by Mr. Shallenberger, the alternating current system was adopted, the Westinghouse Company was organised and Mr. Shallenberger was appointed chief electrician. Mr. Shallenberger was one of the earliest to apply the theories then known about alternating currents to practical operation. A contemporary remarks that he was the first in America to succeed in coupling alternating current generators in multiple. The system used for incandescent street lamps in series, with a shunt of high self-induction around each lamp, was one of his early inventions. Probably his most beautiful conceptions are exhibited in his electric measuring instruments. Mr. Shallenberger was consulting engineer for the Westinghouse Electric and Manufacturing Company, and also organiser and president of the Colorado Electric Power Company.

We regret to hear of the death of Mr. J. B. Chapman, acting principal technical officer of the Engineer-in-Chief's Office, General Post Office. Mr. Chapman, who was an old and valued servant of the department, was well known in connection with high-speed automatic working, many improvements which have been made in this system having been largely due to his initiation.

Lectures.—On the 7th inst., Dr. O. Lodge lectured at Leicester, under the auspices of the Literary and Philosophical Society, on "Electric Oscillations." Dr. Lodge said that much remained to be done before the "wireless telegraph" system could be made of practical utility. It was possible to telegraph through obstacles, but these offered more or less resistance. A message had been sent a distance of 9 miles in Germany and 15 miles in England by means of this system, and at present it was unknown up to what distance it was of use.

Mr. T. B. Murray, Glasgow, on Monday last week, lectured to the members of the East of Scotland Engineering Association on "Electric Motor Carriages." The lecturer, in his opening remarks, stated that to Edinburgh belonged the distinction of having produced the first electric carriage, which was built by a Mr. Davidson about the year 1842. Mr. Murray explained the advantages of the Johnston-Murray patent motor for this class of work. At the conclusion of his paper the lecturer showed a series of lime-light views, depicting a few historical vehicles and the latest types of American, French, and English electrical road carriages.

On the 7th inst., at the Royal College of Science, Dublin, Mr. W. Brown, B.Sc., commenced a series of 15 lectures on "The Practical Application of Electricity."

Prof. Wertheimer lectured at the Merchant Venturers' Technical College on "Wireless Telegraphy" on 5th inst., and will repeat the lecture and experiments on March 2nd.

At a meeting of the Manchester Geological Society on 8th inst., Mr. Bigg-Wither read a paper on "Electrical Shot-firing in Mines."

Prof. John Milne, F.R.S., delivered a lecture at the London Institution, Finsbury Circus, a few days ago, on "Geological Changes Beneath the Ocean."

Prof. S. P. Thompson, president of the Wolverhampton Literary and Scientific Society, will deliver his presidential address at the Agricultural Hall, on February 24th, his subject being "The Coming of the Electric Horse." He will be afterwards entertained at a supper at the Star and Garter Hotel, to which the mayor and the local members of Parliament have been invited.

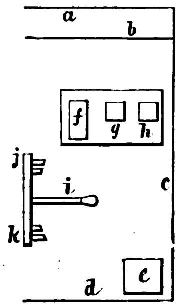
The Telephone and the Electric Tramway Wires in South Staffordshire.—On Wednesday, at the Walsall County Court, before his Honour Judge Griffith, the National Telephone Company, Oxford Street, London, were sued by Messrs. Bedworth & Son, merchants, of 10, Mill Street, Great Bridge, for £37 4s., the price of a horse, the death of which was caused by one of the company's telephone wires giving it a fatal shock. Mr. Ensor appeared for the company, and claimed that the South Staffordshire Tramway Company should be joined with them as defendants, as they were jointly liable. Mr. Disturnal appeared for the tramway company, and Mr. Parfitt represented the plaintiffs. The case was not gone into, but the facts were stated to be that a man in the employ of the telephone company was engaged in repairing one of the wires, and that while so engaged the wire fell across another wire, the latter belonging to the tramway company. This sent through it a current which made the man drop the wire, and after it had fallen plaintiffs' horse became entangled in it, and was fatally shocked. Mr. Ensor urged that the tramway company were bound to insulate their wires, and as they had failed to do this, they were really responsible for the accident. Mr. Disturnal submitted that to make a third party liable in such a case, liability to indemnify must be shown. His Honour held that the falling of the telephone wire on the tramway wire was a trespass, and that the tramway company could not be held liable for that. He therefore dismissed the action against that company with costs. Mr. Parfitt said that, after Mr. Ensor's argument, there could be no defence against plaintiffs' claim, as the parties had agreed that the damages were £35 4s. 6d. He asked his Honour for judgment for that sum. Mr. Ensor said his only defence was, that it was the electricity passing from the tramway wire to the telephone wire which had caused the man to drop it, and it was in that wire that the horse was entangled. He submitted to his Honour that if he were holding a cannon ball, and someone struck his arm and caused him to drop the ball on another person's toes, the man who struck the blow would be liable. This was a similar case. His Honour declined to give judgment on hypothetical cases, but said the telephone company had no right to let their wire rest on the tramway company's wire. Mr. Ensor said that, under the circumstances, he must submit to judgment, which was therefore given for £35 4s. 6d. and costs.

Presentations to Mr. H. C. Fischer.—Mr. H. C. Fischer, C.M.G., who retires from the Post Office service at the end of the month, took formal leave of the officials on Thursday last week, at St. Martin's-le-Grand. Among the presentations from the various departments were the following:—Silver candelabra from Mr. Fischer's personal staff and the controlling and supervising officers (male and female), past and present, of the Central Telegraph Office; three silver fruit dishes, with inscription and monograms, from personal friends in other branches of the Post Office; a brown leather Gladstone dressing bag, containing silver-stoppered cut-glass bottles and silver-mounted fittings; a silver cigar box (cedar wood lined) bearing an engraved centre piece representing a cable with ends showing, presented by the officers of the late Submarine Telegraph Company who were transferred to the service of the Post Office in 1889; a smoker's cabinet, of polished coromandel wood, with silver fittings, from members of the male staff of the Central Telegraph Office; and a silver vesta box, bearing initials H. C. F. and date, from Mr. Fischer's head messenger and his assistant. Mrs. Fischer was presented with a handsome diamond ruby and pearl bracelet.

The Institution of Civil Engineers.—On Tuesday next papers will be read on "The Theory, Design, and Practical Working of Alternate-Current Motors," by Llewelyn B. Atkinson, Assoc.M.Inst.C.E., and "Dublin Electric Tramways," by H. F. Parshall, M.Inst.C.E.

The Ferraris Memorial.—The German fund in aid of the proposed memorial to the late Galileo Ferraris amounts to £190. Of this sum, Dr. Kittler has collected £68, whilst the remainder comprises contributions obtained through the efforts of the editors of the *Elektrotechnische Zeitschrift.*

Ingenious "Booster" Connections.—Mr. James F. Austin, of Philadelphia, writing to the *Street Railway Journal*, says:—"Making the most of things," is the street railway man's watchword now-a-days, and the man who really can make the most of things generally comes out pretty near the top. In a power house not long since, I found a very ingenious arrangement of the generators, whereby one, or three, might be used as the very fluctuating travel demands. In the drawing, the line is shown, the several divisions being designated as follows: *a* and *b*, branches; *c*, main line, and *d* an extension of the main line three miles long and beginning about five miles from the main power station in which were three units; *f*, a modern direct connected generator running at 90 revolutions per minute, and having an output of 1,300 or 1,400 amperes. The smaller generators, *g* and *h*, were of the type of five or six years ago. At *e*, another station was located which could start one of the older generators at will. This company operates about 160 cars, and has a seaside resort at the end,



d, and travel varies from a full load for all the units, to a small load for generator, *g*. In the main power station, connections are such that the three generators can all be operated in multiple, or as travel demands, the line, *b*, can be put on unit, *g*, and the main line and branch, *a*, operate from *f* and *e*. By another combination, the generator, *h*, can be connected up as a "booster," and the main line, clear to and including *d*, may be operated from unit, *f*, and the booster, *h*, without the use of the generator at *e*. The connection of the generator, *h*, is through the switch, *i* (shown in detail), and when the lever, *i*, is thrown in contact with *j*, the generator is running in multiple with the others, but when the lever is thrown to *k*, the connections are such that the machine becomes a "booster," and works in that capacity with whatever feeders may be connected with it. The switch connections are such that either of the branches can be "boosted" or isolated to a single generator at will.

Petroleum Fuel.—The *Scientific American* remarks that it is gratifying to learn that the experiments which the Bureau of Steam Engineering is carrying out in the Stiletto in the use of liquid fuel are meeting with complete success. The great advantages of liquid fuel are, that it may be run into the bunkers or tanks by gravity, thus doing away with the tedious and costly loading by hand. It can be brought into the furnaces without handling, thus reducing the number of stokers, and it produces no ashes. A ton of oil, moreover, contains about twice as much heating power as a ton of coal, and hence the amount of fuel supply may be doubled without adding to the weight of the vessel. With a combination of liquid fuel and the turbine in the same vessel, we may look for some great developments in the present Government experiments.

Informations!—The following note from a correspondent speaks for itself:—"Kindly favour me in asking some one of our numerous readers to give us a few practical hints on the drum bar wound armatures, evolute end windings, the best means in conecting up the joints. You will extreemly oblige C. W."

Heat and Mechanical Work.—The highly interesting article by Marcel Deprez, which appears on page 239, was communicated by the author to the *Revue Générale des Sciences*.

Behr's Lightning Express.—Mr. F. B. Behr informs the *Times* that the Belgian Government has named a commission composed of the following engineers in the service of the State railways:—M. E. Gerard, engineer-in-chief and Chef du Cabinet of the Minister of Railways (president), M. A. Degraux and M. Flamasche, engineers-in-chief of the State railways, and M. Robert, engineer of the State railways (secretary), for the purpose of carrying out a series of important experiments on Mr. Behr's lightning express railway, constructed for that purpose in the neighbourhood of Brussels. Mr. Behr says that in the event of the report of the commission being in every way satisfactory, the Government would agree to the building of an important line on his system. A syndicate has been formed in Brussels, consisting principally of some of the leading bankers in that town, who are providing the money for the purpose. The experiments will begin towards the end of this month, and are expected to last about three months.

Cost of Steam in 1870 and 1897.—One the best papers recently read before the American Society of Mechanical Engineers (says the *Scientific American*), was presented by Mr. F. W. Dean, on the decrease in the cost of steam power between the years 1870 and 1897. This was shown to amount to nearly 40 per cent.; 17 per cent. of this is attributed to the use of multiple cylinder engines, steam jacketing, higher steam pressure and superheating the steam. Five per cent. is due to the use of vertical engines, 7 per cent. to improved boilers, 7 per cent. to economy realised in heating the feed water, and 2 per cent. is put down to the credit of improved construction of grates. Taking the best performances of the two periods named, the least consumption of steam per horse-power per hour in 1870 was 20 lbs., whereas the best for 1897 was 12½ lbs.

Electric Radiation.—Prof. Chunder Bose has communicated two papers to the Royal Society on experiments with electric radiation. It will be within the memory of his recent audience at the Royal Institution that a particular feature of his work in this subject is the reduction of the size of the apparatus employed to that of ordinary optical instruments. He has effected this by using oscillations of wave lengths much shorter than were employed by Hertz or Fitzgerald, though, of course, enormously longer than those of visible light. The experiments described refer to the refraction, and total internal reflection, by glass of electric radiation. The experiments on refraction were designed to test the application to glass of Maxwell's relation between the specific inductive capacity and the refractive index. It was found to be 2·04 for the wave length employed (that for visible light being about 1·5), which would make the inductive capacity 4·16. Different observers are said to have assigned to the inductive capacity of glass of various kinds values lying between 2·7 and 9·8. Hopkinson's figures, given by Prof. Everett, range only from 6·57 to 10·1. The second set of experiments was mainly directed to ascertaining the minimum air distance between two parallel surfaces of glass which would produce total reflection, and appear to have given very precise and satisfactory results. In both sets the oscillator used was the form in which a small central sphere is placed between two small spherical beads, the receiver being a Branly tube. The principal difficulty with the apparatus was so to shield the receiver that it should be affected only by radiation from one particular direction, and we may refer our readers to Prof. Bose's papers for the details of the way in which this was met.

The Brighton Engineer.—The condition attached to Mr. Arthur Wright's appointment as manager of the Brighton Corporation Electricity Works, requiring him to give his whole time to the duties of that office, has been waived, and Mr. Wright will be permitted to take private practice as an advising electrical engineer to other companies or corporations outside the borough.

Accumulator Traction on Common Roads.—Before the Self-Propelled Traffic Association on March 29th, Mr. J. T. Niblett will read a paper on "Recent Improvements in Accumulators, and in their Application to Traction on Common Roads."

Comparison Between Horse-Keep and Motor-Keep.—The *Automotor and Horseless Carriage Vehicle* extracts the following interesting comparison made by M. D. Creuzan, President de l'Automobile Bordelais, in *La France Automobile*:—

Daily Keep of Two Horses.

	Francs.
Food, hay, &c. ...	5.0
Litter ...	1.0
Smith ...	0.30
Harness ...	0.50
Rent of stable ...	0.50
Veterinary, &c.; repairs to carriage, stable and harness	1.15
Total ...	8 45

Daily Cost of an Automotor Vehicle.

Daily journey, 30 miles.

	Francs.
6 litres petrol ...	2.10
Oil, waste, &c. ...	0.15
Repairs ...	1.00
Use of rubber tyres, &c. ...	1.25
Total ...	4.50

Daily saving by using an automotor, 3.55 francs.

The editor of the *Automotor* advises his readers to turn back to its issue for October, and read up the article on "Kelvin's Law of Economy," and apply the above figures or others to any given case, a most instructive and accurate conclusion will be reached, viz, that *it is always much cheaper to use an automotor vehicle.*

North-Western Electrical Association.—The sixth annual convention of this Association was held in Milwaukee on January 19th, 20th and 21st. Mr. H. C. Higgins delivered the presidential address. The following were among the papers read:—"Practice of Theory," by J. C. McMynn; "Electric Lighting for Profit," by Alex. Dow; "Topics of Interest to Central Station Men," by Lieut. F. A. Badt; "Long Distance Transmission," by A. Ekstrom; "Present Efficiency of Incandescent Lamps," by J. E. Randall; "Physical and Chemical Properties of Volatile Oils in Boilers," by W. H. Edgar; "Electricity in Municipal Engineering," by Prof. R. B. Owens; "Municipal Socialism," by F. De Land; "Depreciation," by Prof. Jackson. There was a long discussion on municipal lighting plants.

Treatment of Consumption by Electricity.—According to *Electricity*, New York, a well-known physician, Dr. J. Mount Bleyer, is said to have discovered a method of curing consumption by the use of the electric current. Dr. Bleyer's system is based on the well-known principle that electricity can be made to act as a purifying agent by virtue of the ozone which, under certain conditions, it gives forth. Dr. Bleyer revivifies the blood of the patient by giving ozone. He places pads on the patient's chest, directly over the diseased part of the lung, and a pad on the corresponding point at the back. A current of electricity at extremely high voltage is sent directly through the body for 20 minutes or half an hour. Dr. Bleyer does not specify the amount of electricity he uses, fearing that inexperienced professionals may make the experiment with perhaps fatal results; neither does he say whether he uses direct or alternating currents. It has been proven, it is said, by experiments on rabbits, that the electric current really revivifies the blood by giving it ozone. Advanced stages of consumption cannot be cured by the Bleyer system, but it is claimed that such patients as possess enough of the lung substance as will carry on the physiological processes are susceptible of an absolute cure within a reasonable space of time, by the daily application of the current.

The Royal Society.—Before this society yesterday afternoon the following papers were down for reading:—Prof. A. Gray, F.R.S., and Prof. J. J. Dobbie, "On the Connection Between the Electrical Properties and the Chemical Composition of Different Kinds of Glass;" Dr. E. Taylor, "On the Magnetic Deformation of Nickel."

Multiphase Work.—We learn from a Glasgow daily that a handsome new beam and girder shop has been erected at Glengarnock. It is being driven electrically by Mr. Walter Dixon, of Glasgow, on the multiphase system.

Kruger, the Father of Arts and Inventions.—The Government fees in the Transvaal have not, up to the present, been very high; they have now been increased by the Law, and inventors will have to pay:—

	£	s.	d.
At the deposit of the application ...	1	1	0
At the deposit of an objection ...	2	2	0
At issuing a certificate by the Commission ...	1	1	0
For sealing and signing the Letters Patent ...	5	0	0
Before the expiration of the term of 3 years	20	0	0
" " " 5 to 8 years ...	100	0	0
" " " 8 to 11 years	150	0	0
" " " 14 years ...	200	0	0

The preamble of this new fiscal law is exquisite. Whereas it is desirable to encourage the working of new and lawful inventions, by granting to the inventor, for a fixed period, the exclusive right to exploit his own invention for his own benefit. . . . . President Kruger has a peculiar way of encouraging the inventors!

Electric Light Mains.—From the *Birmingham Daily Gazette* we learn that, "the defects in the supply of electric light at Burton-on-Trent were the subject of an important statement by Alderman Lowe. He said the committee had communicated with about 30 other cities and towns where electric light was used, and had ascertained that in almost every case where the Silvertown cables were used there had been more or less serious defects and breakdowns. Through the kind intervention of Lord Burton, a deputation of the Council had been to London and had a conference with Mr. Frank Bailey, engineer to the City of London Electric Lighting Company, and that gentleman had given them some very valuable information, and they hoped to be able to get Mr. Bailey to visit Burton, and to advise them on the best remedy. He had advised the substitution of the British Insulated Wire Company's cables, and this, Mr. Lowe estimated would cost from £5,000 to £6,000." It is not a little curious that the article in our leading pages this week should have a direct bearing upon the subject of mains, and the above note gives very striking evidence that we have struck the keynote of a matter of vital importance to electricity supply companies. We are aware that the manager and engineer of the Gas and Electric Light Works, Burton-on-Trent, issued a circular letter to various engineers throughout the country, in which he complained of the trouble he was experiencing with high tension mains of Silvertown make, and asking for answers to a set of questions which would be treated *as confidential.* Perhaps Mr. Ramsden will be good enough to communicate to us the replies he received to his circular, as we are desirous of investigating this matter; or if the engineers with whom Mr. Ramsden communicated will send us copies of their replies, we shall be glad to receive them, *absolutely* in confidence. It would be interesting also to learn whether Mr. Frank Bailey had advised the substitution of another kind of cable for those of Silvertown, on the strength of a personal examination and test! Finally, we wish to ascertain whether the mains complained of in 30 cities and towns were jointed and laid by the Silvertown employés, how many years they have been laid, and whether before or after the Board of Trade regulations? We hold no brief, it is scarcely necessary to say, for any cable or other firm; but we cannot forbear entering a protest against a line of policy which seems to have been organised for the express purpose of producing a "scare" in rubber cables.

Reis Memorial.—The Physikalische Verein of Frankfort-on-the-Maine propose to erect a memorial to the late Philipp Reis, the inventor of the telephone. The society, of which Dr. Petersen is the president, have appointed a committee to further the scheme, the carrying out of which is estimated to cost about £1,500.

Forthcoming Book.—Messrs. Crosby, Lockwood & Son announce that the work on "Submarine Telegraphs: their History, Construction, and Working," by Mr. Charles Bright, F.R.S.E., will be published very shortly. The subscription price ceases to apply on the date of publication. Subscription orders should reach them not later than Monday, February 28th.

The Shannon Water-Power Scheme.—The *Times* for Monday contains some particulars of this scheme. A meeting of riparian promoters and others interested in the fisheries of the Shannon was held on Saturday to consider the scheme, from which the promoters anticipate important results in the public electric lighting of various centres in Ireland. The scheme, in which Lord Lurgan, Sir Gerald Dease, and other gentlemen are concerned, is for the erection of electric works and machinery at Landscape, on the Clare side of the Shannon, below Castleconnel, the intake for the supply of water for the turbines being between Castleconnel and O'Brien's Bridge. The canal, a cutting of some two miles in length, will convey 55,000 to 60,000 cubic feet of water per minute for the turbines during the 10 hours of each day that they are to be worked. To meet any deficiency of the volume of water in the summer months, and during seasons of drought, the syndicate proposes to store water at Lough Allen, which has an area of 9,000 acres, the 60,000 cubic feet of water required to work the machinery being by this means available, without possible detriment to other interests, when it could not be had through the ordinary flow from the river. Other safeguards are also mentioned, and the syndicate states that it is prepared to compensate any injury proved to be done to the fisheries by the contemplated works. Lord Massy presided at the meeting, and there was a large attendance, including Lord Lurgan, Sir Gerald Dease, Mr. H. C. Fuller, engineer of the proposed scheme, Mr. V. W. Brown, and Mr. Fitzgerald, C.E. Mr. Fuller explained the details of the scheme, which was subjected to criticism from several gentlemen present. Lord Lurgan asked those present to look on that as a preliminary meeting, and to arrange for conferring with him and his colleagues after a reasonable time had elapsed, and when the details were more advanced. The enterprise was a very large one, he might say a national enterprise, and it should not be lightly cast aside. A further meeting will be held at an early date.

Stone-Throwing at Telegraph Wires.—The Education Department, Whitehall, has been circularising the correspondents of schools on the great damage done to telegraph wires and insulators through mischievous stone-throwing. The following circular, which was issued in 1875 and 1885, is again being sent out:—"The Duke of Richmond is informed that so much damage is done to postal telegraph lines by stone-throwing, that her Majesty's Postmaster-General is compelled to put the law in force against offenders. Most of the damage is caused by mischievous persons; but it is found that much injury is done by school boys, who do not think they are doing any great harm, and are not aware that they render themselves liable to imprisonment, and perhaps to flogging. You are hereby requested to be good enough to caution the children in your school against throwing stones at the telegraph lines, and to impress upon them the risks they run, and the great expense, trouble and annoyance they cause by so doing."

Early Electric Tramway Practice in the States.—We quote the following editorial from the *Street Railway Journal*:—"In the discussion of Philip Dawson's paper on 'Electric Traction' before the (London) Institution of Electrical Engineers, one of the speakers is reported to have denounced with vigour and point 'American haphazard methods. Their standards are no standards at all; they go full speed ahead, and then have to go astern.' There is possibly some basis for this criticism. Nearly the entire burden of experimentation in electric traction has fallen upon America, and it is inevitable that there should have been much duplication of plant in the progress of an industry from birth to what we might call now, perhaps, middle age. Nevertheless, there is one element in the case which is too frequently overlooked by the more conservative engineers and tramway managers both here and abroad, and that is, that the pioneers in the industry who have gone ahead courageously and put in the best apparatus known at the time, have frequently made enough money by doing so to purchase more improved apparatus as it has come out. This is true not only where there has been competition, and where the lines equipped with the better motive power have gained traffic at the expense of their more conservative competitors, but also in cities where there has been no competition, for the development of the 'riding habit' in American municipalities through the introduction of electric traction has been one of the marvels of the American financial world. Sooner or later this feature will, of course, be understood more generally abroad, but meanwhile 'conservatism' will, no doubt, plume itself upon its wisdom, while somewhat forgetful of certain advantages of 'progressiveness.'"

Portable Tools.—We have pointed out that electricity is working in the direction of portable tools where the work is large. *Machinery* illustrates a very convenient portable boring and drilling machine by the Newton Tool Works of Philadelphia. This machine has a base with slide, carrying a stout post. The post carries a horizontal spindle. There are two motors in the machine; one drives the machine and the feed, the other serves simply to raise and lower the head upon the post. The boring bar is driven by a steel worm and phosphor bronze wheel, triple threaded. A lifting shackle is provided for the crane hook to take. The machine is specially adapted for the drilling of the large yokes of motors and dynamos, but is, of course, applicable to any other work. It is a good sample of the new departure in tool making, which electricity has brought about, and which would have hardly been practicable—scarcely, indeed, possible without the new agent of transmission.

NEW COMPANIES REGISTERED.

Rochdale Electric Company, Limited (55,887).—Registered January 31st, with capital £5,000 in £1 shares, to adopt an agreement with W. D. Watson, and to carry on the business of electricians, suppliers of electricity, electrical engineers, electrical apparatus manufacturers, &c. The subscribers (with one share each) are:—W. D. Watson, Falinge Road, Rochdale, silk manufacturer; R. T. Golding, 25, Cambridge Road, Seaforth, Liverpool, chartered accountant; T. Snape, J.P., The Gables, Croxteth Road, Liverpool; T. Watson, Carr Hill, Rochdale, silk manufacturer; Miss M. G. Lendrun, 5, Croxteth Road, Liverpool; Mrs. M. M. Watson, Lydstep, Falinge Road, Rochdale; R. Watson, Oak Cottage, Shawclough, silk manufacturer. The number of directors is not to be less than two nor more than four. The first are T. Snape and W. D. Watson. Qualification, £100; remuneration as fixed by the company. Registered by C. Doubble, 14, Serjeant's Inn, E.C.

Warrington and District Electric Light and Power Company, Limited (55,890).—Registered January 31st with capital £2,000, in £1 shares, to adopt a certain agreement and to carry on the business of electrical and mechanical engineers and contractors, electricians, suppliers of electricity, iron and brass founders, &c. The subscribers (with one share each) are:—R. W. Francomb, Wilderspool, near Warrington, merchant; W. H. Robinson, 49, Wilson Patten Street, Warrington, secretary; J. Cannell, Academy Street, Warrington, physician; A. Curran, Grappenhall, Chester, civil engineer; A. Polley, Wilderspool Road, near Warrington, gentleman; H. W. Francomb, Wilderspool Road, near Warrington, student; C. L. Clarke, 7, South Parade, Manchester, electrical engineer. Table "A" mainly applies. Registered office, 117, Sankey Street, Warrington.

Electrical Works Company, Limited (55,892).—Registered February 1st with capital £10,000 in £1 shares, to carry on the business of electricians, mechanical engineers, suppliers of electricity, and manufacturers of electrical apparatus. The subscribers (with one share each) are:—W. M. M. Forwood, 15, Union Court, Liverpool, solicitor; C. O. Grindrod, 11, Knowsley Road, Rock Ferry, Chester, gentleman; A. E. Haptie, 5, Durham Road, Seaforth, Liverpool, clerk; F. W. Lintern, 104, Northbrook Street, Liverpool, clerk; A. Ruckley, 8, York Road, Seacombe, Chester, clerk; R. Smith, jun., 14, Bramham Gardens, South Kensington, gentleman; J. T. Downes, 8, Marlborough Villas, Wimbledon, clerk. The number of directors is not to be less than two nor more than seven; the subscribers are to appoint the first. Registered by F. J. Leslie & Co., 15, Union Court, Liverpool.

Perth Electric Lighting Company, Limited (55,898).—Registered February 1st, with capital £1,000 in £1 shares, to carry on at Perth, W.A., or elsewhere, the business of electricians, mechanical engineers, suppliers of electricity, and electrical apparatus manufacturers. The subscribers (with one share each) are:—E. Pope, St. Stephen's Chambers, Telegraph Street, E.C., gentleman; J. Doyle, 22, Brompton Square, S.W., gentlemen; J. D. Mackenzie, 12, Redcliffe Square, S.W., gentleman; G. T. Bean, 257, Winchester House, E.C., chairman of company; H. J. Dixon, 257, Winchester House, E.C., secretary; J. J. Daynes, 22, Graham Road, Lower Edmonton, gentleman; F. R. Wolseley, Elmwood, Catford, S.E., gentleman. Table "A" mainly applies. Registered by Williams and Neville, Winchester House, E.C.

Perth Tramways, Limited (55,935).—Registered February 4th with capital £125,000, in £1 shares, to acquire, own and work any concessions, rights and privileges connected with the construction and laying down of tramways in Perth, W.A., or elsewhere, and to equip, maintain and work by electricity, steam, horse, or other mechanical power such tramways. The subscribers (with one share each) are:—E. Pope, St. Stephen's Chambers, Telegraph Street, E.C., gentleman; J. Doyle, 22, Brompton Square, S.W., gentleman; J. D. Mackenzie, Bart., 15, Redcliffe Square, S.W., gentleman; G. T. Bean, 257, Winchester House, E.C., chairman of company; H. J. Dixon, 257, Winchester House, E.C., secretary; J. J. Baynes, 22, Graham Road, Edmonton, N., gentleman; F. R. Wolseley, Elmwood, Catford, S.E., gentleman. Registered without articles of association. Registered by Williams & Neville, Winchester House, E.C.

Buenos Ayres and Belgrano Electrical Tramways Company, Limited (55,957).—Registered February 5th with capital £850,000 in £5 shares (40,000 "A" preference, 30,000 "B" preference, and 100,000 ordinary), to adopt agreements with the Buenos Ayres and Belgrano Tramways Company, Limited, and to acquire, own, and work any tramways, light railways, cars, omnibuses, engines, electrical plant, &c., in the Argentine Republic, or elsewhere. The subscribers (with one "B" preference share each) are:—H. Dixon, jun., 6, Vale Road, Finsbury Park, N., gentleman; G. Proctor, 100, Harberton Road, Whitehall Park, N., gentleman; P. H. Lyne, 7, Ledbury Road, South Croydon, gentleman; A. S. Farmer, Holmside, Arkley, Herts., gentleman, B. J. Tunbridge, Eden House, South Woodford, gentleman; B. G. Gouk, 3, Inderwick Road, Hornsey, N., gentleman; E. Temple, 30, Byron Avenue, East Ham., E., gentleman. The number of directors is not to be less than four nor more than seven; the subscribers are to appoint the first; qualification, £500; remuneration £1,500 per annum, and 10 per cent. of the net profits, after paying 5 per cent. per annum on all shares dividend. Registered by Ashurst & Co., 17, Throgmorton Avenue, E.C.

La Capital (Extensions) Tramways Company, Limited (55,966).—Registered February 7th with capital £100,000 in £1 shares, to acquire, work, and turn to account a concession for the construction and working of tramway lines from a point on the system of La Capital Tramways, Limited, to Mataderos, in the Argentine Republic, and to carry on the business of an electric light and supply company. The subscribers (with one share each) are:—S. H. Granger, 271, New North Road, N., clerk; F. Thursby, 10, Draper's Gardens, E.C., solicitor; C. Hamwerck, 125, Goldhurst Terrace, N.W., gentleman; T. Hinds, 12, The Avenue, Blackheath, secretary; G. H. Short, 13, Cross Street, Hatton Garden, E.C., manager; J. C. Pease, 58, Jermyn Street, S.W., advertising expert; J. N. Bartlett, 2, George Villas, Prince's Road, Romford, clerk. The number of directors is not to be less than three nor more than seven. The subscribers are to provide the first. No qualification; remuneration as the company may decide. Registered by Budd & Co., 24, Austin Friars, E.C.

Self-Charging Electrical Traction Company, Limited (56,043).—Registered February 10th with capital £100 in £1 shares, to acquire, own and work, any patents and rights relating to the production, treatment, storage, application, distribution and use of electricity, and particularly in relation to the use of electricity for the purposes of the propulsion of vehicles. The subscribers (with one share each) are:—F. S. Gaylor, 74, Stockwell Park Road, Clapham, clerk; T. G. Norris, 6, Prideaux Road, Clapham, stationer; P. L. D. Perry, 40, Holborn Viaduct, secretary; R. W. Smith, 40, Holborn Viaduct, gentleman; J. Likeman, 47, Holborn Viaduct, registrar; W. O. Wheeler, 252, Cornwall Road, Bayswater, clerk; A. Burgess, 48, Constance Road, East Dulwich, gentleman. Registered, without articles of association, by Steadman and Van Praagh, 40, Holborn Viaduct, E.C.

Dennelle & Co., Limited (56,049).—Registered February 10th, with capital £10,000 in £1 shares, to carry on the business of French art metal workers, brass or metal founders, metal chasers, silk shade makers, manufacturers of wires, cables, and lines, electricians, suppliers of electricity, engineers, &c. The subscribers (with one share each) are:—R. T. Smith, Linford, Essex, gentleman; C. M. Escare, 23, Whitfield Street, W., art metal worker; J. J. Rawlings, Roseles, Galveston Road, Putney, engineer; E. J. Nicholson, 185A, Earl's Court Road, S.W., engineer; C. H. Fleetwood, 196, High Street, Harlesden, secretary: W. R. Rawlings, 6, Gartmoor Gardens, Wimbledon, S.W., electrician; W. Helliwell, 230, Amhurst Road, N.E., gentleman. The number of directors is not to be less than three, nor more than five; the first are E. M. Escaré, and R. T. Smith. Qualification, 50 shares. Registered by Turner & Co., 61, Carey Street, W.C.

Berrenberg Electric Lamp Syndicate, Limited (56,054).—Registered February 11th with capital £10,000 in £1 shares (100 founders), to acquire, own, and work any inventions for the manufacture of electric lamps and similar appliances, and to adopt an agreement with A. Berrenberg. The subscribers (with one share each) are:—G. H. B. Glasier, Edgecombe Hall, Wimbledon Park, gentleman; A. Halford, 7, Pembridge Square, W., gentleman; J. Howard, Blomidon Cranes Park, Surbiton, gentleman; A. Berrenberg, 11, Crystal Palace Station Road, Upper Norwood, engineer; R. J. Preston, 111, Alexander Road, Wimbledon, solicitor; W. J. Collyer, 13, St. Stephen's Road, Bayswater, solicitor; J. S. Glasbo, Ashmere Road, St. Peter's Park, W., clerk. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first; qualification, £100; remuneration as fixed by the company. Registered by Burton & Co., 23, Surrey Street, Strand.

Electrical Inventions and Manufacturing Company, Limited (56,073).—Registered February 12th with capital £5,000 in £1 shares, to adopt an agreement with J. Moores and H. O. Farrell, and to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity, &c. The subscribers (with one share each) are:—H. O. Farrell, 15, Hanging Ditch, Manchester, electrical engineer; C. H. Cox, 24, Fern Grove, Liverpool, clerk; J. W. Bennett, Tower Cliff, New Brighton, manager; J. W. B. Lockwood, 22, Trinity Road, Bootle, engineer; J. Moores, 15, Hanging Ditch, Manchester, electrical engineer; M. H. Barber, 10, Corporation Street, Manchester, electrical engineer; J. Woods, Burnage Lane, Didsbury, Manchester, secretary; S. E. Linsell, 33, Holland Road, Chorlton-cum-Hardy, electrical engineer. The number of directors is not to be less than two nor more than five; the first are J. Moores and H. O. Farrell. Registered by Bowden and Widdowson, 19, Brasenose Street, Manchester.

CITY NOTES.

Waterloo and City Railway Company.

The eighth half-yearly general meeting of the shareholders of the above company was held on Thursday, February 10th, at Waterloo Station, Mr. Wyndham S. Portal presiding.

The Chairman said it might interest the shareholders to know that there were now 732 holders, as compared with 669 at the meeting last August, and with 600 at the meeting in February, 1897. After referring with regret to the absence, through illness, of Mr. A. E. Guest, one of the directors, the chairman said that the report and accounts were very plain, and could be easily understood by any shareholder. The accounts as they stood gave satisfactory results, both as to the rate of expenditure in the past, and the probable outlay in the future. They had received the whole of the share capital of £540,000, out of which they had expended £360,605 down to the end of June, 1897, and a further £113,170 had been spent during the past half-year, making the total outlay to December 31st, 1897, £473,776. That total included the sum of £25,000 for interest paid to the shareholders during the construction of the line as authorised by the Act of incorporation. The principal item of expenditure last half-year—£80,037, was made up of £76,765 to the contractors for the works, and £3,272 to the engineers for their services. He regretted to say that one of their engineers, Mr. Galbraith, whose services they valued exceedingly, was very unwell, and his doctor had forbade him to attend the meeting. They had, however, Prof. Kennedy with them, who would be happy to give any information that might be required respecting the engineering work. The next large item in last half-year's payments was £24,839, which was for the electrical equipment of the railway. The interest and commission item, £3,289, represented the amount chargeable to capital under that head, after deducting the credit of £1,992 for interest received on their Parliamentary deposit and their bank account. The probable future outlay of the line was estimated at about £103,000, and that was more than covered by their remaining capital powers, which amounted to £237,890. The sum of £8,333 in the accounts was the amount which the Act compelled them to deduct from their debenture powers, representing one-third of the £25,000 which they had paid for interest out of capital, so reducing their further loan capital powers to £171,666—£7,046 for interest accrued and provided for was the amount divided among the shareholders for the past half-year. At the last meeting he referred to the question of calls, and it was gratifying to be able to state that there were no arrears in respect of their final call, everything having been paid up. The whole of the share capital having now been fully paid up, they were in a position to avail themselves of the provisions of the Companies' Clauses Consolidation Act, 1845, and convert the shares of the company into a general capital stock. The directors advised that advantage should now be taken of those powers, as tending to benefit the shareholders. The stock would be much more marketable, and in a much more convenient form. As regarded the work done in the construction of the railway, he could not do better than read the short but interesting report of the engineers. That report told them that all the tunnels were finished except a portion of the white glazed tiling in the up City Station tunnel, and in the inclined approach to the Central London Company's subways at the Mansion House. In the down or southern tunnel the permanent way had been laid from Waterloo to the cross-over road at the western end of the City Station, and in the up or northern tunnel the permanent way had been laid from Waterloo to the river shaft, and the remaining length of road laying was in hand. The low level station at Waterloo was finished, and two of the three communications between the high and low level stations were finished, and the other one would be ready by the end of the month. The yard for the terminal sidings at Waterloo was finished and ballasted, and more than half of the sidings had been laid. The whole of the permanent way materials for the sidings were on the ground. In the generating station the first portion of the engine and boiler houses is ready for the reception of the machinery. Two engines had been fixed, and all the boilers were now in position. In addition to the engines mentioned above, the remaining four machines and the whole of the dynamos were nearly ready, and the switchboard work and other apparatus for the station was far advanced. The travelling crane was delivered and in use. The electrical work in both tunnels was now complete as far as the river shaft. Beyond the shaft the contractors for the electrical work were following on towards the City as quickly as possible, and would reach the cross-over road in the down tunnel in about a month. The rolling stock had been delivered to the London and South-Western Railway Company, and was now being erected at their Eastleigh Carriage Works. One train is complete, and was quite ready to be lowered as soon as the lifts were ready to lower it into the tunnels. The signalling arrangements had been approved by the Board of Trade. The contract for the work had been let, and fixing would shortly be commenced. The works now remaining to be completed were (1) the permanent way in the up tunnel between the shaft in the River Thames and the City station, and already 80 per cent. of the permanent way had been laid complete. (2) Portions of the platforms and tiling in the City station and inclined approach tunnel, and the short staircase and landing connecting the inclined tunnel with the up and down platforms. (3) The remainder of the buildings at the generating station at Waterloo. All the above were expected to be ready by the middle of March. The large lift for lowering the rolling stock was making good progress, and was expected to be in working order on or before February 20th. Of the two temporary exits for passengers at the Mansion House (pending the completion of the Central London subways), one was well advanced, and it was hoped would be ready simultaneously with the completion of the Waterloo and City Railway. The other was progressing, but its completion depended upon the levels of the gas and water mains at the eastern end of Queen Victoria Street, the exact positions of which has not yet been definitely ascertained by the Central London Railway Company, by whom those outlets were being constructed. It was to be regretted that the Central London Company's subways at the Mansion House would not be ready by the time their railway was finished, and to bring the line into use at the earliest possible date, temporary exits would be provided. They were disappointed that they had not been able to commence the new year with the line open, but that was no fault of the directors or the contractors, nor of the Central London Company. The underground pipes met with had created difficulties and delays which were unavoidable. Those were now disappearing, and they expected to be able to arrange with the London and South-Western Railway for bringing the line into use by the middle or the end of next month. They would, therefore, shortly be in a position to realise the earning capabilites of the railway, and they had every confidence that it would prove of great public service in providing a convenient and expeditious means of communication between Waterloo and the City, and that it would be a safe and profitable investment to those who had contributed to the undertaking.

Col. the Hon. H. W. Campbell seconded the motion, and the report was adopted.

The Chairman then submitted a formal resolution providing that from March 1st the whole of the share capital of the company be converted into general capital stock and divided amongst the shareholders according to their respective interests.

Col. Campbell seconded the resolution, which was carried.

The retiring directors and the auditor having been re-elected, the proceedings terminated with a vote of thanks to the chairman for presiding.

Westminster Electric Supply Corporation, Limited.

The ordinary general meeting of the shareholders of this company was held on Wednesday last at the offices, Eccleston Place, Belgravia, Lord Suffield, K.C.B., in the chair.

The report and accounts having been taken as read, the Chairman, in moving their adoption, said: Gentlemen, the report speaks for itself, and therefore I won't trouble you with a long speech with respect to it. I think you will agree with me that there is every reason to congratulate ourselves on the working of the past year, and the increase in revenue, which allows us to recommend the payment of a dividend, which is an addition of 3 per cent. on that of the preceding year. I think we ought to call attention to the fact that we have had again to make very large extensions in all our centres—Millbank Street, Eccleston Place, and Davies Street—and you can well understand that the extensive works at these stations have put the working of the business at a great disadvantage. The cost of generating the supply might have been far less if we had not had to contend with these difficulties, which arose in consequence of these extensions to our works. But perhaps, on the whole, it is satisfactory as it is. You will see that the supply of current still continues to increase at a satisfactory rate, and, as far as we can judge, there is no likelihood of a decrease in the number of applications received, for as the old houses in some parts of our district where no electricity is used are pulled down, they are replaced by new buildings, in many places by large blocks of flats, where electric fittings are put in as a matter of course. I think you will agree with me that the negotiations with the holders of the founders' shares has been satisfactory, because there is no doubt that it is to the advantage of all concerned that all the shareholders are now upon the same footing. I think that arrangement is satisfactory to the proprietors generally. I do not think there are any other points I can usefully draw your attention to, but, of course, if any shareholder present has any questions to ask, I shall be most happy to reply to them. I now move the adoption of the report and accounts.

Mr. E. Boulnois, M.P., seconded the motion, which was carried.

Mr. J. Browne Martin then moved: "That a dividend be declared for the past half-year at the rate of 16 per cent. per annum, less income-tax, payable on March 1st, making, with the interim dividend of 8 per cent., 12 per cent. for the year."

Sir Douglas Galton seconded the resolution, which was agreed to.

Mr. R. W. Wallace, Q.C., in moving the re-election of Lord Suffield as a director, remarked that he need say nothing concerning the qualifications of his Lordship, who made an excellent chairman, under whom he and his colleagues were very pleased to work.

Mr. Hayes Fisher, M.P., seconded the resolution, and said that outside the work which Lord Suffield did in the board room, his personal influence had been of great assistance to the company in other ways.

The motion was carried.

Mr. Wallace next proposed the re-election of Mr. Boulnois as a director, and remarked that he did an immense amount of work in connection with the company, and he especially looked after the transfer department.

Sir D. Galton seconded the proposition, which was agreed to.

Mr. Boulnois, in thanking the meeting for his re-election, said he took a pleasurable interest in the proceedings of the company, of which he had been a member since its formation. He had watched its rise from infancy to its present position, and any man might be proud to be associated with a concern which had made such vast strides during the few years it had been in existence.

The Chairman also thanked the meeting for his re-election, and said that he had always devoted a large amount of attention to the company since he had been on the board. He had been associated with it from the commencement, and it gave him great pleasure to see the progress it had made.

Sir Mark Stewart, Bart., M.P., proposed the following resolution, of which he had given notice: "That the directors shall be paid out of the funds of the company by way of remuneration for their services, the sum of £3,000 per annum, or such other sums as the company in general meeting may from time to time determine, and such remuneration shall be divided among them in such proportions and manner as the directors may from time to time decide" He said he did not think his task would be a very difficult one seeing the prosperous nature of the company. They had something like 180 miles of ways, and they paid something like £50,000 a year dividend, and they had an increasing number of lamps, so that the prospect was that their profits would continue to increase. Ever since the company had been started, it had been progressive. The first year it paid no dividend, but since that time not only had the shares gone up in value, but there had been a steady rise in the dividend. The shares were now four times their original value, owing to the splendid position which the company occupied. He knew the company had got a good district to work, but that would have been no use if they had not been fortunate in obtaining the services of good directors, and he must say that seeing the responsibility that was entailed upon them, they had not justly compensated them for their labours in the past. The increase in the value of the shares and in the dividends had not been by great leaps and bounds, but it had been a steady graduated process, which he hoped would continue. He was anxious to move that resolution a year ago, but was asked not to; but he thought the time had now come when they really ought to increase the remuneration of the board as he proposed.

Mr. F. A. White seconded the resolution, and said he did not think that anybody could say that the present remuneration of the board was fair or reasonable for the amount of work they had to do.

The resolution was agreed to, and the proceedings closed with a vote of thanks to the chairman for presiding.

National Telephone Company.

This company's meeting was held yesterday at the Cannon Street Hotel.

Mr. J. S. Forbes proposed the adoption of the report in a lengthy speech, and complimented the shareholders upon the progressive character of the figures in the accounts. Knowing, as the board did, the very great difficulties which surrounded the company, they felt that the profits were very satisfactory. The income had increased over the previous half-year by £67,600, and the expenses by £37,806, so that there was an increased profit balance of £23,474.

The report was adopted.

Dublin United Tramways Company (1896), Limited.

At the half-yearly meeting, held on the 8th inst. in the Imperial Hotel, Dublin, Dr. William Carte, J.P., presided, and, in moving the adoption of the half-yearly report, gave the following particulars of two companies which they controlled:—The Dublin United Company's results were most satisfactory, showing increased receipts, economic working, and remarkable freedom from accidents. Passengers showed an increase of 1,221,502, representing £5,028, the average fare being 1·39d. for the horse system, and 1d. for the electric; 73,376 additional miles were run. In November last electric traction was introduced on the Clontarf line from Annesley Bridge to Dollymount, with satisfactory results. The speed authorised is 10 miles per hour, and no hitch had occurred. The new power house at Clontarf is built on the most up-to-date system, with best equipments, and in efficiency quite equalled any to be seen abroad. The restrictions as to speed, imposed by the Board of Trade, very seriously affected their receipts on the Dalkey electric system. Unfortunately the Board of Trade had not the power to grant an increased rate of speed, so they had applied to Parliament, and expect, in the coming session, to obtain the same regulations for the Kingstown and Dalkey line as were approved for the Clontarf line. The delay in extending the electric system to Nelson's Pillar, from Haddington Road on the Dalkey line and Annesley Bridge on the Clontarf line, has been unavoidable, owing to the difficulties in arranging with the Corporation. Matters are now, however, settled, and within the next few weeks they hoped to have the electric cars working in to the city. The Rathmines to the sea line is far advanced. They had applied for an Order in

Council to admit of additional lines being constructed in the city and suburbs. Their offer to take over the electric lighting of the city had attracted much public attention. The company considered, from the opportunities at their disposal in being able to use the power stations at night for lighting purposes, they would be in a position to carry out this proposition with advantage to the company and to the ratepayers. But, as it could only be done with the consent and approval of the Corporation, nothing could be done at present. Their application to Parliament for electric powers had been defeated as far as the city and the principal townships were concerned, and the township of Rathmines was promoting a Bill for the expropriation and dismemberment of the tramway system. In considering the present prices of shares they must contrast the position of the company now with what it was at the time when the company was formed. Then they had been unsuccessful in getting electric powers; were threatened with dismemberment by the Rathmines Commissioners; doubts were cast on the titles to our lines; and they were harassed on every side. Since then they had got electrical powers over the whole city and suburbs; they have a certainty of all their lines for 42 years, with 30 per cent. to be added to their then value if the local authorities should decide to purchase the tramways at the end of that period. The public enlightenment on the economy and other advantages of electric tramways had also tended to enhance the price. None of these conditions existed when the company was formed, nor did they seem even probable of fulfilment; and, under all the circumstances, they claimed that they could not have done better for the shareholders of the old company than by securing them in a position which has enhanced the value of their shares by 50 per cent., unless they were prepared for their whole project breaking down at its inception.

Cuba Submarine Cable Company.

The half-yearly meeting of this company was held on Wednesday at the offices of the company. Mr. C. W. Parish, who presided, compared the expenses of the six months under review with those that arose in the similar period of 1896, and the difference was practically £578 in favour of 1897. Alluding to the serious falling off in traffic receipts, which was referred to in the report, the Chairman said that had been principally due to the loss on the French traffic. The shareholders would have been fully prepared for that result, for they were clearly warned last year that the French traffic would eventually go by the new cable from Hayti to New York. A still more serious competitor was the cable between Bermuda and Jamaica, which completed the Bermuda and Halifax route. The chairman then dwelt upon the changes that had taken place since the inception of the Cuba Company, and referred to the loss of income that would accrue to them being compelled to reduce their rates in consequence of the British Government insisting upon a 3s. rate on the New Bermuda line. After referring to a difference that had arisen between their allies, the West India and Panama Company, and themselves, the resolution for the adoption of the report was passed by the meeting.

The National Electric Supply Company.

The ordinary general meeting of this company was held last week at Preston, Mr. H. Booth, J.P., in the chair.

The Chairman, in moving the adoption of the report and accounts, said it was a great pleasure to all the directors to be enabled to recommend a dividend which would be satisfactory to the shareholders. Nearly four miles of additional mains had been laid during the year, and £4,560 was spent on capital account. An alternating plant had been fixed at the works to supply current to Ashton and outlying districts, and an equivalent of 5,000 8-candle-power lamps had been added. The expenses incurred in the reduction of capital had been charged to the revenue account for the year. He hoped that in the future the company would be enabled to materially reduce the price of current to consumers.

Mr. E. Pyke seconded the adoption of the report, and said they looked forward to a very good result for the present year.

The resolution was carried unanimously.

A dividend of 5s. per share to be paid on the ordinary shares was then adopted.

The Epstein Electric Accumulator Company, Limited (in Liquidation).

Mr. P. W. Northey, liquidator, receiver, and manager of this company, has issued the following circular from 28, Victoria Street, Westminster, S.W.:—"As you are probably aware, an action was instituted in the month of July last on behalf of the first debenture holders, and in such action I was appointed receiver and manager and have in that capacity continued to carry on the business of the company. Subsequently, an order was made for the compulsory winding-up of the company, and I was appointed liquidator in such winding-up. An offer has been made for the purchase of the Epstein Company's assets by a new company, which proposes to take over the business as a going concern. The terms of purchase, while not immediately satisfying the entire claim of the first debenture holders (£6,000), give them such interest in the new company, coupled with a guarantee of minimum working capital, that the offer is likely to receive favourable consideration on their part. As to the owners of the second Epstein debentures, these will have the option of applying for fully-paid ordinary shares in the new company, not exceeding in face value the amount of their present holding in second debentures at a discount of 50 per cent. Any such options not exercised by owners will be held at the disposal of other second debenture holders who wish to participate in the new scheme beyond their present holding. The actual assets of the Epstein Company, after collection of outstanding accounts, will be approximately £2,000 in cash, besides:—

	£	s.	d.	
Plant	3,164	17	5	as nominally valued in books on Jan. 1st, 1898.
Stock	3,296	17	11	
Patents	70,050	0	0	

While the before-mentioned offer is under consideration, I desire to invite competitive proposals which may be productive of better results, and I shall be glad to give any desired information with a view to the receipt of ulterior proposals before closing with the one received, which will be open for acceptance till February 26th."

Newcastle and District Electric Lighting Company.

The directors report that the supply of current continues to give satisfaction to the company's consumers, the units sold last year being more than five times the quantity sold in 1890, the first year of the company's operations. The installations connected to the company's mains during the year are equal to 4,400 10-candle-power lamps, bringing the total up to about 32,600, and 642,969 units of electrical energy have been supplied, as against 541,139 units supplied in 1896. During the past year, 3,006 yards of main and branch piping have been laid, together with 4,938 yards of main and branch cable. The gross earnings during the year amount to £5,684 19s. 1d., and after paying interest and making provision for depreciation and reserve funds, the directors are able to recommend a dividend of 5 per cent. for the half-year ending September 31st (less income-tax), which, together with the interim dividend paid in August last, makes the dividend 7½ per cent. for the year.

The Northampton Electric Light and Power Company, Limited.

The annual report to be presented at the annual meeting of shareholders on February 24th, 1898, states that the directors are again able to present a favourable report to the shareholders, notwithstanding several circumstances, but for which the company's progress would have been even more marked. The engineers' strike occasioned much delay and inconvenience, and it is fortunate that no mishap occurred during the busiest season. It became necessary, in view of continued difficulties with the local gas company, to appeal to arbitration on the question of the removal or alteration of gas service pipes, which interfered with the construction of this company's culverts on the safest and most approved plan. The Board of Trade arbitrator has granted the facilities asked for, but at the expense of valuable time, and a resulting loss of revenue. The new system of charging for current has been much appreciated, and will conduce to the advantage of both the company and its customers. The special rebate to consumers during the past year has amounted to no less than £488. The immediate result of this is a loss of income; but the use of electricity for lighting and motive purposes has been so popularised, that the tendency cannot be otherwise than beneficial. The ordinary charge for current is 8d. per unit (less special rebate if shown by the "indicator"); for places of worship 4½d., and for motive power 3½d. (the demand in both cases being at times when the plant is least employed). Discount is also allowed for cash. Further developments are taking place at the company's works. In addition to the two new engines and dynamos referred to in the last report, one more engine of 240 H.P. has been erected, with dynamo complete, making in all six engine and dynamo sets. There has also been fixed a new boiler of a capacity equal to all the three original boilers combined, with an economiser and other subsidiary machinery. Further land and buildings have been acquired, and an additional boiler house has been erected, with a storage tank capable of holding 33,000 gallons of water. A supplemental accumulator battery has been added. The system of supply will be changed over during the present year from two to "three-wire," thereby securing greater efficiency and economy. In view of the increasing demand for current, further plant has been ordered, consisting of boiler, engine and dynamo, all of large capacity. The mains have been extended in several directions during the year. The machinery is maintained in a high state of efficiency.

The balances of the revenue accounts for the past seven years are shown as follows:—

	1891	1892	1893	1894	1895	1896	1897
	Loss £460	*Profit* £308	£536	£762	£819	£1,351	£1,409
Less depreciation ...				£100	£250	£500	£500
				£662	£569	£851	£909

(Shillings and pence omitted).

The lamps in use (at 8 C.P. each) during five years have been 4,600, 5,300, 6,130, 8,014, and 11,084 respectively, motive power being accounted for as lamps. It will be seen by the net revenue account that, after paying interest on debentures and temporary loans to the end of last year, there remains £562 13s. 11d. to be dealt with. It is now proposed to pay a year's dividend on all the shares for the year ending December 31st last, viz.: on 6 per cent. preference shares, £232; on 5 per cent. preference shares, £65 3s. 8d.; and on ordinary shares, at the rate of 2 per cent, £201 0s 3d., leaving £64 10s. to be carried forward. Further shares were issued last year, viz.: ordinary shares to the number of 710, and 3,000 5 per cent. preference shares, but the total debenture issue was not increased. It is now proposed to issue 4,290 further ordinary shares at par, and also to raise £3,950 in 4 per cent. debentures, which will be issued at a small premium. The existing shareholders, debenture holders, and customers of the company will have the first option of taking these shares and debentures.

Messrs. F. H. Thornton and R. Cleaver retire from the board in rotation, and will be proposed for re-election.

The India-Rubber, Gutta-Percha and Telegraph Works Company, Limited.

The directors' report for the year ending December 31st, 1897, to be presented at the 34th ordinary general meeting of the shareholders, to be held at the Cannon Street Hotel, London, on Wednesday, February 23rd, 1898, at 12 o'clock noon, states that after provision for doubtful debts, a net profit for the past year of £41,044 14s. 9d. Adding £22,128 6s. 4d. brought forward, and deducting £12,500 interim dividend paid in July, there remains a disposable balance of £50,673 1s. 1d. The directors recommend the distribution of a dividend of 15s. a share, free of income-tax, amounting to £37,500, making, with the interim dividend paid in July, a total payment of 10 per cent. for the year, and leaving £13,173 1s. 1d. to be carried forward. There has been little cable work during the year. The company's general business has steadily increased, and the steamships have been moderately employed. The factories at Silvertown and Persan are in a high state of efficiency. There was a six months' strike in the engineering departments at Silvertown, which caused some inconvenience and expense, but did not greatly affect the company's business. The block of buildings in which the Melbourne Agency was situated was burnt out on November 21st. Other premises have been taken and new stock has been sent out.

Mr. Darwin retires by rotation, but offers himself for re-election as a director.

Scarborough Electric Supply Company.

The report states that the company continues to make satisfactory progress. During the past year 32 new customers, and the equivalent of 2,340 8-C.P. additional lamps have been connected to the company's mains, making a total of 330 customers and 20,067 8-C.P. lamps connected at the present time. To meet these requirements 310 yards of additional mains have been laid, while the capacity in cables and transformers has also been correspondingly increased. An additional 150-kilowatt set of generating plant has also been ordered, but owing to the strike in the engineering trade, is not yet delivered. During the past year electric energy to the amount of 214,044 Board of Trade units has been supplied to customers, at a revenue, including meter rent, of £5,179 13s. 9d., as against 179,360 units and £4,383 5s. 11d. revenue for 1896. The company has made a profit on the year's working of £2,044 13s. 0½d., as against £1,617 8s. 8d. in 1896, adding the balance of £191 19s. 5d. carried from the previous year, there is, after paying income-tax £23 2s. 8d., bank interest £18 8s., and writing off the sum of £ 00, being the balance of the preliminary expenses account, and putting £250 to depreciation, a sum of £1,845 1s. 9½d. available for distribution. The directors recommend that this should be applied in paying a dividend of 5 per cent (less income-tax), which will absorb £1,656 10s., leaving a balance of £188 11s. 9½d. to be carried forward. It will be observed that, in addition to the £100 written off the preliminary expenses account (which is now extinguished), and the £250 put to depreciation account, a sum of £70 1s. 2d. has further been written off the office furniture and fittings upon removal of the offices, making a total of £420 1s. 2d. written off and put to depreciation during the year. Mr. J. W. Woodall, Mr. John Dale, and Mr. J. Bell Simpson retire by rotation, but are eligible and offer themselves for re-election as directors. The auditors, Messrs. Bradley, Davis & Co., chartered accountants, also offer themselves for re-election.

Tramways Union Company, Limited.

A general meeting of this company was held at Winchester House on Tuesday, Mr. E. M. Underdown, Q.C., presided. In moving the adoption of the report, he said the step they had taken in regard to one of their tramways was extremely important. It would be satisfactory to them to know that in all probability that portion of their system which was intended to be worked by electricity would be in full operation in June. If, as they had not the slightest doubt, the results of this mode of traction proved to be more efficient and profitable, the receipts, which would provide the means of covering the outlay they had incurred for this purpose, would come into account during the remaining half of the coming six months. There had been increases in their expenditure at both Bremen and Bucharest, and the expenditure had not been lessened by the fact that forage had ruled comparatively high in those cities. At Bremen they had practically relaid the system, and otherwise improved it, with results eminently satisfactory. During the current year they would reap the benefit of the improved earnings. The progress of the works at Madrid had been extremely rapid, and the appliances they were putting down there might be confidently said to be of the best and most modern kind. Their colleague, Mr. Concanon, had bestowed the greatest attention on this matter. Among other things he went to the United States, and had satisfied himself that in the arrangements they had made, they had got the very best materials and appliances that could be procured. They all knew the great profit which was obtained by overcoming the mechanical difficulties which arose in the earlier stages of the progress of electricity, and he believed they would be able to work the traffic in Madrid in a very profitable manner.

Mr. George Richardson seconded the motion, which was unanimously adopted, and a dividend was afterwards declared, making 5 per cent. for the year, tax free.

Eastern Telegraph Company, Limited.

An extraordinary general meeting of this company was held on Tuesday to consider a resolution to the effect that the regulations of the company be varied by adding the following articles of association, viz.: 85a—"Continuing directors may act notwithstanding any vacancy in their body." The object of the resolution being to provide against the inconvenience arising through the number of directors falling below the *minimum* allowed by the articles of association, and to enable them to carry on the business of the company, including, of course, the filling up of vacancies.

The resolution was adopted.

Stock Exchange Settlements.—The Stock Exchange Committee has (1) appointed special settling days as under:—Wednesday, February 23rd: Cape Electric Tramways, Limited—285,157 vendors' £1 shares, fully paid, Nos. 1 to 285,157; City of London Electric Lighting Company, Limited—Provisional certificates for a further issue of 10,000 ordinary shares of £10 each, £2 paid, Nos. 90,001 to 100,000; Electric Construction Company, Limited—Further issue of 8,657 7 per cent. cumulative preference shares of £2 each, fully paid, Nos. 16,344 to 25,000; Electrical Copper Company, Limited—150,000 6 per cent. cumulative preference shares of £1 each, fully paid, Nos. 1 to 150,000. And (2) ordered to be quoted in the Official List: Barcelona Tramways Company, Limited—Further issue of 5,072 ordinary shares, Nos. 14,929 to 20,000; City of London Electric Lighting Company, Limited—Provisional certificates for a further issue of 10,000 ordinary shares, £2 paid, No. 90,001 to 100,000.

Elmore's French Copper Company.—A circular has been issued to the first mortgage debenture holders of Elmore's French Patent Copper Depositing Company, Limited, which states that the directors have received a proposal, after several weeks' negotiations, for the purchase of the founders' shares of the Société Française d'Electro Metallurgie, which constitute practically the main asset of the company. The sale of these shares will enable the sum of 6s. in the £ to be paid to the first mortgage debenture holders in discharge of their debt. In accordance with the provision contained in the 10th condition endorsed on the said debentures, a meeting of the first mortgage debenture holders will be held at Winchester House on Wednesday, the 23rd inst., to consider the proposal.

The City of London Electric Lighting Company, Limited.—The directors have decided to recommend to the shareholders the payment of the following dividends, subject to the completion of the audit:—On the preference shares 6s. per share for the six months ended December 31st, 1897, making, with the interim dividend already paid, a total distribution of 6 per cent. for the year. On ordinary shares, Nos. 40,001 to 80,000, £1 per share for the year, and on ordinary shares, Nos. 80,001 to 90,000, 10s. 7d. per share for the year, being a distribution at the rate of 10 per cent. for the year ended December 31st, 1897. Both dividends will be payable on March 3rd, 1898.

Brush Electrical Engineering Company, Limited.—The directors have declared an interim dividend at the rate of 6 per cent. per annum on the preference shares for the half-year ended December 31st, 1897, payable on March 15th, 1898. The transfer books will be closed from March 2nd to the 16th, 1898, inclusive.

City of London Electric Lighting Company.—The transfer books and registers of members will be closed from the 16th inst. to March 2nd, both days inclusive.

TRAFFIC RECEIPTS.

The Bristol Tramways and Carriage Company, Limited. The receipts for the week ending February 11th, 1898, were £2,296 3s. 9d.; corresponding period, 1897, £2,120 15s. 5d.; increase, £175 8s. 4d.

The City and South London Railway Company. The receipts for the week ending February 13th, 1898, were £1,058; week ending February 14th, 1897, £1,062; decrease £4; total receipts for half-year, 1898, £7,514; corresponding period, 1897, £7,673; decrease, £159.

The Dover Corporation Electric Tramways. The receipts for the week ending February 5th, 1898, £101 0s. 5d.; total receipts, February 5th, 1898, £538 0s. 8d. The traffic returns for week ending February 12th, 1898, £105 8s. 6d.; total receipts, February 12th, 1898, £643 6s. 2d.

The Dublin Tramways Company. The receipts for week ending, February 11th, 1898, £375 9s. 5d.; corresponding week last year, £433 13s. 5d.; decrease, £58 4s.; passengers carried, 64,846; corresponding week last year, 68,108; aggregate to date, £2,478 5s. 8d.; aggregate to date last year, £2,463 9s.; increase to date, £14 16s. 8d.; mileage open, 8 miles.

The Liverpool Overhead Railway Company. The receipts for the week ending February 13th, 1898, amounted to £1,380; corresponding week last year, £1,219; increase, £161.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 11th, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,146.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, Feb. 9th.	Closing Quotation, Feb. 16th.	Business done during week ended Feb. 16th, 1898. Highest.	Lowest.
137,400l	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	...	...	100 —104	100 104	...	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	6 — 7	6 — 7	...	...
125,000	Do. do. 5% Debs. Red.	100	...	...	...	93 — 96	93 — 96	...	...
923,960l	Anglo-American Teleg., Ltd.	Stock	£2 9s.	£2 13s.	3 %	62 — 64	60 — 62 xd	61	...
3,038,020l	Do. do. 6 % Pref.	Stock	£4 18s.	£5 6s.	6 %	113 —114	110 111 xd	111⅞	110½
3,038,020l	Do. do. Defd.	Stock	...	...	...	13¼ - 13⅝	12½ - 13	13¼	13⅜
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	...	...	16¾ - 17¼	16⅝ - 17¼	17¼	16 13/16
75,000l	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	...	...	112 —116	112 —116	...	...
44,000	Chili Teleg., Ltd., Nos. 1 to 44,000	5	4 %	4 %	...	3 — 3½	3 — 3½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	...	187 —192	187 —192	...	...
653,586l	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	106 —108	106 —108	107½	106⅝
224,850	Consolidated Teleg. Const. and Main., Ltd.	10/-	1½%	2 %	...	1/16 — 3/16	1/16 — 3/16	1/16	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	...	8 — 9	7½ — 8½	8⅜	7⅞
6,000	Do. 10 % Pref.	10	10 %	10 %	...	17½ — 18½	17½ — 18½	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	...	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	...	10 — 11	10 — 11	...	...
30,000l	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	...	103 —106%	103 —106%	...	...
60,710	Direct United States Cable, Ltd.	20	2½%	2½%	...	10¾ — 11¼	10¾ — 11¼	11¼	10⅞
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	...	18 — 18½	18 — 18½	18 7/16	18⅛
70,000	Do. 6 % Cum. Pref.	10	6	6%	...	19 — 20	19 — 20	19½	19¼
89,900l	Do. 5 % Debs., repay. August, 1899	100	5 %	5%	...	100 —103	100 —103	...	...
1,302,615l	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4%	...	131 —134	131 —134	...	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7%	...	18¾ — 19¼	18¾ — 19¼	19⅛	18⅞
25,200l	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5%	...	99 —103	99 103	...	...
100,500l	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5%	...	100 —103	100 —103	101	...
320,000l	Do. 4 % Deb. Stock	Stock	4 %	4%	...	130 —133	130 —133	...	...
51,100l	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5%	...	99 —103	99 103	...	...
69,200l	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5%	...	100 —103	100 —103	...	...
300,000l	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4%	...	102 —105	102 — 105	...	...
200,000l	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4%	...	108 —111%	108 —111 %	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	...	12 — 12½	12 — 12½	12⅝	12⅜
180,042	Do. do. 6 % Pref.	10	6 %	6%	...	17¾ — 18¼	18 — 18½	18¼	18
150,000	Great Northern Teleg. Company of Copenhagen ...	10	10 %	10%	...	27 — 28	27½ — 28½	...	...
160,000l	Do. do. do. 5 % Debs.	100	5 %	5%	...	101 —104	101 —104	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10%	...	52 — 55	52 — 55	...	...
100,000l	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6%	...	108 — 111	108 —111	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	...	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5½%	5½%	6 %	6¾ — 7	6¾ — 7¼	7⅛	6⅞
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	14 — 16	14 — 16	16	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6 — 6½	6 — 6½	...	...
130,766	Do. do. Nos. 119,235 to 250,000, £5 paid	5	...	...	5 %	6 — 6½	6 — 6½	...	...
329,471l	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	104 —109	104 —109	105	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	⅝ — ⅞	⅝ — ⅞	⅝	...
100,000l	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	...	105 —108	105 —108	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	8 — 9	8 — 9	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	140 — 145	140 — 145	...	...
58,000	United River Plate Teleph., Ltd.	5	4 %	...	...	4 — 4½	4 — 4½	...	...
146,733l	Do. do. 5 % Debs.	Stock	5 %	...	...	101 —106	101 —106	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	nil	...	4 — 5	4¼ — 4¾	...	...
213,400l	Do. do. do. 5 % Debs.	100	5 %	5 %	...	103 —106	103 106	...	...
64,268	Western and Brazilian Teleg., Ltd.	15	3 %	2 %	...	10½ 11	10½ 11	10⅞	10 9/16
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	...	7½ 8	7½ — 8	7 11/16	...
33,129	Do. do. do. Def. Ord.	7½	¼ %	...	...	3½ — 4	3½ — 4	3⅝	3½
382,230	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	105 —107	105 —107	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅛%	1 %	...	½ — ¾	½ — ¾	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	6 %	...	7¾ 8¼	8 — 8½	8½	8¼
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	6 %	...	5 — 7	5 — 7	...	...
80,000l	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	...	105 108	105 —108	...	...
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7%	...	105 —110	105 —110	...	...
160,100l	Do. do. 6 % Ster. Bonds.	100	6 %	6%	...	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	5 %	6 %	7 %	14 - 15	14 — 15	14 5/16	14
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6½ - 6⅝	6 — 6½xd	6⅝	6 5/16
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	...	11¼ — 11⅝	11⅝— 14¼	12⅛	11⅞
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	4½%	4½%	...	112 —114	115 —117	...	...
40,000	City of London Elec.Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	7 %	10 %	28½ - 29½	28½ 29½	29⅜	28⅜
20,000	Do. do. Prov. Certs.	5	...	...	10 %	27½— 28½	27½— 28½	28	...
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17½ 18½	17½— 18½	17⅞	17⅜
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	129 —134	129 —134	132	...
30,000	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—30,000	10	nil	nil	..	15¾ - 16¼	15¾— 16¼	16⅛	15¾
20,000	Do. do. do. 6% Pref., 40,001—60,000 ...	10	6 %	6 %	.	15¾— 16¼	15¾— 16¼	16	...
10,000	† House-to-House Elec. Light Supply, Ord., 101 to 10,100	5	...		...	10½— 11½	10½— 11½	11 1/16	10¾
10,000	Do. do. 7 % Cum. Pref. ...	5	...	.	...	11½— 12	11½— 12	11⅞	
40,000	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	4 %	5 %	...	20 — 21	20 — 21	20⅞	20½
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem. ...	10	...	...	...	19½ - 20½	19½— 20½	...	...
200,000l	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	117 — 121	117 —121	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	2 %	4 %	...	18 — 19	18½ - 19½	19⅛	19
20,000	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,000	5	7½%	10½%	14½%	18½ 19½	18½ — 19½xd	19⅜	18 13/16
20,000	Do. do. 7 % Pref., 20,001 to 40,000	5	7 %	7 %	7 %	10 11	10 — 11 xd	10 9/16	10½
[illegible]	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	4 %	104 —107	107 —110	...	...
[illegible]	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2⅞— 3⅛	2⅞— 3⅛	3	2 15/16
[illegible]	Westminster Electric Supply Corp., Ord., 101 to 80,000 ...	5	7 %	9 %	12 %	18 - 19	18 — 19	18⅝	18

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME	Stock or Share ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, Feb. 9th.	Closing Quotation Feb. 16th.	Business done during week ended Feb. 16th, 1898. Highest.	Lowest.
30,000	British Electric Traction	10		..	...	17¼ – 17¾	17½ – 18	17⅞	17¾
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...				...	2⅛ 2⅜	2 – 2¼	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000				...	2⅛ 2⅜	2⅛ – 2⅜	2⅜	2 3/16
125,000*l*	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock			...	109 113	109 113	...	...
50,000	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock			...	102 – 105	102 – 105	...	...
19,126	Central London Railway, Ord. Shares	10			...	10 – 10½	10½ – 11	10 15/16	10 5/16
143,106	Do. do. do. £6 paid	10		.	...	5¾ – 6¼	6½ – 7	6⅞	6 5/16
58,830	Do. do. Pref. half-shares £1 pd. ...	..	..	.	...	1¼ – 1¾	1½ – 2	1 13/16	1⅝
61,777	Do. do. Def. do. £5 pd. ...	..	...	..	...	4¼ – 4¾	4¾ – 5	4 15/16	4 13/16
630,000*l*	City and South London Railway	Stock	[illegible]%	1[illegible]	1⅞ §	69 71	68 – 70 xd	69	68¼
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180		*nil*	.	...	2¼ 2¾	2¼ 2¾	2½	...
99,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 99,261		5 %	5½%	...	2½ 3	2½ 3 xd	2 13/16	2⅝
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5½%	...	4 – 5	4 – 5xd	...	...
110,000	Electric Construction, Ltd., 1 to 110,000		5 %	6 %	...	2¾ – 3	2⅝ 2⅞	2⅞	2 11/16
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 ..		7 %	7 %	...	3⅛ 3⅜	3⅛ 3⅜	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,080			..	...	½ ¾	½ ¾	...	..
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ..			..	...	⅜ ⅝	⅜ ⅝	...	
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ..		0½%		...	9 – 11	9 11	.	
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	[illegible]	8 %	10 %	12 %	22½ 23½	22½ 23½	23⅜	22⅞
8,000	Do. do. do. 7% Pref.	[illegible]	7 %	7 %	7 %	19 – 20	19 20	...	..
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½ %	110 – 115	112 117	...	
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ..	[illegible]	[illegible] %	10 %	10 %	22 23	22 23	22⅞	22¼
300,000	Do. do. do. 4 % 1st Mort. Debs	100			...	103 – 107	103 – 107	...	...
37,500	†Liverpool Overhead Railway, Ord.	[illegible]	2⅞%	2⅞%	3¼ %	11¼ 11⅜	10 15/16 11 1/16	...	...
18,000	†Do. do. Pref., £10 paid	1[illegible]	5 %	5 %	5 %	16 16½	15¾ – 16¼	.	...
37,350	Telegraph Constn. and Maintce., Ltd.	[illegible]	5 %	15 %	15 %	39 42	39 – 42	40¾	...
150,000	Do. do. do. 5 % Bonds, red. 1899	[illegible]	5 %	5 %	5 %	2 [illegible] 5	102 – 105	...	...
54,000*l*	Waterloo and City Railway, Nos. 1 to 54,000	[illegible]			...	13½ 14	13¾ – 14¼	14⅛	13⅞

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0°/₀; 1891—7°/₀; 1890—8°/

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

* Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7¾, £5 (fully paid) 11.

Electric Construction Corporation, 6 % Debentures, 105 – 107.

House-to-House Company, 4½% Debentures of £100, 108 – 110.

Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 16½—17; 1st Preference Cumulative 6 %, £5 (fully paid), 8¼—8¾: Dividend, 1896, on Ordinary Shares 7 %.

London Electric Supply Corporation, £5 Ordinary, 4⅝—4⅞.

* T. Parker, Ltd., £10 (fully paid), 14¼.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8—8½. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount 3 per cent. (October 14th, 1897).

COMPARATIVE COST OF STEAM AND ELECTRIC POWER.

III.

The author is of opinion that electricity is finding it difficult to compete with steam power, or rather to effect a breach in the citadel, because nine-tenths of steam users do not allow a tithe of the constant charges to enter into their calculations of cost at all. They do not, therefore, suspect that their power is costing them so much as it is, and they also believe they are using more power than they really are—using, that is, in its true sense, not wasting it on shafting. It is in small steam plants that the very high ratio of constant charges is found worst developed.

Men who have any idea of what their power costs are very rare indeed. One man is quoted who did know that his 200-H.P. engine operated 6,160 hours a year, cost for everything but rent 2 cents an hour per horse-power on a basis of load factor being unity. But load factors are far from being unity; they are, as a rule, low, and the author tries to trace the line of demarcation on either side of which steam or electric power will be the cheaper to employ. Below 100 H.P. so-called constant loads will have a factor of only ·50 to ·75 on the brake H.P. of the engine.

Three sample cases are taken:—I. Unity load factors; II. High variable power load factors; III. Low variable power load factors. In the estimates the possible saving due to more direct application of power is not taken into account, although, undoubtedly, in cases of very low load factors there can be no doubt but that this is the most important consideration.

Indeed, in a case before us as we write, it happens frequently that the power absorption all the day may never exceed a seventh of a horse-power of current, and this would be running 4 to 5 hours of the day. With steam power, fuel alone would cost at least 2s. a day, and loss of time in the morning would run to an hour, and might affect two to ten men more or less directly. Attention to the boiler would cost either a man's whole wages or a large proportion of them, or it would delay work and call for partial attention of skilled men. Breakdowns and stoppages of small plant are innumerable and an expensive item additional to above costs. Our author estimates the cost of steam plant for an engine B.H.P. of 10, 25, 50 and 100 to be in round numbers £400, £800, £1,150 and £1,800. These are the laid down costs, including buildings, iron stack and all details of engines and boilers of good design. The annual costs per year for insurance, rent, depreciation and interest are respectively £88, £131, £189 and £285. The load factors are now assumed as follows:—Case I., 100 per cent.; Case II., 46 per cent., made up of five hours at 30 per cent., three hours at 50 per cent., and two hours at 80 per cent.; and Case III., load factor of 18 per cent., made up of four hours at 10 per cent., four hours at 15 per cent., and two hours at 40 per cent. As small plants are, as a rule, non-condensing this class of engine is assumed, and for Case I. the four engines will cost in labour as follows:—

The 10-H.P. engine 60 per cent. of a man's time, or £93; the 25-H.P. engine, man's full time or £156; the 50-H.P. engine, man's full time at £187; and for the 100-H.P. engine, full time of engineman and a fireman at £320. These are American figures, of course, the wages of engine and boiler men being rather high in America, on account of the necessary high wages due to cost of living, but the figures are given as for efficient men and are not a minimum. For Cases II. and III., without going into detail, the wages costs are for the four powers, £78, £117, £156, and £187; the cost of oil, waste, and tools being £7½, £15½, £26, and

£40. Allowing ash removal to equal 2½d. per ton of coal, coal to cost 8s. to 16s. per ton, and water about 8d. per 1,000 gallons, the cost of each case can be made up.

REVIEWS.

Lockwood's Builders' and Contractors' Price Book, 1898. London: Crosby, Lockwood & Son.

The new edition of this year book appears to be carefully edited and brought up to date. In the preface it is stated that in the building trade (especially in London) the past year has been an exceptionally busy one. As a consequence prices have gone up, so that the cost of building now is in excess of what it was a year ago. In the electric lighting section of the book reliable guidance is given, and reference made to latest developments. The free wiring system is spoken of, and the method of the Conduit and Insulation Company. The object chiefly aimed at in the information given, is to enable builders to form a correct idea of the probable cost of installing the electric light where current is supplied from a generating station. At the same time the uses are explained of the machinery and apparatus required in the case of private installations. A few names are given of makers of steam engines for driving dynamos, but the possibility of using gas engines for the purpose does not appear to be recognised. The "General Conditions" issued by the City of London Electric Lighting Company are given as illustrating the requirements usually imposed by supply companies.

The Automotor and Horseless Vehicle Pocket Book of Automotive Formulæ and Commercial Intelligence for 1898. London: F. King & Co., Limited, 62, St. Martin's Lane, W.C.

This pocket book has been compiled by Mr. G. H. Little, C.E., and contains a good deal of useful information, a great deal of it relating to the subject of automotors, but a good deal, shovelled in, doubtless, as a fill up, having not the remotest connection with the subject, such, for instance, as the Morse or telegraph alphabet, nautical speed tables, and a fire-stream (fire engine) table. However, in spite of absurdities of this nature, and they are very plentiful, there is very much that has a very direct bearing on the subject, such as "Tractive Data Relating to Cycles," "Ball Bearings," "Chain Gearing," "Liquid Fuel Burners," "The Serpollet Boiler." Doubtless in future editions the really useful matter will be extended and the useless omitted.

Practical Electricity and Magnetism. By John Henderson, B.Sc. (Edin.), A.I.E.E. London: Longmans, Green, and Co.

This volume is the second of a series of laboratory manuals by two authors, who jointly sign the preface to the series. Its 390 small pages, openly printed, and freely illustrated, traverse most of the ground of electrical measurement. Explanations of the principles involved are omitted, because, as explained in the preface, they would give the book "unwieldy dimensions; besides, mathematical investigations do not come within the scope of a practical manual, but of a theoretical treatise." The practice of electricity and magnetism, with which the work deals, is the practice of a science school, not of an engineer's laboratory.

The book is not of a kind which recommends itself to a reviewer. Errors of orthography, punctuation, and typography, a deplorable English style, loose and inaccurate statements meet him continually, and give a disagreeable impression of negligence and inexactness. Still, books are not made for reviewers, any more than examinees are made for examiners, and such expressions as "the annunciation," not of a virgin, but "of a law" (the law in question was not Newton's maiden effort), "staunous acid," "analine," do no one any particular harm, while not a few famous philosophers, and indeed journalists, have written infamous English prose. So a student whose general training is wide enough to supply the mathematical demonstrations necessary for the experiments, will probably not be misled by the loose and inaccurate statements of Ohm's law, page 24, or of the swing of a ballistic galvanometer, page 211, by the irregular use of H and H in places where both mean the same thing, or the reason for using a heterostatic method on page 238. Errors in the formulæ of page 195 are, however, more serious.

Apart from such criticism, which we are not disposed to press, the book presents a fairly extensive collection of such methods of electrical measurement as are commonly used in technical schools, and will be useful to many science teachers. The collections of references to recent English scientific papers at the ends of the several chapters is certainly a valuable feature.

THE AMERICAN ELECTRO-THERAPEUTIC ASSOCIATION.

The seventh annual meeting of the American Electro-therapeutic Association, an abstract of which has recently come to hand, was held at Harrisburg, Pa., in the Academy of Medicine, on September 21st, 22nd and 23rd, under the presidency of Dr. William T. Bishop, of Harrisburg, who called the meeting to order at 10 a.m. on Tuesday, September 21st. The Rev. Leroy F. Baker, of St. Paul's P.E. church, offered an opening prayer, after which Mayor Patterson welcomed the delegates to the city. Dr. Robert Newman, of New York, a former president, responded in a very witty strain, and took occasion to remark that electricity was not treated with the consideration it deserved in the medical colleges.

The privileges of the floor were extended to the many visiting physicians.

Dr. Margaret A. Cleaves, of New York, chairman of the committee on meters, presented her report. She drew attention to the fact that several makes of meter had been withdrawn permanently from the tests of the committee because of their demonstrated inefficiency, and that a new company had come into the field with a novel apparatus—a milliamperemeter and a voltmeter for use on alternating current circuits, both sinusoidal and the interrupted or faradic.

Dr. Robert Newman, of New York, read a paper on "Electric Treatment in Gout and Uric Acid Diathesis." From careful observation and experience, he could positively assert that gout and kindred diseases could be checked, relapses prevented, and in many cases a cure effected by the judicious application of electricity, particularly the static form. He cited himself as a case in point. The advantages of static electricity are that it is generally diffused through the body, penetrating deeply; it is a general tonic; the "breeze" generally allays the pain in a few minutes, and secures freedom of motion; headaches and mental confusion are dissipated, and the temperature and circulation equalised; the icy coldness of the feet relieved, nervous debility removed, the secretory and excretory organs stimulated, inflammatory products absorbed; it also gives passive exercise. Urinary analyses were presented, verifying the claim for static electricity to abate gout.

Dr. Francis B. Bishop, of Washington, D.C., presented a paper on "Chorea." It was reasonable to believe that an unstable condition of the higher nerve centres predisposed to the condition, and that a poison affecting these centres might produce in one person epilepsy, in another general neurasthenia, and in a third chorea. In his section of the country malaria was largely responsible for chorea. Treatment consisted in attention to the bowels and diet, securing proper rest, and the use of static electricity by means of the "static cage," which, while gently stimulating the periphery, soothed the general nervous system; at the same time the patient is made to inhale the ozone, thus supplying oxygen to the impoverished blood.

"Sources of Atmospheric Electricity," by Dr. R. J. Nunn, of Savannah, Ga. He considered the solar system a vast static induction machine; the atmosphere close to the earth's surface must revolve with the earth as the latter turns upon its axis, while the tendency of that portion of the atmosphere at a distance from the earth's attraction is to accumulate behind the earth. At some point the atmospheric inertia must neutralise the earth's attraction, and where this occurred there must be friction, which would necessarily cause electrical phenomena; other factors were of importance, such as variation in pressure, temperature, humidity.

"Some Thoughts and Considerations on X Ray Work," by Dr. Eugene R. Corson, of Savannah, Ga. The author thought that the experiments on polarisation and refraction had been conducted too close to the tube and that there might be a point at which they would come within the control of present methods. He thought that the X ray would prove even more valuable in dislocations than in fractures. He suggested that a careful outline tracing be made of the negative by transmitted light, all extraneous light being shut off. The eye could much more readily pick out the essential features in such a tracing than from the usual print or radiograph. Radiographs were shown, proving that the X ray penetrated a deposit of urate of soda much more readily than it did bone. Many useful suggestions were made.

"Some Considerations Relative to the Therapeutic Application of the Current," by Dr. George E. Bill, Harrisburg, Pa. The writer threw out many suggestions as to the best methods of applying electricity, especially as to polarity.

"The Early Electrolysis of Nævus," by Dr. Charles R. Dickson

Toronto, Canada. Two cases were cited in support of the contention that nævus should be operated upon as early as possible, that the operation was much simpler, less prolonged, and the chances of scarring much less than when the operation was deferred until later in life.

"Heart Failure in Cardiac Diseases due to Defective Circulation," by Dr. Eli H. Coover, Harrisburg, Pa. Many suggestions as to appropriate treatment were made.

"Expenditure of Electrical Energy," by Dr. Margaret A. Cleaves, New York. In order to have an intelligent conception of the force by means of which electricity is made available, or of the laws governing its action, it was necessary to use a voltmeter as well as a milleamperemeter. In the treatment of acute neuritis, or acute pelvic inflammation, the wise physician would employ the minimum rate of expenditure in volt-amperes; our purpose is to expend the energy in such a way as to exercise a directive influence upon the molecules and atoms, not to cause any disruptive action. In the treatment of a fibroid tumour on the other hand, greater pressure would be required in order to overcome the resistance of the denser structures in the conducting path; current density in its practical bearings was carefully gone into. Numerous tabulated clinical records were exhibited, containing the data mentioned in the paper.

"Molecular Effects of Electricity," by Prof. Dolbear, of Tuft's College, Boston. The laws governing molecular motion were discussed in a masterly manner, physical laws are immutable, and the effects produced by what we call electricity, are really due to heat.

"The New Electro-Mercuric Treatment of Cancer," by Dr. G. Betton Massey, Philadelphia, was a further elaboration of a paper presented to the American Medical Association in June, 1897. It was only applicable in cases where the general system had not yet been infected.

"Current Regulating Apparatus," by Mr. Edward Jewell, E.E., Chicago, described methods of controlling dynamo currents and adapting them to therapeutic work. Absolute protection could only be secured by using the "motor-dynamo," which was made by connecting together by an insulated coupling the shafts of two one-eighth horse-power shunt motors, the winding on one of them having been reversed.

"Report of the Committee on Electrodes," Dr. Charles R. Dickson, Toronto, chairman. A binding post was presented, devised by one of the members, which could be used for any existing tips. The metric system of measurement was again recommended. On motion of Dr. Robert Newman the report was accepted, and on motion of Dr. John Gerin the Association accepted the metric system for all measurements.

"Galvinism as an Aid in the Treatment of Goitre," by Dr. Caleb Brown, Sac City, Ia. His cases ranged from 12 to 56 years of age, 33 per cent. being "hard" (a preponderance of connective tissue), and 67 per cent. "soft" (a predominance of fluid in the follicles or vascular tissue), every case of the first was benefited, but none completely cured. By galvinism in fully 75 per cent. of recent cases of "soft" goitre, occurring mostly in young women, the gland returned almost, if not quite, to its normal size, and had remained so in 25 per cent. of the cases. Mild currents, frequently repeated, was his rule.

"Further Studies of the Manifestations of Uric Acid, and their Treatment, Electrically and Otherwise," by Dr. J. Griffith Davis, New York. Special emphasis was laid on the statement that uric acid and its salts are the result or product of nerve and muscle waste. Among cases cited was one of very severe puerpural eclampsia, followed by a most obstinate form of insomnia, which latter yielded finally most satisfactorily to general faradisation. Among methods of prevention of the retention in the system of uric acid, the bicycle was lauded as a means of obtaining exercise in the fresh air, it was advised that the body be clothed in wool. For acute manifestations the writer preferred medicine, but for the more chronic forms had found the galvanic and faradic currents very useful.

(To be continued.)

THE N.C.S. NEW PATTERN POTENTIOMETER.

In this potentiometer, which is shown in skeleton diagram by fig. 1 and in general view by fig. 2, all the contacts are made on to the terminals of definite resistances.

The working of the instrument is as follows:—A secondary battery is joined on to the two terminals, F, and sends a current through the two dials, C and D, in series and then through adjusting resistances, K and H. The C dial has 150 exactly equal coils in it, numbered from 0 to 150. The D dial has 100 equal coils in it, the whole dial being exactly equal to one coil in C. The dial, K, contains 19 equal small wire resistances, and H is a carbon resistance for fine adjustment of the current.

A standard cell of known E.M.F. is joined up to A+ and A−, and the switch, L, is put over to A.

Any convenient galvanometer, the most convenient form being a D'Arsonval, is joined up to the galvanometer terminals.

Say the voltage of the standard cell, at the temperature used, is 1·4412; the arm of the C dial is then set to 144, and that of the D dial to 12

The galvanometer key is then depressed on to its first stop (taking care that the catch is underneath so that it cannot go right down) and the outside resistance, K, is adjusted till—with the switch on one

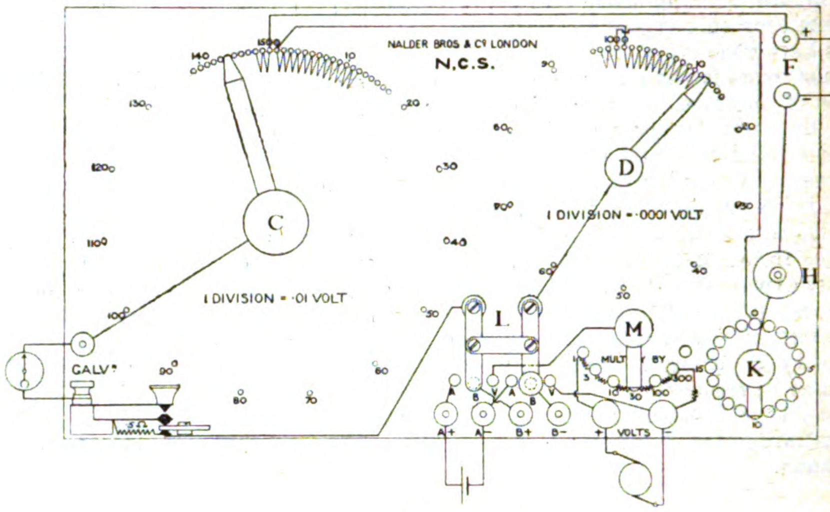


Fig. 1.

stop—the deflection is one way, and, with it on the next, in the opposite direction. The head, H, is then turned until an exact balance is obtained.

The catch on the galvanometer key is then turned aside and the latter depressed fully. This cuts out a ½ megohm which was previously in circuit to protect the cell.

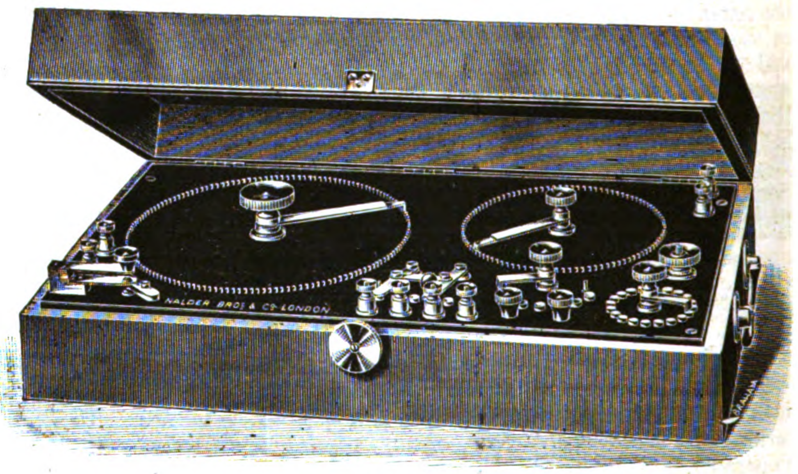


Fig. 2.

An exact balance can now be obtained by further adjustment of H or (if necessary) K.

The result of these adjustments is such that each division on C is now equal to ·01 of a volt, and each division on D is equal to ·0001 volt.

Any low E.M.F. to be measured is joined to B B terminals and the switch L set to B; for example, a Leclanché cell or the terminals of a low resistance for current measurement.

The galvanometer key is then again fully depressed and a balance obtained by moving C and D.

The E.M.F. between B and B is then read direct on the two dials; for example, if the reading on C is 83 and that on D is 67, the volts between B and B is ·8367. Any volts higher than 1·6 have to be measured on the terminals marked volts + and −, and with the switch, L, turned to V. The switch, M, is then turned to any convenient multiplying power, 3, 10, 30, &c., and the readings obtained from C and D (when the balance is obtained as before) has to be multiplied by this multiplying power; for example, if C is 103 and D 26, and M is standing at 30, the volts on the terminals are 1·0326 × 30 or say 30·98.

The resistances in H and K are arranged so that any voltage up to three volts can be used at F, thus allowing either a secondary cell or two large Leclanché to be used.

THE COST OF ELECTRIC ENERGY PRODUCTION.

In connection with the many references to this subject that we have recently made, and more particularly in regard to the supply of electric energy from lighting stations for tramway purposes (see the Electrical Review, January 14th last, page 36), some interesting figures and estimates have been sent to us by Mr. Shallcross, of the Birkenhead Electricity Works, to show that it is not only possible, but quite easy for such stations to profitably supply current at 1¼d. per unit for tramway work.

Our correspondent assumes station plant of an output equal to, say, 1,500 H.P.—which is quite a fair average for an ordinary large tramway system—and shows how, on the basis of long hours' consumption per day, an excellent profit can quite well be obtained, not merely at full load for the generating plant throughout the working day, but also when it is considerably underloaded.

Thus, a plant of the size mentioned, working for 18 hours per day—not an excessive daily period at all for tramways—would only be working at a little less than half load if it produced 2,000,000 units per annum.

The cost of this output our correspondent sets forth as follows:—

	£
Coal (10s. per ton)	1,859
Oil	100
Water	293
Wages, &c.	910
Repairs and maintenance	1,250
Interest and sinking fund	1,500
Insurance and sundries	200
	£6,114

and the revenue at 1¼d. per unit metered, *i.e.*, allowing for losses in mains, &c., amounts to £10,416, leaving a balance of profit equal to £4,302.

When the generating plant is worked at full load for the whole 18 hours daily, as might readily be done through the use of storage batteries in the main or sub-stations, the proportion of profit becomes still greater, and our correspondent's figures then may be set out as follows:—

Total output, 5,584,500 units per annum. Cost:—

	£
Water	864
Coal	5,499
Oil	100
Wages	1,066
Repairs and maintenance	1,250
Interest and sinking fund	1,500
Insurance and sundries	200
	£10,480

and the revenue at 1¼d. per unit, allowing for losses, &c., as before, amounts to £24,723, leaving a balance of profit equal to £14,243.

Without pledging ourselves in any way to the exact accuracy or completeness of our correspondent's figures, we may at any rate emphasise them as showing how important it is for municipalities and others, who are thinking of supplying current for tramway purposes, to bear in mind the long hours of supply, and the great difference which this makes in the net profits. The second instance which he gives would appear to show that energy might be generated by the tramway undertaking itself at a cost of ½d. per unit. It is hardly fair, therefore, to expect so much higher a price for current from a municipal station than what it would cost when generated by the tramway company.

THE DIRECT TRANSFORMATION OF HEAT INTO MECHANICAL WORK BY THE EMPLOYMENT OF ALLOYS OF FERRO-NICKEL.

By MARCEL DEPREZ.

In a recent article* I showed how the magnetic properties of the alloys of iron and nickel can be utilised for producing an electromotive force, undulatory in form, and I said that I would indicate the conditions under which these properties would be capable of giving practical results. A deep study of the question has led me to the conclusion that if these results are ever obtained great difficulties will have to be overcome, the nature of which will be explained in this article. Instead of the problem we had in view we propose to turn to account the thermo-magnetic properties of the same alloys to obtain an available mechanical work.

I.

We will suppose that in a uniform and permanent magnetic field has been placed a rod of ferro-nickel, moving round an axle passing through its centre perpendicularly to it, and also to the lines of force of the field. Left to itself, the rod will immediately place itself in the direction of the lines of force, and if we displace it, it will tend to return, developing a couple the value of which is given by the equation:

$$c = \mathfrak{M}\, h \sin \theta$$

in which $\mathfrak{M}$ represents the magnetic momentum of the rod subjected to the inductive intensity of the field of intensity h and θ, the angle which it makes with the lines of force.

$\mathfrak{M}$ is a function of θ, for the magnetising intensity of the rod is smaller in proportion as the angle which it makes with the lines of force is greater, and when θ attains a value equal to $\frac{\pi}{2}$ (*i.e.*, when it is perpendicular to the lines of force) we see at once that the rod cannot receive any magnetisation, and that according as it deviates very slightly to one side or the other of this critical position, the sign of its magnetisation is changed.

The nature of the function that connects $\mathfrak{M}$ with θ is unknown to us, but we will suppose that the value of $\mathfrak{M}$ remains constant while the rod, leaving the position of unstable equilibrium at which its magnetisation is *nil*, describes a right angle and places itself in the direction of the lines of force of the field producing mechanical work. In order to place ourselves under the most favourable conditions possible, we will assume that during this angular displacement the value of $\mathfrak{M}$ is constantly equal to that which corresponds to the position of equilibrium established when the direction of the rod follows the lines of force. It is easy to see that under these conditions the mechanical work, $\mathfrak{T}$, developed while the rod describes a quarter of a revolution is expressed by $\mathfrak{T} = \mathfrak{M}\, h$.

The rod being thus brought to its position of stable equilibrium, we will raise its temperature until it completely loses its magnetic properties, and we will make it describe another quarter of a revolution in the same direction so as to bring it into the position perpendicular to the lines of force of the field; we will keep it still and cool it until it regains all its magnetic properties. It is then ready to go through again the cycle of operations that we have just described. Designating by $\mathfrak{I}$ the intensity of magnetisation of the rod and by v its volume, we get

$$\mathfrak{M} = \mathfrak{I}\, v; \text{ whence } \mathfrak{T} = \mathfrak{I}\, v\, h.$$

On the other hand if we call T_0 and T_1 the initial and final temperatures of the rod, and c the specific heat of the alloy of ferro-nickel, m the specific volume, the quantity of heat which must be supplied to the rod and which must then be withdrawn from it in order to describe a cycle of operations is expressed by:

$$\mathfrak{Q} = c\, m\, v\, (T_1 - T_0).$$

The value of the work produced per unit of heat is therefore:

$$\frac{\mathfrak{T}}{\mathfrak{Q}} = \frac{\mathfrak{I}\, h}{c\, m\, (T_1 - T_0)}.$$

We see that it is greater in proportion as the intensity of magnetisation and the magnetic field are themselves greater.

Iron, steel, and cast-iron have been subjected to many experiments, having for their object the determination of the values of $\mathfrak{I}$ as a function of h; but unfortunately it is not the same for the alloys of iron and nickel studied by M. Guillaume, and we must content ourselves with hypothetical values which we will choose, letting ourselves be guided by the single consideration that nickel is considerably less magnetic than iron. We will assume, then, that the maximum of $\mathfrak{I}$ is about 1,000 C.G.S. units, whereas that of soft iron is equal to 1,500, unless the inductive field possesses an extremely high intensity and becomes, in consequence, difficult and costly to produce.

This last consideration will lead us to adopt for the inductive field a moderate intensity, which we will fix at 1,000 gauss.

As regards the factors which enter into the denominator of the second term of the equation, which gives $\frac{\mathfrak{T}}{\mathfrak{Q}}$, we will assume the following values:

$$c = 0{\cdot}12,\ m = 8,\ T_1 - T_0 = 50°.$$

We thus get for the value of the mechanical work (expressed in ergs) produced by an expenditure of heat equal to a small calorie:

$$\frac{\mathfrak{T}}{\mathfrak{Q}} = \frac{0{\cdot}12 \times 8 \times 50}{1{,}000 \times 1{,}000} = 20{,}800 \text{ ergs.}$$

The mechanical equivalent of a small calorie being equal to 41,690,000 ergs, we see that the available mechanical work would only represent $\frac{1}{2000}$th of the work equivalent to the quantity of heat expended. Now *the worst steam engines* consuming 30 kilogrammes of steam per H.P. hour transform into work $\frac{1}{25}$th of the available heat; they have, therefore, an efficiency nearly 80 times as great as that which we have just found.

This is not all; to make a motor of one steam H.P., we must furnish each hour to the magnetic alloy a quantity of heat equal to that which represents theoretically the work of one H.P. during this period of time (635 large calories), multiplied by the inversion of the fraction, $\frac{\mathfrak{T}}{\mathfrak{Q}}$, or 1,270,000 large calories.

But this number only represents half the flow of heat that must pass through the magnetic parts that are alternately heated and cooled, for after a certain quantity of heat has been supplied to these parts in order to get rid of their magnetic properties, it has to be taken away in order to make these same properties disappear, and these changes of temperature must take place in a much shorter time than that which represents the duration of a cycle if we would not lower considerably the feeble efficiency that we have just found. Thus it is not the movement of 1,270,000 large calories per hour that would necessitate the production of one steam horse-power, but twice that quantity or 2,540,000 calories: and the duration of these changes of heat should certainly not exceed a quarter of the time

* *Comptes Rendus*, Académie des Sciences, October 11th, 1897, p. 511.

required for the production of the mechanical work, or the efficiency will be considerably weakened, as I have said before, because if the heating and cooling were not almost instantaneous, the work produced by a given displacement of the magnetic parts would have a lower value than that calculated. It would therefore be necessary to use heating and cooling processes of extreme energy, of which we can form an idea by comparing them with what takes place in locomotives, where *a square metre* of heating surface gives passage to about 200,000 calories an hour at the most.

Thus, briefly, with the hypotheses we have assumed, the production of one steam H.P. of work would require an expenditure of 1,270,000 calories of heat per hour, which would be equivalent to the total quantity of heat produced by the burning of 150 kilos of coal.

II.

The results of these calculations are of a nature to lead us to abandon all hope of turning to account the very remarkable properties of the alloys of ferro-nickel as far as their application to the transformation of heat into mechanical work is concerned. I am, however, going to show that they may be considerably improved: 1st, by increasing the intensity of the magnetic field; 2nd, by employing a particular method of heating and cooling; by making the body which serves as a vehicle for the heat pass successively over a series of rods made of alloys in which the percentage of nickel varies according to a law determined by means of the formula (furnished by M. Guillaume)* We will now examine these three ways of increasing the efficiency.

The Augmentation of the Intensity of the Magnetic Field.—The mechanical work developed during a cycle being in proportion to the intensity, h, of the field, whereas the quantity of heat necessary to effect the disappearance of the magnetic properties of the alloys of ferro-nickel is to all intents independent of it, we may say, without making any appreciable error that the economic efficiency is in proportion to the intensity of the field.

Therefore, if this intensity amounted to 10,000 units instead of 1,000, the efficiency would be multiplied by 10. This intensity of 10,000 units, although very high, could be attained without requiring the use of any extraordinary methods, but it is certain that it could not be obtained with simple permanent magnets. However, we purposely abstain from taking into account the expenditure of energy that it will necessarily entail.

2. *Methods employed for Supplying or Withdrawing the Heat from the Magnetic Alloy.*—We have seen that, with the efficiency of $\frac{1}{2000}$, the production of a power of 1 steam H.P. would necessitate the employment of methods of heating and cooling of extreme energy. If the efficiency were brought to $\frac{1}{200}$ by employing a field of 10,000 units, the quantity of heat that would have to be supplied to, or withdrawn from, the magnetic alloy, would evidently be $\frac{1}{10}$ of that required in the former case; but its value would still be so great that we could not reasonably expect to obtain it directly from the products of combustion, on account of their low specific heat per unit of volume. The heating, and also the cooling, of the magnetic mass must be almost instantaneous. Now there is only one process that enables us to supply or withdraw from a body of small volume a considerable quantity of heat in a very short time: this is to bring it into contact with a liquid considerably hotter or colder than itself, and, moreover, to divide the body into thin plates or into wires of small diameter so as to increase as far as possible the ratio of the surface exposed to the changes of temperature to the volume of the body. This method, moreover, enables us to vary the temperature of the body alternately between two determined limits without any considerable consumption of heat, unless, however, its specific heat is not a function of the temperature alone (and this is what takes place when the body produces mechanical work). This is, moreover, the principle of the regenerators of heat formerly used in hot air engines. But, for this process to give the economic results required of it, the following conditions must be fulfilled:—(1) The body that is to be heated or cooled must not conduct the heat in the direction of the movement of the liquid, so that its temperature decreases according to a logarithmical law in the direction of the movement without its different parts tending to place themselves in equilibrium of temperature; it should, on the contrary, conduct in a direction perpendicular to the movement of the liquid. (2) We must avoid all causes of disturbance in the liquid so that the layers that are affected by the same movement should have no tendency to mix and place themselves in equilibrium of temperature. (3) A definite relation should exist between the mass of the thermo-magnet, the extreme limits of temperature that cause its magnetic momentum to vary, and the quantity of liquid set in motion during one cycle. If this relation is not observed, a great diminution of the useful effect might result. The two first conditions are easy enough to fulfil by forming the thermo-magnet of a series of plates of very slight thickness, with a breadth of 10 to 15 millimetres in the direction of the movement of the liquid, and separated from one another by an interval of 2 to nearly 3 millimetres.

Lastly, in order that the displacement of the thermo-magnet in the magnetic field should be slight while the changes of temperature are taking place, it will probably be necessary to impart to it an alternating movement like that of the piston in a steam engine; the changes of heat would then take place at the ends of the stroke. The circulation of the liquid would be alternating and would be controlled by a piston set in motion by a handle fixed at right angles on the motive handle.

3. *The Simultaneous Employment of Several Thermo-magnets Working at Different Temperatures.*—Is Carnot's principle applicable to the phenomena brought into play in the thermo-magnetic motor? It is extremely probable, as, up to the present, the conclusions that have been drawn from it when it has been applied to the study of the various manifestations of energy, in which there is a transformation of heat into mechanical work, have always been verified. If it is so in the present case the economic efficiency of the thermo-magnetic motor can only attain a high value on condition that the limits of temperature between which the thermo-magnet oscillates in order to completely, lose or recover its magnetic properties shall be as far apart as possible. Now the interval between them, in the case of the alloys of ferro-nickel, is only 50°; but by varying the proportion of nickel, the absolute value of the extreme temperatures can be modified at will, their difference remaining always equal to 50° We can thus, with the aid of M. Guillaume's formula, arrange the percentage of nickel in a series of alloys so that the richest of them shall lose its magnetic properties at 350° and recover them completely at 300°, whereas a second alloy will lose them at 300° and recover them at 250° and so on. We arrive thus at the last alloy of the series for which the extreme temperatures will be 150° and 100°. The fall of temperature of the liquid will thus amount to 250° and the efficiency will be five times as great as if only the first of the alloys were used. We could even go lower than 50° and realise an alloy, the cycle of which would be comprised between 100° and 50°.

This process would, therefore, enable us to increase six-fold the economic rendering of which we gave the value at the commencement of this article; as, besides, this same efficiency can be multiplied by 10, by employing a magnetic field of 10,000 units we see that the coefficient $\frac{1}{2000}$, the value of which we gave at first as representing the fraction of the heat displaced transformed into work, would become $\frac{10 \times 6}{2{,}000} = \cdot 03$, even *if we did not employ* the mode of heating and cooling described above.

III.

In short, we see that, if it is not impossible to utilise the curious thermo-magnetic properties of the alloys of ferro-nickel for transforming heat into mechanical work, very great difficulties will have to be overcome in order to obtain really practical results.

The question of the direct transformation of the heat into electrical work has a close connection with the one now under consideration, but it is much more difficult to treat it directly; it is, moreover, almost evident that the conclusions at which I have just arrived apply equally to this second mode of transformation. I must observe that this is not the first time that it has been proposed to utilise the thermo-magnetic properties of either iron or nickel, for transforming heat into mechanical or electrical work. Edison has tried to solve this problem,* using the property that iron possesses of ceasing to be magnetic at about 750°. But none of the conditions necessary either for obtaining a practical economic efficiency or for ensuring the rapidity of the changes of temperature were fulfilled. M. Nodon wrote to me after the publication of my first note on this subject, that he had in 1890 sent a sealed packet to the Académie des Sciences, in which he described a process consisting of the employment of a metallic gauze of pure nickel serving to close a magnetic circuit. This metallic gauze was alternately heated and cooled by means of a current of air, and the variations in the flow of magnetic force which resulted from the variations of temperature thus produced served to generate an alternating current.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

An Electrolytic Process for the Manufacture of Parabolic Reflectors.† By Sherard Cowper-Coles, Member, Assoc.M. Inst.C.E.

Glass mirrors at the present time are almost exclusively used for projectors for search lights and similar purposes, on account of the difficulty that has been experienced in producing a true metallic reflector that will not readily tarnish when exposed to the heat of an arc light. One advantage of a metallic reflector is that the rays from the carbon points are collected into a parallel beam by means of refraction only, and is not catadioptric, as most glass mirrors are. Spun reflectors are never true, as it is found in practice impossible to spin them quite true to the moulds. Experiments have been made with a view to substituting cast metal for glass, but the cost of grinding and polishing, and the unsatisfactory surface that is obtained, have resulted in the attempts being abandoned. Stamped reflectors have also been tried, but with no more satisfactory results. The present process I propose to describe to you is an electrolytic one, one of the chief features being that the surface produced requires no after polishing or trueing up. When once a true mould has been produced, any number of reflectors can be taken from it at a nominal cost. A glass mould is prepared, the convex side of which is accurately shaped and polished to form a true parabolic, or other reflecting surface. As the mould only requires shaping and polishing on the convex side, it is comparatively cheap as compared to a glass reflector, which has to be ground on both sides. On the prepared surface is deposited a coating of metallic silver, which is thrown down chemically on the glass and then polished, so as to ensure the

* Given in my note to the Académie.

* *La Nature* published in 1888 an article in which we find the methods used by this scientist described.

† Abstract of Paper read on Wednesday, February 9th, 1898.

copper backing being adherent to the silver. The mould thus prepared is placed in a suitable ring and frame (which I will describe later on), and immersed in an electrolyte of copper sulphate, the mould being rotated in a horizonal position, the number of revolutions being about 15 per minute. The copper adheres firmly to the silver, and together they form the reflector, which is subsequently separated from the glass mould by placing the whole in cold or lukewarm water, and then gradually raising the temperature of the water to 128° Fahr., when the metal reflector will leave the glass mould, due to the unequal expansion of the two. The concave surface of the reflector obtained is an exact reproduction of the surface of the mould, and has the same brilliant polish, and requires no further treatment to answer all the purposes of a reflector, with the exception that it must be coated with a film of some suitable metal to prevent tarnishing. Palladium is found to answer this purpose best, as a bright coating can be deposited rapidly to any desired thickness; the palladium resists tarnishing and the heat of the arc to a wonderful degree.

Palladium is a silver-white hard metal, and is sufficiently ductile to be rolled into thin sheets. Its specific gravity is about 12, being half that of platinum. The present price of palladium is about double that of platinum, but, its weight being one-half, the same area can be covered at the same cost. It melts at an extremely high temperature—about the same as wrought-iron. When only slightly heated in hydrogen gas, it has an extraordinary power of absorbing mechanically large volumes of this gas. Graham investigated this very curious phenomenon, and found that a piece of palladium foil, when heated below 212° Fahr., takes 240 times its volume of hydrogen, but that it had not the power of absorbing oxygen or nitrogen. At a moderately high temperature palladium assumes a blue colour, and the formation of a thin film of oxide, which it loses at a higher temperature, due to the decomposition of the oxide. Palladium is not readily attacked by sulphuric or hydrochloric acid.

In carrying out the manufacture of reflectors by this process, it is essential that the glass mould be perfectly clean and free from grease before the silver coating is applied. It has been found, however, that, if the cleaning is solely effected by chemical means, there is a great liability of the silver adhering too firmly to the glass, whereby the mould is in danger of being broken during the removal of the reflector. This difficulty has been overcome by cleaning the glass mould with a suitable paste or powder, such as peroxide of iron, then removing such paste or powder by washing the glass with a 50 per cent. solution of ammonia. It is necessary that this cleaning operation be repeated prior to the production of each reflector. After the convex side of the mould has been properly cleansed as described, a thin coating of metallic silver is applied as follows: Ammonia is added to a solution of nitrate of silver until the precipitate that is first formed is re-dissolved, then re-precipitating by caustic soda, again dissolving in ammonia, then adding glucose to the solution. Excellent results have been obtained with a silvered solution of the following components, equal parts of each being used:—Silver nitrate, 0·5 per cent.; caustic potash, 0·5 per cent.; glucose, 0·25 per cent. The surface of the mould to be coated is immediately dipped into the solution, when it becomes coated with a film of silver. The silver coating is thoroughly washed, and then allowed to dry, and the silver which has been deposited is burnished bright with a piece of cotton wool and peroxide of iron, preferably precipitated by ammonia from a dilute solution of ferrous sulphate. The cost of the silvering is found to vary from 2d. to 4d. per inch diameter. I have here a film of the silver and copper stripped from a glass mould, which is quite transparent to transmitted light, having a green tinge, but is capable of reflecting light.

The copper solution generally used is of the following composition:—Copper sulphate, 13 per cent.; sulphuric acid, 3 per cent.; water, 83 per cent. As soon as the requisite thickness of metal has been deposited, the mould, with the reflector attached to it, is placed in a bath of cold or lukewarm water, which is then raised to a temperature of 120° Fahr.; whereupon, owing to the difference of the expansion of the glass mould and the metal backing, the latter separates from the mould. The only thing that requires to be done now is to coat the reflector with an untarnishable metal. This is accomplished by placing the reflector in an earthenware pan, containing a 0·62 per cent. solution of palladium ammonium chloride in about a 1 per cent. solution ammonium chloride. The solution is used at about 75° Fahr., the current used for a 2-foot reflector being about 0·5 of an ampere, the E.M.F. at the terminals of the bath being 4 to 5 volts. An anode made out of carbon, and curved approximately the shape of the reflector, is attached to a rod, which is connected by an arm to a rotating disc which causes the anode to swing to and fro, thereby ensuring an even coating of palladium, and agitating the solution and preventing the depositing upon the reflector of particles of foreign matter which may be present in the solution.

The back of the reflector is usually varnished before placing it in the bath, to prevent local action setting up between the copper and the silver or palladium. The reflector is removed from the bath and dipped in boiling water, and then placed in boxwood sawdust, which is kept hot by means of a steam jacket. The reflector is then ready to be mounted in a suitable ring.

Reflectors made by the process which has just been described have been subjected to a number of tests, and found to withstand excessive heat without tarnishing. Salt water has been thrown on the reflectors when they have been too hot to touch, the result being that the water was driven off as steam, and the salt left as a white deposit on the reflector, which was easily removed with a wet cloth.

A reflector recently tested at Portsmouth had a number of rifle bullets passed through it, when the beam was found to be little affected. On the other hand, the first shot fired at a glass reflector splintered it to pieces.

Although palladium does not reflect light as well as a silver surface which is perfectly clean and bright, silver is found quite unsuitable, as after being in close proximity to an arc light for a short time the silver tarnishes, and the light is greatly reduced in intensity. With a palladium-faced reflector the intensity of light is found to remain practically constant, as little or no tarnishing takes place.

THE SOCIÉTÉ INTERNATIONALE DES ELECTRICIENS.

THE usual monthly sitting of the Société des Electriciens took place February 2nd, 1898, with M. Violle in the chair. M. G. Janet, in consequence of a death in the family, could not read his paper on "The Temperature of Incandescent Lamps."

M. BRANLY called attention to the fact that various experiments had been made in producing continuous or intermittent electric waves, transmitting them to a distance, receiving them, and registering them. The transmitter is a Hertz oscillator, with two spheres immersed in an insulating liquid. This oscillator is worked by a little Ruhmkorff coil, placed in a box lined with metal, and provided with a contact key for obtaining short or long discharges.

The Hertz spark resonator is replaced by a tube of iron filings. The latter, which are enclosed in a tube, and placed between two conductors, and which form a circuit with a battery and a galvanometer, offer a great resistance to the passage of the current; they become conductive when excited by an electric wave. This conductivity is destroyed by a shock, to reappear when a fresh wave strikes the tube. The sensibility is very great, and manifests itself at a distance. In 1895 M. Popoff had an apparatus constructed for receiving and registering electric waves. The receiver is a tube of iron filings placed in circuit, with a battery and a relay. The latter is put in motion as soon as the tube is struck by an electric wave at a distance. M. Branly referred to his experiments in connection with the paper read at the last sitting by M. Voisenat on "Telegraphy Without Wires."

M. BOUCHEROT then read a paper on "Industrial Condensers: on their Employment in Distributions at a Constant Intensity, and on a Self-exciting Alternator."

In industrial condensers, the quality of paper used is an important consideration. Some kinds of paper heat and keep together, others do not heat, but easily crack. The specific resistance of the paper varies from 1 to 3 megohms per centimetre.

The temperature should also be considered. In some measurements taken between 20° and 100°, M. Boucherot obtained for the insulation resistance of various condensers—for oil, 3,500 ohms at 95° and 1·45 megohms at 17·1°; for paraffin, 500,000 ohms at 99° and 10 megohms at 17°; for oiled paper, 150,000 ohms at 44°, and for paraffined paper 6 megohms at 40°. A paraffined paper condenser gave an insulation resistance of 2·6 megohms at 37°, of 700,000 ohms at 50°, and of 100,000 ohms at 80°. To obtain good working from a condenser, we must not, at present, exceed a difference of potential of 800 volts.

Various experiments have shown that, on alternating current systems, the difference of potential rises to values above the normal and pierces the condensers. We can now make condensers for 40 periods per second at 3,000 volts, at the rate of 100 francs the kilowatt, and at 100 volts for 150 francs the kilowatt. For 50 periods per second, we must reckon at 3,000 volts 50 francs the kilowatt, and at 100 volts 75 francs the kilowatt, but condensers are only advantageous for low powers.

M. Boucherot then showed the advantages of condensers, first, for counteracting the effects of self-induction, and then for distribution at a constant intensity. On an effective difference of potential is branched a circuit formed of a self-induction coil and a capacity. We can then place in derivation, either at the terminals of the condenser or at the terminals of the self-induction coil, a circuit formed of various apparatus in series. The intensity remains constant in the circuit.

The writer then discussed various other cases, and made some experiments for purposes of demonstration. In conclusion, he spoke of a self-exciting alternator, but he merely gave a brief sketch of its principle.

M. KORDA then said that some condensers had already been constructed at Buda-Pesth with an insulator of oil in vacuo.

THE ENGINEERS' STRIKE.

As the results of the men's ballot came in, they showed in favour of acceptance of proposals 28,588 and against 13,727, a more than two-thirds majority. The terms of settlement being formally agreed upon, it was arranged to resume work on Monday, January 31st. There was a good deal of kicking against the inevitable, and talk about a general organisation. This, we are certain, will for long be impossible, except some entirely new actuarial basis be built upon, with proper division, by hard and fast lines, of the funds for fight and for benefit. In its late existing form the Amalgamated Society of Engineers is a total wreck. Never was a trade struggle carried on with less turmoil and strife, and never has so huge a struggle terminated so disastrously for its originators. The men have secured nothing by the struggle. They have not even gained any recognition for even fancied principles. True, certain hitherto accomplished aims have been specifically named in the agreement, but to them have been tacked equally specific limitations not hitherto allowed a right in trades union ideas. Militant unionism has been set back to a line far in the rear of its previous outposts, and the line is fortified by the employers who have mounted guns on previously dismantled positions. Everything now depends upon the amicable working of the men under new conditions, and upon the determination of the employers to insist on a day's work for a day's pay, and to keep their plant up to modern conditions.

Labour will then begin to profit by the change and by the regaining of lost trade, and we fully believe that with these things thoroughly carried out the eight hour day will come to be general. A really earnest day of eight hours will be better for everyone than the half-hearted nine hours' day, which we hope has ceased to be. The estimates as to the proportion of the locked-out men that could be taken on again varied considerably for different towns. At one place hardly any, at another 75 per cent., and the remainder in a few weeks, were reported as probable.

In this last ballot of the men the smallness of the numbers voting is remarkable. At Paisley, Blackburn and Leeds, Dundee, Wigan and Keighley, the majority of votes were cast against returning to work, whereas in London, the place of the original mischief, the men wanted to go back to work. This sort of thing must annoy the men of the north, who, having taken up the battle for London, find themselves sold by the London executive, who, a short time ago declared they had funds to go on fighting indefinitely, and yet hardly had funds to meet weekly engagements. The hope of supplies had, in fact, kept men fighting to the last ditch, and there, figuratively, they were left while Mr. Barnes cynically abandoned them to their fate, as having no choice. The great change which the strike has shown to be coming upon the engineering trade is specially made plain in the case of a firm which finished two steamers by the aid of apprentices only, the steamers passing the trials and tests as up to standard. Why, with all the facts before them, the executive allowed the fight to go on upon the mere formality of a formal recognition by the employers of the notes appended to the clauses of the agreement, it is difficult to say. The notes were the notes of the employers, and would be cited, whether formally recognised or not, in the future. Probably the truth is that Mr. Barnes hoped by refusing the clauses to force public opinion in favour of the men, in which he lamentably failed. He then seized upon the notes, and asked the masters to say over again what they had already pledged themselves to. This delay has done trades unionism no good. Nothing more has been obtained, but only the nakedness of the treasury has been shown up and a defeat has been converted into a rout, for the men could have far better gone to work direct from the conference, while every day's delay has shown up the hollowness of the cry of the skilled man as necessary in machine production.

Finally, we should like to say a word as to the threat to carry things to Parliament. The working man to-day is full of economic heresies. He seems to think he can ask Parliament to pay wages out of funds which exist in his imagination, as though Parliament could do anything and everything. This nonsense is the result of preaching to the so-called working man as though he were a wonderful creature, all virtue and with no vices, and he has been patted on the back by M.P.'s and the like until he has come to think he is all that fancy paints him. It is all this which has led up to the conduct of the men in respect of restriction of output and general insubordination to the truth and to the principles of business morality. Their line of procedure has been followed for long past much as a train may run safely over a line of rails for a long time until it reaches a junction. In the case of the engineers they have run their train full of economic heresies until it has intersected that of foreign competition and the result we have seen. Others have seen the convergence of the lines and the advancing trains. Mr. Barnes and his friends have contrived to time the trains to arrive very much together at the point where further concessions to the men brought matters in England to the wrong side of the line for foreign competition. The strike is, however, now a thing of the past, and it is hardly likely that another can be started on the same false and mistaken issues. It will be long before such a strike can be financially possible, and in the interim educational influences have a chance to operate on men and on masters. For the moment the beaten and disappointed leaders are talking frothily about the next attempt. For the sake of the men, it is to be hoped by then that they will have obtained more intelligent leaders.

As the shops were opened on the first Monday in February, it was at first decided by the employers to take on only one-fourth of the number of men necessary to fill vacancies. This was done in order to give all shops an equal chance to obtain hands. But so many shops had already so large a complement of free labour, that it was seen there would not be places enough to go round, and word was given to take on all there was room for. This still left a lot of men out of work, for many shops were short of orders, none having been sought during the strike, and it would therefore be some time before all the strikers could be taken on. So far as we can learn, the men themselves have gone back to work in a fairly agreeable spirit, the fact being that they see plainly enough they have been following a bad lead. The employers also, we are glad to hear, are doing all they can to smooth matters and are not injudiciously flaunting a flag of victory before their late opponents. Only in one or two American papers, such as the *Western Electrician*, do we find the termination of the strike viewed with spiteful ill-nature. This journal is a sample of that fortunately diminishing section of the American people, which hopes and prays for overwhelming disaster to overtake the British nation—America's best customer. We do not think much weight need be attached to such evidently biassed statements as the writer is so evidently uninformed, but he lays all the blame on the neglect of the employers to provide improved tools—a clear proof that he knows nothing of the machine question and of restriction of output which underlay the whole dispute. But while we may excuse the western editor, what are we to say of such a man as Sir John Gorst at the dinner of the United Club which had before it the question of the relation of capital and labour. He spoke on the question in an exceedingly unpractical manner, assuming that it were better to leave work alone than to attempt it at the cost of reduced wages. This way of looking at things assumes at the outset that both men and masters are doing their best, and cannot improve so as to afford a so-called living wage. It also assumes that when articles are made in this country for which only low wages are practicable, such low wages are paid to people who, if not compelled by the employers to work for poor wages, would be working at something else for good wages. The idea is absurd. No man is compelled to work for less than he can get elsewhere, and the inference is that in badly paid trades the work is unpopular, and is only taken up by those who otherwise would be idle. But it is not by any means employers who are the cause of low wages in certain employments. It is due to the workers themselves, who rush into badly paid work rather than take up well paid work which they can have for the asking. It is customary, for example, to cry shame on the management of a certain bread company which pays huge dividends out of purveying very ordinary provisions, and is said to pay poor wages. The sole reason is that the women who crowd the doors of the company for employment and accept poor pay for long hours, have open to them far more respectable and well paid work in domestic service, which is not fashionable among this class of women. Yet philanthropists so called can always be found to condemn the wrong person, and there are those who in the recent strike condemn the employers because they have refused simply to pay away in wages more than they have made in profits, a process that to anyone but a rabid philanthropist cannot long continue. When Sir John Gorst assumes it may be necessary to throw up the sponge, he is indeed a pessimist. In the first place he does not even present the hope of doing better; in the second, as an alternative to small profits and wages, he has nothing to offer. When it is remembered that he was speaking in connection with the engineering business, of which shipbuilding, our national pet industry, is a part, are we to conclude that England had better go out of business at once? Sir John spoke just as if he had been of opinion that the recent strike was a protest by the men against a starvation reduction in wages. So at least his reported speech reads, and he ought to have known better. The public at large did know better, or very soon learned the facts, and the strike was really crushed before it had existed a fortnight, and everyone saw this except the men themselves, and even they saw it sooner than their leaders, who tried to buoy up their followers by extolling the German and American subscriptions.

We hardly think that English workmen will be such fools to be caught by the high sounding "brotherhood of labour" business in the future. During the whole strike for eight hours, the selfish German workmen did not, so far as we can learn, make even the shadow of a demand for the reduction of their own 12 hours' day, which would have assisted their dear English bulldogs. They simply subscribed a few pfennig each, and raked in the wages for the work the English would not do, and unless the English workmen will study these things for themselves, and not put their lives into the hands of the first stump orator who gets up and froths, they must expect foreigners to treat them as fools.

TESTS OF THE SYNCHRONOGRAPH ON THE TELEGRAPH LINES OF THE BRITISH GOVERNMENT.*

By ALBERT CUSHING CREHORE and GEORGE OWEN SQUIER.

In April, 1897, a paper was read before the American Institute of Electrical Engineers, describing the general principles of the synchronograph and the experiments at that time completed in developing it.† Since then opportunity has been presented to make trials on actual lines of considerable length and having different distributed capacities. The tests were made over loops of varying lengths from the General Post Office, London, where both transmitters and receivers were located.

The apparatus available for experiment comprised a high frequency alternator, giving practically harmonic waves from 50 to 720 complete waves per second; actual telegraph lines with values of K R varying from 0 to 261,000 and resistance varying from 0 to 10,000 ohms; an artificial submarine cable representing within 1 per cent. of accuracy an actual cable of 180 knots in length, and also the latest types of Wheatstone transmitters and receivers, with adjustable condensers, &c.

The longest loop tried was 1,097 miles, from London to Glasgow, Aberdeen, Edinburgh, and return to London by a different pole line. This contained some iron wire and also 48 miles of underground cable, and a total value of K R equal to 261,000.

* Abstract of a report to the Postmaster-General of the United States, read before the Franklin Institute, January 19th, 1898, and published in the *Electrical World*.

† See Electrical Review, May 7th, 1897.

It was found in the course of trials with the different apparatus that it was possible to operate the Wheatstone receiver without alteration by the synchronograph transmitter, and a test was made over the longest line to compare the efficiency of the two transmitters when operating the same receiver under identical line conditions. The surprising result was discovered that the synchronograph could operate the Wheatstone receiver approximately three times as fast as the Wheatstone transmitter on any line, provided the mechanical limit of the receiver is not already reached. The Wheatstone system operated from London to Aberdeen ordinarily employs two automatic repeaters to increase the speed. Without any repeaters the synchronograph operated the Wheatstone receiver over this line practically up to its mechanical limit. By the synchronograph method of transmission it thus becomes possible to operate Wheatstone receivers at the present speeds without repeaters anywhere in the British Islands.

One of the most important results of the trials to be described has been to emphasise the probability that the sine wave possesses superiority over other forms of wave for any speed, slow or fast.

The messages are prepared for the Wheatstone transmitter by perforating paper tape with two rows of holes at the proper intervals to secure correct signals, one row on each side. In the centre, between these two rows of holes, runs an uninterrupted series of smaller holes, which serves to feed the tape regularly through the transmitter.

A characteristic of the transmitter is the fact that the contact for the electrical circuits is not made through the holes in the paper, as in some transmitters, but by small steel rods, which pass through the holes in the paper, contacts are made and broken in another part of the apparatus by means of levers. Only the positive currents cause the receiver to make a mark. A dot, together with the accompanying space corresponds to a complete wave of current. A dash with its following space occupies twice the time of a dot with its space, and corresponds to the time of two complete waves, although in reality it is a single wave with the positive portion three times as long as the negative, and thus the mark for a dash is about equal to three dots.

The chief characteristics to be noted are that the waves of impressed E.M.F. are square-topped, and those for a dash are longer than for a dot.

An essential part of the receiver is a polarised relay consisting of a permanent magnet and an electro-magnet. The armature of the receiver, to which the recording wheel is attached, is moved in one direction for a direct current and in the opposite direction for a reversed current. A small recording wheel is kept moistened with ink, and every positive current drives it against the paper, while a negative one raises it from the paper. The paper tape is driven forward by clockwork, and thus a series of marks is made upon the tape corresponding to the positive portions of any set of current waves.

In practice it is found that, when connected directly to the line and the return, and operated by the transmitter, the speed obtainable over most lines can be increased by the use of condensers shunted by non-inductive resistances and inserted in the main line. Common values of the resistance and capacity are about 8,000 ohms and 10 to 20 microfarads, which would vary according to the line.

The details of the experimental transmitter used in the synchronograph experiments were practically the same as those employed in the original experiments, and described in the first paper to which reference has been made. The messages were prepared by fastening strips of paper upon the metal surface of a large wheel geared directly to the shaft of the alternator as there described.

As it was desired to make tests over a considerable range of frequencies, the small Pupin alternator used in the first experiments was again utilised for these trials. The alternator was driven by a 1 H.P. Lundell motor, supplied from 100-volt constant potential mains, and a storage battery was available for the excitation of the rotating field of the generator. Since the generator is, in fact, four alternators of 18, 22, 26 and 30 poles respectively, and the motor could be run regularly at very slow speeds as well as high, this combination with a field excitation, which could be varied at will, permitted a wide range of frequencies at any desired voltage. Transformers were used when desired. For the most rapid speeds the chemical receiver, using the formula of Delany, was employed with the synchronograph. The paper was prepared and used in the form of sheets instead of tape.

The lines first used in the tests of August 8th ran from London *viâ* Leeds to Newcastle-on-Tyne, and return to London *viâ* York.

With no earth, messages were received with ease at a frequency of 652 cycles, or 1,304 alternations per second. This frequency was limited by the fact that the greatest number of poles to the generator was 30, and the number of revolutions to produce this frequency was 2,608, beyond which it was not then thought advisable to go for fear of injuring the machine.

With earth and a total value of K R equal to 81,518, a frequency of 165 cycles, or 330 alternations per second was reached.

To obtain a longer line with a greater value of K R, a second loop was made up from London *viâ* Leeds to Glasgow, and return *viâ* Edinburgh, Newcastle-on-Tyne, and York to London.

As before through this line without earth, K R being 31,771, a current was sent having a frequency as high as safety to the alternator permitted, viz., 652 complete waves per second, and no limit of speed due to line damping was reached, the messages being received with perfect clearness. With earth and K R = 127,082, no records were received at all on this date on account of not having at hand a suitable transformer to produce high enough potential at the slow speed of the alternator necessary. Before the next trials were made a suitable transformer was available to deal with a value of K R much larger than the above.

To test the fact that the messages were actually passing through Glasgow, and that the records were not being caused by leakage currents across the line at some point, the circuit was broken by the operator at Glasgow at a certain time, and restored five minutes later. Before and after the line was so broken the messages were transmitted readily, while during the time it was broken not the slightest record could be obtained.

An instructive experiment, illustrating forcibly the influence of increase of distributed capacity upon aerial wires, was that of suddenly plugging in and out the earth connection, thereby practically changing the capacity of the line four-fold, when at the instant the earth was connected the motor would slow down and labour under the increased load.

On Thursday, August 12th, it was decided to try the synchronograph with the Wheatstone receiver, which was at hand in the same room. This was done, and without any alteration of the receiver whatever it responded readily to each wave of current from the alternator. Messages were then correctly transmitted and received. This was done by two different methods. First, the messages were interpreted by the portions of current omitted, as described in the former paper, the omission of a single mark denoting a dot and two marks a dash, the marks themselves meaning spaces. Second, the presence of the marks was used for dots and dashes, and one mark denoted a dot, while two or three consecutive marks denoted a dash. The marks are all regularly spaced, and the eye experiences no difficulty in reading the dash, even though it is made up of two or three separate consecutive marks instead of a single long mark, since the length of the dash is of more moment than the continuity of the mark.

These preliminary tests developed the fact that messages could be received by the Wheatstone receiver in the laboratory faster with the synchronograph than with the regular Wheatstone transmitter. When this discovery was made the engineer-in-chief desired to make a more extensive series of experiments and try the synchronograph with the Wheatstone receiver over actual lines having a value of K R sufficient to reduce the speeds. As the Wheatstone receiver was to be used with the alternating current, the first thing wanted was a knowledge of its constants. The inductance of the instrument measured by the impedance method was found to be ·875 henry for a single coil and 3·46 henrys for the coils in series. When the coils were connected so as to give opposing magnetic effects the measurements gave an inductance of ·187 henry. The two coils of the receiver are wound together, the two wires being wound as one upon the spools in such close proximity that the mutual induction between the coils is at its maximum, and is nearly equal to the inductance of each coil. In such a case the inductance of the two coils in series should equal four times that of a single coil if there were no magnetic leakage, and when connected in opposition the inductance would vanish. This agrees approximately with the measurements when allowance is made for small magnetic leakage.

When the receiver coils are connected in parallel the inductance is practically the same as that of a single coil, since the two coils are like a single one having larger wire, the number of turns being identical.

Thus, with a frequency of 650 cycles per second, the reactance is many times larger than the resistance of the coil. In either case of a series or parallel connection of the coils it is 22·75 times as much.

When the receiver is used with reversing currents, such as are employed in the Wheatstone system, or with alternating currents, the impedance is the important element, and the value of the resistance makes very little difference, provided it bears so small a ratio to the impedance.*

When the synchronograph was used with the Wheatstone receiver the resistance with its shunted condenser, described above, was removed from the line, and the condenser shunted directly around the receiver. The receiver and condenser thus form a resonant circuit, and by properly choosing the condenser it is possible to increase the receiver current materially, making it larger than the line current. This is the benefit of using a condenser, but the capacity for the best effect should vary with the frequency of alternation. By knowing the inductance of the receiver and the frequency, the condenser capacity can be readily calculated. The value of the capacity for any frequency is not very critical; that is, a condenser will improve the working for a considerable range of speed.

With lines having a low value of K R, the speed of the Wheatstone system is limited to about 600 words per minute, as this is found to be very near to the mechanical limit of operation of the receiver, due to the inertia of the moving parts, the spattering of ink or other causes.

A copper aerial line having K R equal to about 30,000 will reduce the Wheatstone speed to about 400 words a minute; and when a line exceeds this it is customary to insert an automatic repeater, by which the speed is maintained over longer distances. Speeds of 400 words a minute are regularly maintained in England in commercial working, while the limit of the commercial working in the United States is considerably lower, about 200 words per minute.

The speed of the synchronograph transmitter and a chemical receiver would be greater than that with the Wheatstone receiver, because of the shorter code permissible with this receiver. There would then be no limit at 600 words due to the mechanical construction, so that the value would run up into thousands of words per minute. The speed cannot be given, as the experiments have not yet established the law of speeds for this combination of instruments.

Opportunity was presented for tests of this method of transmitting signals over the artificial cable belonging to the British

* With the receiver in circuit with the main line the inductance of the former should be considered in comparison with the resistance of the whole circuit, and its combination vectorially therewith affects the latter very slightly.—EDITOR.

Post Office, and making direct comparisons of the alternating current method with the present Wheatstone system over the same cable. This cable, which represents within 1 per cent. the real cable used from England to the Continent, to Ireland, the Channel Islands, &c., is made in 60 sections of 3 knots each, making a total of 180 knots or 207·5 miles. Each section has K equal to 1 microfarad and R = 33 ohms, making total K = 60 microfarads and total R = 33 × 60 = 1,980 ohms, and total K R = 118,800. The cable is of the type in which the distributed capacity is obtained by condensers placed at regular intervals along its length.

Through this cable, with a voltage of 110, messages were sent at a frequency of 93·6 periods, or 187·2 alternations, per second, using the synchronograph and the chemical receiver. The next experiment was with the Wheatstone system transmitter and receiver, using 100 volts constant potential, and a speed of 120 words per minute, equivalent to 72 complete waves per second, was reached by the post office officials.

From a long experience in the British service the basis which is there used to calculate the number of words per minute in terms of complete cycles of current by the Wheatstone system is 36 complete cycles = one word, or ·6 of a complete cycle of current per second equals one word per minute. This basis has, therefore, been used throughout in calculating the comparative speeds, using the synchronograph with the Wheatstone receiver, so that the comparative results given are independent of the length adopted for a dash, or indeed of the particular code employed.

The cables from England to the Continent are not at present operated by the Wheatstone system, although by so doing the speed would undoubtedly be increased; but the Hughes system, by a present international agreement, is employed. By the Hughes system the messages are printed on a tape, which can be mounted on a blank and delivered.

With the experience already gained and the constants of the Wheatstone receiver measured, a wider range of experiments was planned, to include tests over each line for speed as follows:

(1) Wheatstone transmitter and receiver.
(2) Synchronograph and Wheatstone receiver.
(3) Synchronograph and chemical receiver.

Two other lines were made up, which, being used both with and without earth, were equivalent to four separate lines. One of these was a loop from London *viâ* York and Leeds to London with values R = 2,783, K = 11·95, K R = 33, 257, and K R with no earth = 8,314.

(*To be continued.*)

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1898.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents*, 322, *High Holborn, London, W.C., to whom all inquiries should be addressed.*]

18,718A. "Improvements in, and relating to, electric railways and tramcars." S. H. Short. Dated February 3rd. (Date claimed under Patents Rule 19, August 12th, 1897.) (*Complete.*)

2,433. "An improved system of adapters, to adapt all existing fittings for electric lighting to armoured, sheathed, or other concentric cables." H. F. Phillips. Dated January 31st.

2,455. "Improvements in electric contacts suitable for railway signalling and other purposes, and apparatus for use in combination therewith." R. Burn and A. C. Brown. Dated January 31st.

2,479. "Improvements in terminals for electrical connections, especially adapted to incandescence lampholders." G. Byng and H. Bevis. Dated January 31st.

2,485. "An improvement in electric arc lamps." C. Oliver. Dated January 31st.

2,487. "Improvements in apparatus for distributing electricity." H. Pengelly. Dated January 31st.

2,495. "Improved method of insulating electric apparatus and conductors." J. L Berthet, M. Mollard and L. Dulac. Dated January 31st. (Date applied for under Patents, &c., Act, 1883, Sec. 103, July 2nd, 1897, being date of application in France.)

2,522. "An improved electrical striking mechanism for bells." A. Eckstein and H. J. Coates. Dated February 1st.

2,538. "Improvements in, or in connection with, the electrical propulsion of road vehicles." G. Wilkinson and L. W. Holmes. Dated February 1st.

2,551. "An improved combined electrical dynamo and motor." T. Cooper. Dated February 1st.

2,571. "Improvements in electro-dynamic elements." C. Vallot and E. Pauze. Dated February 1st.

2,572. "Improved paper carriers and spacing mechanism applicable for use on typewriters or linotype machines, telegraphic, printing, and recording instruments." A. G. O'Farrell, J. E. Schumacher and W. R. Makins. Dated February 1st.

2,580. "Improvements in electric lighting media." H. A. Kent. Dated February 1st.

2,584. "Improvements in the manufacture of electric glow lamps." W. L. Wise. (C. Pieper, Germany.) Dated February 1st.

2,591. "An improvement in electric plating." F. T. Harris. Dated February 1st.

2,604. "Improvements in systems and apparatus for electric time control." W. P. Thompson. (The Self-Winding Clock Company, United States.) Dated February 1st.

2,618. "Improvements in supports, chiefly designed for electric incandescent lamps." L. Weldon. Dated February 1st. (*Complete.*)

2,669. "Improvements in electrical cut-outs." W. McGeoch, Jun. Dated February 2nd.

2,670. "Improvements in electrical keyholder and analogous switches." W. McGeoch, Jun. Dated February 2nd.

2,684. "Improvements in apparatus for the electro-deposition of metals." F. Fisher, Benjamin John Round, Benjamin James Round, and A. Round. Dated February 2nd.

2,723. "Improvements in electric arc lamps." H. Crudgington. Dated February 2nd.

2,734. "Improvements in, or relating to, electric incandescent lamps." A. J. Boult. (C. Duvivier, Belgium.) Dated February 2nd.

2,735. "Improvements in, or relating to, dynamo machines and electric motors." M. H. C. Shann and R. E. C. Shann. Dated February 2nd.

2,761. "Improvements in high tension electric switches." E. W. Cowan and A. Still. Dated February 3rd.

2,770. "Improvements in holders for incandescent electric lamps." G. Jaeger and H. Bender. Dated February 3rd. (*Complete.*)

2,784. "Improvements in electric switches." O. C. Immisch. Dated February 3rd.

2,788. "Improvements in electric incandescent lamps." R. B. Roxby. Dated February 3rd.

2,805. "Improvements in electrical tumbler switches." H. Crudgington. Dated February 3rd.

2,814. "A new or improved manufacture of insulated wire for electrical purposes generally." J. F. Brennan. Dated February 3rd.

2,819. "Improvements in electric cigar lighters." W. F. Kessler. Dated February 3rd.

2,849. "Improvements in electric switches." A. E. Tanner and F. A. C. Leigh. Dated February 4th.

2,871. "Improvements in electric furnaces." W. H. Graham. Dated February 4th.

2,876. "Improvements in electric lamp bulbs." J. Atherton and C. M. Downie. Dated February 4th.

2,891. "Improved announcing and recording apparatus applicable to telephones." F. B. Grunert. Dated February 4th. (*Complete.*)

2,904. "Improvements in electric heating and melting, specially applicable to the metal pots of linotype machines and the like." The Linotype Company, Limited, J. Place and M. Barr. Dated February 4th.

2,967. "Improvements in electro-depositing anodes." H. L. Haas. Dated February 5th. (*Complete.*)

2,968. "Improvements in electric switches." R Belfield. (G. Wright, United States.) Dated February 5th.

2,991. "Improved double arc lamp." W. Mathiesen. Dated February 5th. (*Complete.*)

2,998. "Improvements in and relating to the decomposition of alkaline salts by electrolysis and in apparatus therefor." J. Greenwood. Dated February 5th.

2,999. "Improvements in transmitters of Morse telegraphic apparatus for continuous and alternating currents." C. Rossi and P. Forcieri. Dated February 5th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free,* 9d. (*in stamps*).]

1896.

21,236. "An electric regulator." W. Emmott. Dated September 25th, 1896. The brightness of lamps or the strength of a current through a circuit is controlled by means of a self-induction coil. The coil may be in sections and the current may be sent direct or through one or more of the sections by means of a suitable switch; or the core may be movable within or in relation to the coil by means of a switch lever.

21,293. "Improvements in electrical door bolts." S. F. Page. Dated September 25th, 1896 The bolt is arranged to be shot or withdrawn or both shot and withdrawn by an electro-magnet. A bolt is shown which is shot by a spring and withdrawn by a magnet, the circuit of which may be closed by a person in bed, for instance. A metallic rod on the back of the bolt operates an alarm when the bolt is withdrawn. Two electro-magnets may be arranged around the bolt, one for shooting and the other for withdrawing it.

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ELECTRIC TRACTION AT THE MECHANICAL ENGINEERS.

EVEN a lapse of three months since the adjournment of the discussion upon Mr. Philip Dawson's paper before the Institution of Mechanical Engineers has not proved sufficient to cool down the thirst of some English engineers and manufacturers for Mr. Dawson's blood, in consequence of what was considered on his part undue advocacy of American traction methods; and more than one of the speakers at the renewed discussion felt obliged to put in a few good words for the paper and its author, as being worthy of more praise than censure.

Probably if more real and unbiased experts in this field had joined in the discussion, it would have been clear that, as often happens, both sides were right and both were wrong; the fault with each lay in too hasty and comprehensive a generalisation.

We ourselves have been accused in more than one quarter of advocating the use of American designs and plant in electric traction work on this side; whereas, what we have always said, and what we still maintain is, that we do not need to go to the United States (in spite of the valuable and long experience they have had over there) for steam engines, dynamos, generators, boilers, tramcar bodies, switch gear, trolley wire, or numerous other essentials to an electric tramway; but when it comes to motors and controllers, as well as a series of designs for car trucks capable of enduring the severe work entailed upon motor cars, purchasers on this side may well pause before deciding upon home-made articles turned out by makers without a tithe of the experience possessed by Americans, who have gone through the costly mill of "trial and error." Moreover, these latter items are now being made in the States in such large quantities—at a low price even allowing for freight, and of high efficiency—that English makers cannot hope to compete in this direction for some time with any great measure of success.

While, therefore, the members of the Institution who joined in the debate, may have been right in criticising Mr. Dawson's advocacy of things American as of far too sweeping a character, they might with advantage be reminded that we have not as yet, in this country, surpassed, or even equalled, American methods and appliances of all kinds.

In regard to the question of engine types suitable for traction, there seems but little need to add any words to the remarks made by Mr. Mark Robinson. It is ludicrous to specify for a governor that shall govern an engine, and an engine that shall be governed, to within less than 1 per cent. of the normal engine speed. It is not as though the cars must be, or are, run with an unvarying pressure: with lighting it is different—a slight variation in engine speed tells at once upon the lights—but who knows of it when the line voltage of a tramway varies 40 or 50 volts in 500, or what practical difference does it make to the service? The cars at the end of a long line may slow off a little, but the variation is only momentary, and cannot have any serious sustained effect.

So long as an engine is not overloaded, and has automatic expansion gear, with a governor to prevent racing, it ought to work perfectly well, and the particular decimal fraction of 1 per cent. variation in speed is not worth troubling about. Even if it were, we have plenty of engine builders in this country who can turn out engines equal to, if not better, than the American-made articles, and with as good, if not better, governing powers.

Turning to one other point which cropped up rather prominently at this discussion, it may be worth while emphasising again the real reason for the want of progress in electric traction here as compared with America. One speaker seemed to think that the reason was because we have much better roads than are usual in the States; but if so, have we a greater number of public road vehicles, such as omnibuses? Certainly not, and, therefore, his argument falls to the ground at once. As a matter of fact, the average passenger-car-mileage density is, we believe, greater in this country than in the States, so that such tramways as we have are as much used in proportion as are those in America.

The true reason for greater development across the Atlantic is obviously that which other speakers insisted upon, viz., the absence of absurd legislation and official restrictions, such as those embodied in the Tramways Act of 1870, the title of which offers the choicest piece of sarcasm we ever remember to have seen:—An Act to *facilitate*, &c., the construction, &c., of tramways!! In driving this truth home, Sir Frederick Bramwell appears to have spoken at the meeting with his official muzzle removed; and the fact is worth noting that the same official referee called in to adjudicate upon the value of a tramway, &c., under the Tramways Act, should, when speaking as a private individual, criticise so strongly the results of the very Act he has practically been called upon to administer.

A strong contrast is noticeable between the remarks of practical men like Mr. Robinson, who dealt only with the points they specially understood, or were qualified to discuss, and the more or less vague and general utterances of the "professors." Why, for instance, should a man of so high a capacity as Prof. Unwin advocate the use of conduit lines instead of the trolley, and mention as an argument that 200 horses had been killed in Boston? Surely he knows the enormous cost of a conduit line, and that if one is being put down in New York, many others (in the shape of cable roads) elsewhere are being replaced by the trolley. There is only one New York, and the conditions of tramway work there are almost unique, just as they are in London. As for the horses, if a blizzard *will* persist in coming every few years, breaking down wires of every sort, it certainly seems wiser to employ a trolley system that can be easily repaired, and is usually less liable to stoppage, than a conduit line, even at the risk of shocking a few horses to death. It takes precious little current, anyway, to kill a horse, and if public convenience is preferred the horses must either go off the streets altogether or take the risk. The average horse would, we think, prefer to take the one-in-a-million chance of being shocked to death rather than the one-in-a-hundred chance of being worked to death on a tramway in a couple of years.

In concluding this notice of the discussion, a word of admiration ought to be put forward in regard to the persistence with which the subject of bicycle-wheel fly-wheels is introduced by the inventor or deviser. Should a paper be announced for any of the Institutions wherein there is the least reference to a fly-wheel, so surely does that familiar diagram appear on the wall or the blackboard, accompanied by figures and formulæ sufficient for two ordinary college lectures. Mr. Dick was always very fond of introducing King Charles's head into conversations not always connected therewith. The inventor of tangential fly-wheel spokes had more excuse for bringing up his pet subject at the Institution discussion, and he made the most of it. There is much to be said for his device, when the old-fashioned forms of fly-wheel are considered; but Mr. Robinson knocked a good deal of ground from under the feet of this idea (if it can be said to have any) by showing that the disc form of fly-wheel, with small diameter, is quite good enough with high-speed, short-stroke engines.

We shall await Mr. Dawson's written reply to the discussion with interest. He has, at any rate, plenty of points to deal with.

Storage Battery Traction.

SOME time ago we commented upon the Englewood-Chicago storage battery line, giving particulars of the power house, plant, &c., when equipment was going on, and anticipating further information after actual work had begun. Tests—of a rather qualified nature, so far as their practical value is concerned—have lately been made on the generating plant and batteries, and the figures derived therefrom are to be found in another part of this issue of the ELECTRICAL REVIEW. So far as the engine house plant is concerned, with coal at 7s. 8d. per ton (giving 10,145 B.T.U. per lb.) the net cost of fuel per kilowatt-hour at the switchboard was about ·305 of a penny. The batteries gave an apparent energy efficiency of 60 per cent., but quite an insufficient series of charges and discharges are taken for this result, and we imagine it to be the case (as we expected) that at least a year's working must be taken before any effort can be made to get at the exact state of affairs in battery working. By the end of that time the balance-sheet ought to be as good a test as any of the possibility of using battery traction with reasonable hope of success from an economical standpoint. As a rule it is an all sufficient test, but there has been in time past too great a tendency to bolster up storage battery traction by the manufacturing interests engaged, irrespective of absolute results. The battery cars appear to have required 1·41 units per car mile at the charging table, and about ·87 unit per car mile at the motors, equal to 10 lbs. of coal per car mile. The difference, ·54 unit, represents the loss per car mile in the battery. We shall not be at all surprised if further experience shows this loss to be continually greater as the battery deteriorates with use. No figures are given as to the cost of labour or maintenance, so that final judgment in regard to this instance of a storage battery worked line must still remain suspended. The line is evidently of a very level nature, otherwise we should expect motor cars weighing nearly 12 tons when fully equipped would require a considerably greater consumption of energy per car mile than that above named.

Post Office Telegraphs.—The Postmaster-General has appointed Mr. Edward May to the Controllership of the Central Telegraph Office rendered vacant by the retirement of Mr. H. C. Fischer, C.M.G. Mr. Thomas Barlow will succeed Mr. May as Deputy Controller.

ENGLEWOOD AND CHICAGO ELECTRIC STORAGE BATTERY ROAD.*

Ever since the consolidation of storage battery interests in this country, electrical engineers have looked forward with a feeling of satisfaction and vindication to the time when the storage battery would displace the uncomely overhead and expensive underground trolley. The problems which had up to that time occupied the minds of a few investigators, were now being attacked by numerous inventors desirous of producing a light weight accumulator, one which would not deteriorate rapidly, and a generally practical system of handling storage roads.

While these questions received the closest attention of electrical engineers, the steam generating and transmitting, as well as electrical machinery, were being marvellously developed. But while we heard of storage batteries performing many useful functions in central stations, the only roads worthy of mention whose cars were equipped with accumulators, were those of Berlin, Paris, Vienna and Birmingham. On the other hand, the Metropolitan Railway Company of New York, after a thorough investigation of all existing methods of street car propulsion, adopted the electric conduit system over a large network of thoroughfares.

We have watched, meantime, in conjunction with everyone interested in electric traction, ever since its inception in 1895, the progress and success of the Englewood and Chicago electric storage battery road, and now that the results of carefully executed efficiency tests have been made available, we take pleasure in presenting below some of the results and conclusions of these tests to our readers. During last summer over 20 motor cars were operated, often with trailers, and thousands of people were carried each day. The tests were conducted under actual operating conditions, no effort being made to obtain results better than might be expected in everyday service. The engines developed a total of 232 72 horse-power; the electrical output was 186 9 horse-power, showing an efficiency of 80 per cent., the average all-day efficiency being 79·3 per cent. The log of the boiler tests shows that the steam pressure was 168·3 lbs., and that 8·22 lbs. of water were evaporated per pound of combustible from and at 212° F., and that the boilers developed 149 horse-power each; 62 86 per cent. of the total calorific power of the fuel was utilised. The results of the tests on engines, dynamos and auxiliaries show that 18 lbs. of dry steam were used by each engine per indicated horse-power hour. The average output of each generator was 128·3 kilowatt, which was 67·5 per cent. of full load. The load factor was ·82, and the watt hours per pound of coal 155·2. The cost of coal was $1.90 per ton, and its cost per net kilowatt hour ·611 of a cent. The conditions of the test were not favourable, however, as the steam pressure was lower than it should have been and the vacuum was only 24·25 inches. The engines were also overloaded during the entire run and were not operated at their rated speed. The average percentage between the horse-power developed in the cylinders and the electrical horse-power delivered on the switchboard is shown to be 79·27 per cent., which is very satisfactory, and the efficiency of the generators (running 32 per cent. below their rated capacity) is 93·1 per cent. The total station efficiency from coal pile to switchboard is 5·58 per cent. As a matter of comparison we may state that the efficiency of the Chicago Edison Company's Harrison Street station, producing electrical energy for ·3 of a cent. per kilowatt hour, is only 4·61 per cent.

To make a fair test of the batteries, 110 trips were made on one day and 123 trips on another, giving a total of nearly 3,500 car miles. The results of these tests show the following:

Kilowatt hours at switchboard per car mile, 1·37 and 1·63 for the two days, respectively; pounds of coal per car mile, 9·45 and 10·50; cost of coal per net kilowatt hour, ·655 and ·611 of a cent; cost of coal per car mile, ·897 and ·966 of a cent. It should be remarked that there was a coating of ice upon the rails during the latter part of the second day. The total number of stops during four trips was 57, and the average speed of the cars was 11·84 miles per hour. Two efficiency tests of the battery give results of 58·6 per cent. and 62·32 per cent., respectively. These results, however, show the efficiency in actual service, but do not represent the possibilities of the batteries. All these results have been carefully plotted in the form of curves, including acceleration and current curves.

While the figures given are very gratifying, it should be stated that the tests do not demonstrate the best results that may be expected of storage battery traction, and were not made for that purpose. The primary object of the test was to determine where improvements could be made, and if this is kept in mind when comparing the results with those obtained on a trolley system of about the same size, it will be seen that the cost of fuel for accumulator traction of something less than one cent per car mile is very favourable to storage battery traction. After the improvements suggested by the tests have been made, and better coal than was used on the test, at a cheaper price, has been secured, the fuel cost per car mile should be brought well within one-half cent. The batteries have operated from 8,000 to 14,000 miles and are standing the service remarkably well, so that the maintenance account up to the present has been comparatively small.

The tests were in charge of Mr. George A. Damon, consulting engineer, who was ably assisted by Prof. T. P. Gaylord and a corps of students from the Armour Institute of Chicago. In conclusion we venture to express the opinion that the experience gained by the enterprising Englewood and Chicago Street Railway Company will benefit all interested and engaged in electric street railway development, and that it will lead to further improvements in accumulators, and the more extensive introduction of storage battery traction in the United States.

* New York *Electrical Engineer*.

THE VENTILATION OF THE METROPOLITAN RAILWAY TUNNELS.

We are in receipt of a pamphlet from Mr. Robert Cox, M.P., on the above subject. It appears to have been compiled by Mr. Ernest Callard, of the London Chamber of Commerce, and to be essentially the evidence before the Board of Trade Committee of Inquiry of Mr. Jas. Keith. Mr. Keith practically confines himself to positive fan ventilation by means of slow running fans placed midway of the stations, and we are glad to see that an absence of sulphurous smoke from the tunnels of the South London electric lines is not allowed by Mr. Keith to stand for ventilation.

The Metropolitan Railway may be foul with sulphurous fumes, but it is probably little worse than the South London line, which has not the advantage of germicide smoke to disinfect it. We do not believe in this purification of tunnels by choking fumes of sulphur, but an electrical line ought not to be put down without any attempt at ventilation. Mr. Callard shows that the Metropolitan Company hold their powers under their Act of 1854, which gives them full power to use any sort of motive power they like to employ, *without any approach to Parliament for further powers*. This being so, he questions the honesty of the company in procuring the insertion of inspired paragraphs in the press that they are seeking Parliamentary powers to adopt electric traction. All this is to beguile the public; as to which, however, there may be two opinions, as we shall show later.

It is certain that electric traction would prove a fair cure for the Metropolitan fumes. Being so near the surface, there would always be a change of air at the blow-holes sufficient to purify the tunnels of the only then possible pollution due to the presence of a certain number of people passing through.

The deeper-buried electric line in South London cannot purify itself, and is not even arranged, as it has been claimed to be arranged, so that the trains will assist ventilation. The trains churn the air, they do not push much out. Yet they might easily have been made to do so, and the otherwise necessary fans avoided. Any mining engineer would have shown how to ventilate the South London tunnels by the aid of a few brattices. As it stands, this line is but poor testimony to the boasted purity of electric traction.

It is worth note that on the Metropolitan line, at Gower Street platform, Dr. Haldane found 89·4 parts of CO_2 per 10,000, or over 22 fold the atmospheric normal. The committee would draw the maximum limit at 15 to 20 parts. As to the beguiling of the public by asking powers from Parliament, there is another side to the question. The company may have the legal right to use any motive power they wish to use, but rights are of little use unless supplemented by financial ability, and it is the financial ability which we understand is the real object of the Bill. Money is required to equip a railway for electric traction, and when this has been done, it will be time enough to apply mechanical ventilation, if such is needed. We do not believe it will be needed. In a shallow buried railway, the movement of the trains and the natural current caused by wind pressure acting at the open stations will probably be ample to keep pure the tunnels when these are free of the locomotive products. Such means, however, are quite inadequate to deal with deeply buried lines. At one time there was a good deal of nonsense written about piston trains, which would clear out the tunnels in front of them, and draw in fresh air behind them. As carried out with each tunnel opening into the same station at each end, the piston effect has resolved itself into a mere horizontal circulation of air from south to north by the up tunnel, and back again by the down tunnel to the south. There has been no serious attempt to let in fresh air from the surface, and to expel foul air to the surface, by any systematic piston effect of the trains. The thing is feasible enough, no doubt, and if not feasible, it ought not to have been seriously advanced. These deep tunnels are multiplying all over London, and they will have to be ventilated in some way. In the report before us, a Mr. Morrison is quoted to the effect that 1 lb. of coal burned is equivalent to the pollution of a tunnel by 500 people. This is an entirely wrong view. The amount of carbonic acid gas produced may be equivalent, but so is the amount of this gas produced from an ounce of graphite and an ounce of diamonds. The latter equivalence no more determines the market price of diamonds and of graphite than does the former measure the real pollution. It is not so much the presence of CO_2 that is harmful as the toxic poisons, the wasted organic tissues, the organic nitrogenous substances—in short, "the rich steams of sweet humanity" so ably discoursed of by Mokanna. These are what render the South London line so objectionable, and what future lines should have a care to eliminate.

MORE THIRD RAIL SYSTEMS.

It is most surprising to see the frequency with which American inventors make efforts to improve upon the details of some well known principle, where an English engineer would rather break fresh ground altogether and try absolutely new methods instead of changing parts of a mechanism.

Thus, in a recent number of the *Electrical World*, were described and illustrated a couple of so-called "third rail systems," both of which have evidently had a considerable amount of trouble and ingenuity spent upon them by their devisers, but which may safely be classed amongst the "might-have-beens." To our mind it seems really a waste of time to spend even a single hour upon working out such devices so long as the simple third rail and overhead trolley wire systems remain feasible for ordinary working conditions.

The first of the devices under notice claims to be especially suitable for elevated and suburban railways usually worked by steam. It consists of a sectional third rail with alternating live and dead portions, the mechanism for throwing over the switch contact arrangement (sending current into each live section) being actuated by frictional end pressure due to the contact shoe upon each separate section of the third rail, which has a slight amount of end play.

The only advantage of such a device is that the current is kept from an exposed rail conductor except on such portions as are covered by the car or train, and presumably this is considered to be worth the extra cost and complication of the system. But the only persons to consider (in this country at least), so far as freedom from shock is concerned, are the railroad employés who are naturally supposed to know the dangers of their work and take precautions accordingly. There is no great economy of current in keeping it within a feeder, save only on the portions of line under the trains themselves: usually the third rail itself is feeder and conductor rolled into one.

The working details of the device are, however, developed in a most ingenious way, and make one wonder what the inventor might not do if he were to attempt a contrivance on absolutely new lines.

The other device is also characterised by novelty and ingenuity. It is intended for use with a third rail in street tramway work, and embodies the use of a small set of storage batteries and a motor generator on the car of sufficient size (but obviously quite small) to actuate the magnetic switches generally employed for throwing current into the third rail sections, one after the other. This motor generator is wound to take a small current from the battery at 10 volts and convert it into a 500-volt current, so that the third rail and rail return may be introduced directly into the magnetic switch circuit.

The third rail sections are alternately live and dead, the former as a rule about 8 feet long, the latter 6 feet. With two shoes upon each car there is always one live section in circuit.

This device may also be considered well worked out in detail, but the surface contact system for street tramways has, in any case, but little chance of general adoption, even in the towns and cities of this country where some amount of prejudice exists against overhead wires.

STEAM ENGINE MECHANICAL EFFICIENCY.

A correspondence is going on in *Engineering* anent an expression of opinion by Mr. Raworth that there would be a loss of only 15 per cent. between indicated and electrical horse-power in a cotton mill, as compared with a loss of 40 per cent. between cylinder and crank-shaft in the present arrangement. Mr. Herschmann corrects the writer, and points out that Mr. Raworth's figures had reference to the waste between the cylinder and the driven shafts of the machines. Nevertheless he is sceptical of Mr. Raworth's 15 per cent. for electricity. This correspondent rightly states that the cotton spinner is in a position to use large engines of an economical kind, and that in cotton mill driving, power is taken fairly direct to machinery, and that machinery may be classed as grouped, and properly looked upon as suitable for driving from shafting. The speed of motors also is too high for direct connection to machine shafts, and generally it is concluded that cotton mill driving does not afford the best field for electricity.

There is a good deal in what this correspondent says. A cotton mill is not a large cube through which a horse-power of 1,000 or 1,200 indicated is required to be distributed. Driving is very direct from the engine fly-wheel to the line-shafts. As compared with the losses in the ropes and shafts, there would be the loss at the dynamo, in the leads, and at the motors, and it is not as though there were any particularly long pieces of shafting. It is certain that at present a mill-owner would think twice before buying electricity; he might make his own, and use electrical transmission. But in a cotton mill there is never a considerable percentage of machinery standing idle. Almost everything in a cotton mill is paid for at piece rates, and while machinery is largely self-stopping, the attendants are particularly quick to set them going again when the "ends" are pieced up. Even supposing that electricity could be cheaply purchased, there remains the question of heating. Throughout the year some heating is necessary, or may be any morning. In winter it is a *sine quâ non*.

There must be steam boilers for this alone, and this fact would always help out the generation of power on the spot. The importance of reducing frictional losses to a minimum is rendered very evident in cotton mill practice. The product of a cotton mill contains very little energy—at most that represented by the torsion put upon the fibres twisted at an exceedingly small moment of resistance. A large mill probably turns out about 1,000,000 miles of single yarn every week, containing about 1,250,000 millions of twists, which has been estimated to require, at the outside, 60 foot pounds of work per minute, or about $\frac{1}{500}$th of a horse-power. To secure this small end demands, say, 1,200 indicated horse-power, all of which disappears as friction and reappears as heat. A running mill soon warms itself to an intolerable degree in summer-time, and windows are opened.

There are those who probably hope to see electrical motors still more sub-divided than as at present. The ultimate divisibility would come in where every spindle had its own little motor; but it is not in the spindle driving that power is lost: it is in revolving the several rows of heavily weighted rollers, badly lubricated, that power is absorbed, to an extent compared with which the few lines of well-attended shafting are a small item.

As in most machinery, not much is known as to the power requisite to turn cotton machinery. The total work per spindle may be known, but we cannot learn of a roving frame being dynamometered when running complete and also with the rollers at rest, or of a spinning frame being measured for power absorbtion when run empty and when full. The difference goes into the drawing and twisting of the yarn, and is a mere nothing.

But to return to Mr. Herschmann, if the cotton spinner can himself generate a horse-power for 2 lbs. of coal, he becomes a difficult customer to deal with by an electrical company, even if this company generate with only 1½ lbs. of fuel. For electrical driving of factories the cotton mill, in fact, is one of the worst cases to deal with, and the large and widely-scattered workshops and tools of the ship yard or engineers' shop with occasionally worked heavy tools, stand as examples favourable to electricity.

THE BURNING QUESTION.

Our article under this heading on February 4th, concluded with the remark that we considered the cost of labour per ton of refuse burned, in relation to the wages paid, and the number of hours worked by the men, the most important element in the destructor question. This by no means removes the necessity of fulfilling the other conditions which we mentioned, viz., that nuisance from dust or smoke must not occur, that the refuse should be completely burned, and that the temperature should be maintained as high as possible. But as we laid such stress upon cost, we considered it our duty to make some further inquiries upon this subject; and we have received the most courteous replies from the engineers of whom we sought information.

In view of the letter from Mr. Jones, C.E., of Ealing, which also appeared in our issue of February 4th, our first desire was to compare the cost of the systems of destroying refuse and sludge mixed at Ealing and at Leyton.

Mr. Jones resented warmly the statement made in a non-technical contemporary, which has been repeated in many other journals, that the Leyton destructor was the first to deal successfully with sewage sludge, and we confess we sympathise with him. It is hard to hear such statements made after one has had a destructor doing that very thing for 15 years. Mr. Dawson, C.E., of Leyton, is kind enough to point out to us that his sludge is first pressed, whereas Mr. Jones's is unpressed.

We quite admit that pressing gives the stuff a soap-like consistency, and that it may be harder to burn pressed than unpressed; but, if so, why press it? We find that burning it unpressed is, from the point of view of cost, wholly in Mr. Jones's favour.

Mr. Dawson informs us that the cost of burning the refuse and sludge at Leyton works out to 1s. 7d. per ton for some months past, though taking only the last month it is 1s. 6½d.

To consider first the sludge alone.

We will assume that the cost of pressing is 6d. per ton of *wet sludge*. This we know to be a low estimate. The cost of burning is 1s. 6½d. per ton of *pressed* sludge. Assuming that one-third of the weight of wet sludge has been removed by pressing, this would amount to, say, 1s. per ton of *wet* sludge.

The total cost is, therefore, 1s. 6d. per ton of wet sludge for pressing and burning.

On the other hand, Mr. Jones states his cost at 1s. 1½d. per ton burned, exclusive of returns in the shape of sale of of clinker, &c.

Mr. Jones's 15 years' practice, therefore, appears to come out, as regards cost, superior to the "new departure" at Leyton. We make these remarks in the hope of eliciting further information in the comparison of the two systems.

At the same time, we do not profess to admire the low temperature system of destructors, and we believe that modern forced draught furnaces would, in Mr. Jones's hands, further secure his historical pre-eminence in sludge burning.

But if we are to pursue this question of sludge still further, what are we to say of Sir Douglas Galton's startling statement at Leyton in reference to the London sludge fleet?

We have now had an opportunity of studying his remarks at leisure in the *Leyton Express and Independent* of January 29th, which modestly refers to the destructor, in a leading article, as "*the pride of Leyton*."

Sir Douglas Galton is reported to have said:—"In the metropolis a charge of above £100,000 a year is incurred to get rid of it [the sludge] by putting it into barges, from which it is dropped into the sea. That, I must confess, seems to me a wasteful process. . . . .

"Here, at Leyton, with the assistance of Messrs. Beaman and Deas, you have done much better than London now does. You have obtained a destructor which deals in a marvellous way with the refuse sludge. You avoid the cost of barging, for after removing it from your tanks, you have only to squeeze it thoroughly, and throw it into furnaces, and then the heat from its perfect combustion assists in working the necessary machinery."

Now we have seen that the cost of pressing and burning the sludge is about 1s. 6d. per ton of wet sludge at Leyton. We obtained from the London County Council the report of their able chief engineer, Sir Alexander Binnie, on the treatment of London sewage during 1896, this being the latest report for a complete year which was available to us.

We must say that Sir Alexander Binnie has no need of any champion to defend the system inaugurated by his distinguished predecessor, and improved by himself, for we have never read a more interesting, exact, comprehensive and satisfactory statement upon any branch of municipal business than this report.

We find from it that no less than 2,178,000 tons of sludge, containing 91·08 per cent. to 91·44 per cent. of moisture, were sent to sea in that year. The average cost of conveying this enormous mass of offensive matter 50 miles out was 3·4 pence per ton for working expenses, or 4·59 pence per ton inclusive of capital and all other charges. In view of these figures, does Sir Douglas Galton seriously advocate a substitution of the Leyton process for that now in operation at Barking and Crossness?

To put it at the lowest figure, we think London will object to paying an extra charge of 1s. 1d. per ton of sludge, or, in other words, £118,000 per annum, over and above the present cost, which is £41,654.

Allowances should be made for Sir Douglas Galton, as he was the "lion" of the occasion; and, presumably, his remarks were intended for a popular audience; but lions should be careful how they roar, particularly when they are well-known scientific authorities.

To return to the question of cost per ton burned for refuse in general, we have before us a report from which it appears that at the "Lero" destructor at Leicester, which is on the natural draught, low temperature system, under the management of the designer and patentee, Mr. Biddles, there were burned, in 1896, 12,956 tons of ashpit refuse; 373 tons of trade refuse; 147 tons of fish offal; and 267 mattresses. The total wages paid to firemen were £328.

We exclude the wages paid for repairs, mortar grinding, weighing in, and rat-catching, as we believe these items are not usually reckoned in the cost per ton burned.

The cost of labour per ton burned is, therefore, according to this statement kindly furnished to us by Mr. Biddles, under 6d. per ton.

From an interesting paper by Mr. George Darley, superintendent of the cleansing department at Leeds, published on January 29th last, in our esteemed contemporary, the *Public Health Engineer*, we learn that the cost of labour at the destructor at Meanwood, Leeds, is 7½d. per ton, while we are informed that at Bradford, Hammerton Street, it is 7d. per ton. The two last mentioned destructors are on the Horsfall system, and are worked at high temperatures under forced draught.

These figures show that the cost of labour at Leyton of 1s. 6½d. per ton burned is susceptible of very great improvement. It must not be forgotten that sludge is being burned at Leyton; but we think that the weighty nature of the sludge, and the fact that 60 per cent. of it is water, and requires only to be evaporated, more than compensates for its damping effect on the fires.

Moreover, other authorities have carried out tests at Leyton on refuse only, without sludge, and the costs published tend to confirm our opinion.

We look forward to the time when, at every important destructor, the costs will be kept and tabulated as carefully and completely as those relating to the disposal of the London sludge; or to name an example more familiar to our readers, the works' costs of practically every electricity station in the country.

ELECTRICAL NEWS FROM AUSTRALIA.

[FROM OUR SPECIAL CORRESPONDENT AT SYDNEY.]

Australia has, unfortunately, recently added two more to the list of electrically caused deaths. On Sunday, September 11th, a lad named Richard Trusswell, aged 17 years, residing at Armadale, a suburb of Melbourne, challenged two companions to climb to the top of an electric light pole in Stanhope Street, Malvern, in less time than he could. The challenge being accepted, Trusswell quickly ascended the pole, and caught the wire with both hands, and almost immediately fell to the ground insensible. Medical aid was quickly summoned, but death had evidently been instantaneous. The lad's hands were terribly burnt, and one finger was burnt off at the joint. According to the evidence of his companions, sparks flew from his hands when he caught the wire, his legs came off the post, and after swaying a second or two he fell. He made no exclamation when he came in contact with the wire, but when, black in the face, he fell to the ground, he groaned once or twice, and then expired. The wire, which was insulated, was the property of the New Australian Electric Company.

The second instance occurred in Brisbane. On November 3rd, a man named Fox, foreman in charge of a gang doing repair work on the trolley line, received a shock and fell from the top of a waggon platform, and died within a few minutes, before medical aid could be summoned. The medical evidence showed that his skull was fractured, but it did not appear to be clear as to the exact cause of death: whether it was the shock, the fall, or both combined. There was no rail round the platform, and though rubber gloves appear to have been served out, they were not used. The men started work at 5.30, before current was turned on, and the accident happened immediately after 6.30, at which time current was turned on as usual for the first train to take up the regular running.

In connection with the various electric tram lines in Sydney, several contracts have been let, principally in connection with the George Street line. Tenders were called for the construction of permanent way and erection of poles in two sections, one going to J. McSweeney at £12,754, and the other to Wilmot & Morgan at £25,690, the highest tenders being respectively £18,118 and £31,820, 10 tenders being received for each; the contract for car house entrance going to H. W. Peabody for £1,200, as did also the construction of the crossing of the cable tram in King Street for £268. Messrs. G. & C. Hoskins are constructing the boilers locally, their accepted tender being for the sum of £4,718. The excavations for the power house at the back of Harris Street will cost £886, and is being carried out by C. McClure. Messrs. Noyes Bros., agents for Callender and Co., have secured the contract for the supply of feeder cables and junction boxes at schedule rates (about £7,540) for the George Street line, and also for the Rose Bay line at £459. The generators for the latter line are still lying outside the cable power house, but it is expected that they will be put in place before the end of the year, and the outside construction work will be commenced shortly. The estimated cost is £13,225. As before stated, Messrs. H. H. Kingsbury and Co., agents for the General Electric Company of U.S.A., are supplying generators for both lines.

The method adopted by the Goulburn (N.S.W.) Borough Council on entering into the question of electrically lighting the town has ended in a *fiasco*. As I mentioned in a former letter, the Council employed a consulting engineer, at an absurdly low fee, to draw up a "general specification," upon which tenders were called, with the result that so little being specified, a meeting of the electrical trades was held in Sydney to protest against the vagueness of the details supplied. First the consulting engineer was asked to give some more definite details of his requirements, and on his failing to accede, recourse was had to the Goulburn Council, who expressed themselves as highly indignant at being called upon to go to the expense of providing information, and one alderman, in defending the specification, said "the complaint came from a ring who desired the Council to expend money on information they should procure themselves." The majority of the aldermen defended the specification, "as the responsibility thrown on the tenders is a great saving to the Council." Out of the dozen or more firms who might have tendered, only two sent in.

The specification commences with a preamble to the following effect: "This specification is prepared with a view to enable electric light contractors to submit tenders to the Municipal Council of Goulburn, for the lighting of that city, on equal terms with one another, while leaving them entirely free to select those special classes of machinery and fittings which they represent or prefer. Contractors must understand that there is no intention of expressing any preference for particular types of boilers, engines, dynamos, conductors, or lamps, but they are to take the following particulars rather as statements of the conditions which they are to fulfil, and the basis on which rival tenders will be compared, &c." A map was provided, showing public lighting and the street frontages where provision is to be made for private lighting. A schedule of arc and incandescent lamps is then given, with the amount of watts required, the total being given as *66,000 watts*. Immediately below this comes the following delightfully ingenuous statement: "If the whole of the contract current of *80 kilowatts* is to be delivered from one dynamo, or if that portion of it required for the incandescent lights is to be supplied from one machine, and that for the arc lighting from another one of a different character; then there will require to be a complete duplication of the generating plant, altogether making the dynamos equal to a total of *160 kilowatts;* but should the contractor propose to supply both the arc and incandescent lights from two similar machines equal to 40,000 watts each, then a triplicate machine making a total possible output of 120 kilowatts will be sufficient as a reserve."

Not content with giving so many alternatives in the matter of generators, additional choice is given in the matter of sites, two being available at a considerable distance apart, and as one site is near the water works, with water handy for condensing purposes, the question of condensing or non-condensing engines is left for the poor unfortunate contractor to put in an alternative tender for. The power house is left entirely to the contractor's imagination and architectural ideas. In the matter of boilers the contractor is once again given a free hand. "Contractors will be at liberty to tender on either the 'internal fired,' 'water tube,' or 'multitubular' systems; and the matter of spare boiler power is arranged on the same plan as is adopted in the case of the dynamos, the contractors being permitted to put in two, three, or any other number they consider advisable;" the clause relating to boilers finishes as follows: "Although not here expressed in detail, it is to be understood that the most modern system of construction and highest class of workmanship is to be stipulated for by tenderers." In the clause relating to boiler-mountings, the following phrases occur: "The front fittings and doors are to be of handsome get up." . . . "One spare set of fire-bars *had better* be included, and two sets of fire tools." In referring to steam pipes also the phrase occurs: "These pipes *had better* be of copper." The specification is also very open-minded on the subject of steam engines. "The engines are to be of compound type, either open or closed, and may be connected to the dynamo direct or by belts. Contractors who propose to drive smaller dynamos at a higher speed by belts must set against the saving in the cost of the dynamos the extra cost of the larger building required, &c." (What does this mean?) In dealing with the switchboard, superlative wisdom is shown in the remark that "The character of the switchboard will as greatly depend upon the nature of the scheme, that absolute requirements cannot be set forth." Why, certainly! Contractors are required to supply and fix all transformers, if any, that may be required; but apparently they are at liberty to state how many will be necessary, and the sizes of same. No mains are shown on plan, but they must be provided, and must have an insulation resistance of 600 megohms per mile "when coiled on the ground," and "the sections are to be so proportioned, that when carrying the full load, the fall of potential shall not be more than $2\frac{1}{2}$ per cent. in either primary or secondary mains." (This latter information seems to show that the consulting engineer has a hitherto carefully concealed preference for alternating currents.) Coming to poles, the contractor is given another opportunity for diversion, by providing the option of galvanised tubular poles at the centres of street intersections, or iron brackets from the corners of buildings; and further, is permitted the choice of overhead or underground conductors, with the further advantage of a solid or draw-in system for the latter.

Towards the end a suggestion is airily thrown out that, after all, perhaps a continuous current transformer system might be preferred, and this is made further use of to perplex the already addled tender with its bearing on the use of open or closed arc lamps. At a low computation there would be no difficulty in sending in a hundred alternative tenders, all of which would comply with the specification. What a fortunate thing it is for the consulting engineer that only two firms have tendered, and that each have sent in only six alternative tenders for him to consider the merits of.

The Corporation of Port Adelaide (S.A.) have saved themselves all this bother by coming to terms with Mr. W. W. Crawfurd, agent for Messrs. Johnson & Phillips, who is undertaking the lighting of the town on the three-wire system with Johnson and Phillips' dynamos direct coupled to Belliss engines with a reserve of accumulators. It is understood that this work is being carried out by the same syndicate that is endeavouring to get a Bill through the South Australian Legislative Assembly with the object of lighting the City of Adelaide; the Bill is being strenuously opposed by the Adelaide Council in the belief, as they expressed it, "that the promoters were not a *bona fide* company anxious to carry out the electric work themselves, but rather a grasping syndicate wishful to secure electric rights for speculative purposes." The company, however, answered this by promptly offering to deposit £2,000 if the City Corporation would give them a contract for lighting Adelaide. In an examination in connection with this Bill the town clerk stated that the Corporation were paying between £4,600 and £4,700 per annum for 992 gas lamps. At Port Adelaide 130 gas lamps are being replaced by 24 arc lamps and 66 50-C.P. incandescents.

The question of private lighting was discussed at the meeting of the Melbourne City Council lately. A report was received from the Public Works Committee stating that Government sanction to the supply of light for public and private purposes by the Corporation had been secured, and recommending that advantage should be taken of the privilege. At charges of 5d. per unit for incandescent lamps, and £25 to £19 per annum each for arc lamps (according to the time they were kept alight) the present plant of the Council should give a revenue, when fully employed, of £5,295, besides supplying certain corporation buildings. Deducting the working expenses and other charges, this, the committee estimated, should leave a profit of £1,200. Many applications for the supply of electricity to private premises had been received, some of which were very urgent, and were being supplied. In the discussion which followed, several of the aldermen counselled delay, averring that unless the electric light improved considerably, it would be superseded by the Welsbach gas light. This idea was scouted by others, and ultimately the committee's report and suggestions were adopted.

Mr. Hesketh, the Queensland Government's electrical engineer, in reporting on the proposed electric lighting of Brisbane, states that he thinks electric lighting a proper and remunerative undertaking for the Corporation, and recommends that at first operations should be confined to the main streets of the city, using the direct-current system, with a three-wire distribution at 400 volts.

The first long distance telephone line in New South Wales, between Sydney and Newcastle, is almost completed. The connection is made by means of a cable passing through the telephone tunnel recently constructed in Pitt Street, thence into George Street North, joining the Harbour Cable at Dawes Point Battery to meet the overland line. The total length of line is close on 100 miles, and the tariff is to be 3s. for a three-minutes' conversation.

THE MEASUREMENT OF FAULT RESISTANCES WITH A VOLTMETER.

By STUART A. RUSSELL.

THE first proposal to use a voltmeter for the measurement of the fault resistance of an electric circuit without interrupting the service dates back many years; but when it was first proposed, the conditions necessary to obtain a correct result were not properly understood, and even as late as 1889, it was stated in a paper read at the Institution of Electrical Engineers that if a voltmeter was connected from one conductor to earth, the total leakage current could be calculated by dividing the voltmeter reading in volts by the resistance of the instrument. In the discussion it was pointed out that such a method could not give correct results, but no description of the proper way of using the voltmeter was given by any of the speakers.

Although the correct method of measuring fault resistances with a voltmeter was published about this time, and must be well known to many readers of the ELECTRICAL REVIEW, improper or incomplete methods are still frequently used, and the full amount of information that may be derived from a voltmeter test does not appear to be generally known. It is proposed, therefore, in this article to describe several applications of the use of the voltmeter and to draw attention to the results that may be obtained.

Two-wire Circuit.—In fig. 1 let A and B be the positive

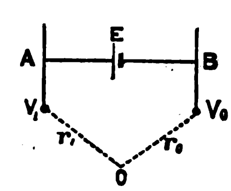


FIG. 1.

and negative conductors of a circuit having a difference of potential between them of E volts.

Let O be the earth taken at zero potential.

Let r_1 and r_0 be the fault resistances of A and B, and F be their combined resistance so that $\frac{1}{F} = \frac{1}{r_1} + \frac{1}{r_0}$.

Connect A to earth by a voltmeter of resistance G, and note the potential, V_1, of the conductor; then connect B to earth by the same voltmeter and note the potential, V_0, of B (which will be a negative quantity), and finally connect A and B and note the difference of potential, E.

$$\text{Then } \frac{V_1}{r_1} + \frac{V_1}{G} + \frac{V_1 - E}{r_0} = 0, \text{ or } V_1\left(\frac{1}{F} + \frac{1}{G}\right) = \frac{E}{r_0}, \quad (1)$$

$$\text{and } \frac{V_0}{r_0} + \frac{V_0}{G} + \frac{V_0 + E}{r_1} = 0, \text{ or } V_0\left(\frac{1}{F} + \frac{1}{G}\right) = -\frac{}{r_1}. \quad (2)$$

By subtracting (2) from (1) we get $(V_1 - V_0)\left(\frac{1}{F}+\frac{1}{G}\right)=\frac{E}{F}$,

$$\text{whence } F = G\,\frac{E-(V_1-V_0)}{V_1-V_0}. \qquad (3)$$

From (1) and (2) we also see that $\frac{V_1}{r_1} = -\frac{V_0}{r_0}$ and by substituting this value of $\frac{V_1}{r_1}$ in (1) we get

$$-\frac{V_0}{r_0}+\frac{V_1}{G}+\frac{V_1-E}{r_0}=0, \text{ whence } r_0 = G\,\frac{E-(V_1-V_0)}{V_1},$$

and in similar manner from (2) we get $r_1 = G\,\frac{E-(V_1-V_0)}{-V_0}$.

It must be noted that if the voltmeter readings V_1 and V_0 are used without regard to the direction of the current through the instrument, the sign of V_0 must be changed in these equations as V_0 itself is a negative quantity; the equation for the combined resistance becoming

$$F = G\,\frac{E-(V_1+V_0)}{V_1+V_0},$$

whilst $r_0 = G\,\frac{E-(V_1+V_0)}{V_1}$ and $r_1 = G\,\frac{E-(V_1+V_0)}{V_0}$.

As the Board of Trade Regulations stipulate that the leakage current shall not be more than $\frac{1}{1000}$th of the maximum supply current, and as other regulations fix the maximum permissible ratio of leakage current to supply current, it is desirable that the value of the leakage current, c, should be known, and we see from the above equations that

$$c = \frac{E}{r_1+r_0} = \frac{-E\,V_1\,V_0}{G\,(V_1-V_0)\,\{E-(V_1-V_0)\}}.$$

When using a voltmeter in this manner the best results are obtained if its resistance is about equal to the combined fault resistance, that is when $V_1 - V_0 = \frac{E}{2}$. If the resistance of the voltmeter is much less than that of the fault, the readings are too low down on the scale where the calibration of most instruments is least accurate; whilst if the resistance of the voltmeter is very high compared with that of the fault, $V_1 - V_0$ is so nearly equal to E that a small percentage error in the values of E or of $V_1 - V_0$ causes a large percentage error in $E - (V_1 - V_0)$ which is the numerator in the equations. A convenient plan is to have the voltmeter fitted with one or two shunts which can be used as required to get suitable readings; the value of G used in the equations being, of course, the resistance of the shunted voltmeter.

If an electrostatic voltmeter, or one of very high resistance only is available, a resistance coil of known value, S, should be obtained and the test can then be made in the following manner: connect one conductor to earth by the voltmeter and note the reading, V, then shunt the voltmeter by the resistance, S, and note the reading V′. If the voltmeter is connected between A and earth (fig. 1), and we suppose the value of G so high that $\frac{1}{G}$ is negligible, we have

$$\frac{V}{r_1}+\frac{V-E}{r_0}=0, \text{ or } \frac{V}{F}-\frac{E}{r_0}=0, \qquad (4)$$

and when the shunt S is also connected between A and earth, we have

$$\frac{V'}{r_1}+\frac{V'}{S}+\frac{V'-E}{r_0}=0, \text{ or } \frac{V'}{F}+\frac{V'}{S}-\frac{E}{r_0}=0. \qquad (5)$$

From these two equations we get

$$\frac{V-V'}{F}-\frac{V'}{S}=0, \text{ or } F=\frac{S\,(V-V')}{V'}. \qquad (6)$$

The values of r_0 and r_1 can be obtained separately by substituting in the equation $\frac{V}{F}-\frac{E}{r_0}=0$, the value just obtained for F, which gives

$$r_0 = \frac{E\,S\,(V-V')}{V\,V'},$$

and since from equation (4) we know that

$$r_1 = r_0\,\frac{V}{E-V},$$

we get

$$r_1 = \frac{E\,S\,(V-V')}{V'\,(E-V)}.$$

The leakage current $c = \frac{E}{r_1+r_0} = \frac{V\,V'\,(E-V)}{E\,S\,(V-V')}$.

Three-wire System.—Similar methods of determining the value of F may be used on a three-wire system, but under ordinary working conditions the separate values of the fault resistances of each conductor cannot be fixed. It is, however, possible to determine the minimum values that these fault resistances can have, and the maximum leakage current to earth that can exist under the conditions observed at the time of the test; and, further, by a modification of the conditions of testing, the actual values of the separate fault resistances can be determined.

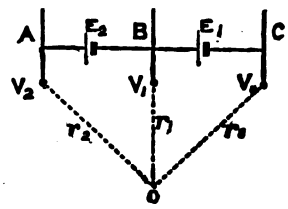


Fig. 2.

Let A, B, and C, be the three conductors, E_2 and E_1 the potential differences between A and B and between B and C, r_2, r_1, and r_0, the fault resistances of positive, neutral, and negative conductors, and F their combined resistance.

Connect A to earth by a voltmeter of resistance G and note the potential V_2 of the conductor, then connect C to earth by the same voltmeter, noting the potential V_0 of the conductor and finally measure E_2 and E_1.

$$\text{Then } \frac{V_2}{r_2}+\frac{V_2}{G}+\frac{V_2-E_2}{r_1}+\frac{V_2-E_2-E_1}{r_0}=0,$$

$$\text{or } V_2\left(\frac{1}{F}+\frac{1}{G}\right)-\frac{E_2}{r_1}-\frac{E_2+E_1}{r_0}=0. \qquad (7)$$

$$\text{and } \frac{V_0}{r_0}+\frac{V_0}{G}+\frac{V_0+E_1}{r_1}+\frac{V_0+E_2+E_1}{r_2}=0,$$

$$\text{or } V_0\left(\frac{1}{F}+\frac{1}{G}\right)+\frac{E_1}{r_1}+\frac{E_2+E_1}{r_2}=0. \qquad (8)$$

From these two equations we get

$$(V_2-V_0)\left(\frac{1}{F}+\frac{1}{G}\right)-\frac{E_2+E_1}{F}=0,$$

$$\text{whence } F = G\,\frac{E_2+E_1-(V_2-V_0)}{V_2-V_0} = E, \text{ or if } E_2 = E_1 \qquad (9)$$

$$F = G\,\frac{2\,E-(V_2-V_0)}{V_2-V_0}.$$

It must again be noted that as the potential V_0 of C is negative, $V_2 - V_0$ is equal to the sum of the voltmeter readings, if these latter are used without regard to the direction of the current through the instrument.

From these equations it is not possible to determine the separate values of r_2, r_1 and r_0; but if the values of E_2 and E_1 can be varied, we can get two equations containing only two of the three unknown quantities. This method was first suggested to the author by Prof. Rousseau, of the Brussels University; the test being made at the time of minimum output by first making the ratio, $\frac{E_1}{E_2} = K$, as large as possible, and then repeating the measurements, after having changed the pressures so that $\frac{e_1}{e_2} = k$ is as small as possible. From the first set of measurements we can determine the value of F, as shown above, and we also get equation (7), which can be written

$$\frac{V_2}{E_2}\left(\frac{1}{F}+\frac{1}{G}\right)=\frac{1}{r_1}+\frac{1+K}{r_0}. \qquad (10)$$

If now we change the pressures between the conductors and measure e_2, e_1 and v_2, we have

$$\frac{v_2}{e_2}\left(\frac{1}{F}+\frac{1}{G}\right)=\frac{1}{r_1}+\frac{1+k}{r_0}. \qquad (11)$$

Subtracting (11) from (10) we have

$$\left(\frac{V_2}{E_2}-\frac{v_2}{e_2}\right)\left(\frac{1}{F}+\frac{1}{G}\right)=\frac{K-k}{r_0}$$

or $r_0=\dfrac{E_2\,e_2\,(K-k)}{(e_2\,V_2-E_2\,v_2)\left(\frac{1}{F}+\frac{1}{G}\right)}$. By substituting this value of r_0 in equation (10) we can get the value of r_1; and r_2 can then be calculated from $\frac{1}{r_2}=\frac{1}{F}-\frac{1}{r_1}-\frac{1}{r_0}$.

If it is not convenient to vary the values of E_2 and E_1, it is still possible to determine the minimum values which any of the three resistances can have, and also the maximum leakage current to earth.

We know from (7) and (8) that

$$V_2\left(\frac{1}{F}+\frac{1}{G}\right)=\frac{E_2}{r_1}+\frac{E_2+E_1}{r_0}$$

and

$$-V_0\left(\frac{1}{F}+\frac{1}{G}\right)=\frac{E_1}{r_1}+\frac{E_2+E_1}{r_2}$$

From these equations we see that r_2 and r_0 will have their minimum values when $\frac{E_1}{r_1}$ and $\frac{E_2}{r_1}=0$, *i.e.*, when $r_1=\infty$; and, similarly, r_1 will be a minimum when either r_0 or r_2 is infinite. We, therefore, get the following values:—

$$r_2\text{ min.}=\frac{E_2+E_1}{-V_0\left(\frac{1}{F}+\frac{1}{G}\right)}=\frac{F\,(V_2-V_0)}{-V_0}=\frac{G\,\{E_2+E_1-(V_2-V_0)\}}{-V_0}$$

$$r_1\text{ min.}=\frac{E_2}{V_2\left(\frac{1}{F}+\frac{1}{G}\right)}=\frac{E_2\,F\,(V_2-V_0)}{V_2\,(E_2+E_1)}=\frac{G\,E_2\,\{E_2+E_1-(V_2-V_0)\}}{V_2\,(E_2+E_1)}$$

$$\text{or}\quad=\frac{E_1}{-V_0\left(\frac{1}{F}+\frac{1}{G}\right)}=\frac{E_1\,F\,(V_2-V_0)}{-V_0\,(E_2+E_1)}=\frac{G\,E_1\,\{E_2+E_1-(V_2-V_0)\}}{-V_0\,(E_2+E_1)}$$

according to whether V_2 is numerically smaller or greater than V_0,

$$r_0\text{ min.}=\frac{E_2+E_1}{V_2\left(\frac{1}{F}+\frac{1}{G}\right)}=\frac{F\,(V_2-V_0)}{V_2}=\frac{G\,\{E_2+E_1-(V_2-V_0)\}}{V_2}$$

The maximum leakage current to earth will occur when r_2 or r_0 is a minimum, that is, when $r_1=\infty$ and is equal to

$$\frac{E_2+E_1}{r_2+r_0}=\frac{E_2+E_1}{F\,(V_2-V_0)\left(\frac{1}{V_2}-\frac{1}{V_0}\right)}=\frac{-V_2\,V_0\,(E_2+E_1)}{F\,(V_2-V_0)^2}$$

If an electrostatic or high resistance voltmeter is employed to make the test, one conductor, say A, is first connected to earth through the voltmeter, and the reading, V, is noted; and then the shunt, S, is also connected between A and the earth, and the reading, V′ is noted. We then have

$$\frac{V}{r_2}+\frac{V-E_2}{r_1}+\frac{V-(E_2+E_1)}{r_0}=0,\text{ or }\frac{V}{F}-\frac{E_2}{r_1}-\frac{E_2+E_1}{r_0}=0 \qquad (12)$$

and

$$\frac{V'}{S}+\frac{V'}{r_2}+\frac{V'-E_2}{r_1}+\frac{V'-(E_2+E_1)}{r_0}=0,$$

or

$$\frac{V'}{F}+\frac{V'}{S}-\frac{E_2}{r_1}-\frac{E_2+E_1}{r_0}=0; \qquad (13)$$

whence

$$\frac{V-V'}{F}-\frac{V'}{S}=0,\text{ or }F=\frac{S\,(V-V')}{V'}. \qquad (14)$$

By assigning, as before, different values to the ratio $\frac{E_1}{E_2}$, the values of r_2, r_1, and r_0 can be calculated, since we get

$$\frac{V}{F\,E_2}=\frac{1}{r_1}+\frac{1+K}{r_0}\text{ and }\frac{v}{F\,e_2}=\frac{1}{r_1}+\frac{1+k}{r_0},$$

whence

$$\frac{1}{F}\left(\frac{V}{E_2}-\frac{v}{e_2}\right)=\frac{K-k}{r_0}\text{ or }r_0=\frac{F\,E_2\,e_2\,(K-k)}{e_2\,V-E_2\,v}.$$

When the values of E_2 and E_1 cannot be varied the minimum values of r_2, r_1, and r_0, and the maximum leakage current can be calculated as follows:—We have from (12) and (14)

$$\frac{E_2}{r_1}+\frac{E_2+E_1}{r_0}=\frac{V}{F}=\frac{V\,V'}{S\,(V-V')},$$

from which we see that

$$r_0\text{ min.}=\frac{(E_2+E_1)\,(V-V')\,S}{V\,V'}\text{ when }r_1=\infty,$$

and

$$r_1\text{ min.}=\frac{E_2\,(V-V')\,S}{V\,V'}\text{ when }r_0=\infty.$$

The equation (12) may also be written

$$\frac{E_1}{r_1}+\frac{E_2+E_1}{r_2}=\frac{E_2+E_1-V}{F}=\frac{V'\,(E_2+E_1-V)}{S\,(V-V')}$$

from which we see that

$$r_2\text{ min.}=\frac{(E_2+E_1)\,(V-V')\,S}{V'\,(E_2+E_1-V)}\text{ when }r_1=\infty,$$

and

$$r_1\text{ min.}=\frac{E_1\,(V-V')\,S}{V'\,(E_2+E_1-V)}\text{ when }r_2=\infty.$$

The maximum leakage current to earth will occur when r_2 and r_0 have their minimum values and $r_1=\infty$, so that

$$e=\frac{E_2+E_1}{r_2+r_0}=\frac{V\,V'\,(E_2+E_1-V)}{(E_2+E_1)\,(V-V')\,S}.$$

Either of the voltmeter methods described above can, as we have indicated, be made to give very valuable information concerning the condition of the mains; and as the tests require very little apparatus and are easily and rapidly made, it is somewhat surprising that so few central stations should be provided with fault measuring instruments as part of the ordinary switchboard equipment. The author has found the high resistance voltmeter method the more convenient in practice, and has used it in conjunction with a high resistance registering voltmeter permanently connected between one main and earth: the continuous record of the variations of earth potential coupled with the results of periodic measurements of V and V′, forming a fairly complete record of the condition of the mains.

The fault resistances measured by the above methods are those of the complete circuit, including dynamos, batteries, mains, and house circuits; and if it is desired to measure the resistance of a part of the circuit, it is necessary to isolate that part from the remainder and measure its fault resistance in some other way. This may be done with a portable testing set and battery or magneto, but by a slight modification of method, the fault resistance of a house circuit, or of any section of the circuit that can be isolated for a minute or two from the remainder, can be measured by the voltmeter using the street mains to supply the testing pressure, and thus doing away with the necessity for a special testing set and battery or magneto.

In fig. 3 let A and B be the conductors of a two-wire main, having a difference of potential, E, between them; and

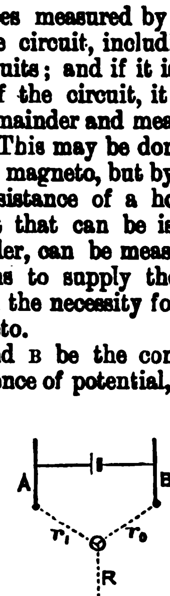


FIG. 3.

let D be a terminal, to which are connected the conductors of the house circuit or other section of the mains whose fault resistance R is to be measured, it being understood that the section under test is disconnected entirely from the live mains. Using the same notation as before, we have, when the voltmeter is connected between A and O, from equation (1)

$$\frac{E}{r_0}=\frac{V_1\,(F+G)}{F\,G},$$

and when connected between A and D,

$$\frac{E}{r_0}=v_1\left(\frac{1}{F}+\frac{1}{G+R}\right)=v_1\left\{\frac{F+G+R}{F\,(G+R)}\right\}=v\left(\frac{F+G+R}{F\,G}\right)$$

if v is the voltmeter reading and v_1 the potential of A under these last conditions. From these equations we get

$$V_1 (F+G) = v (F+G+R) \text{ or } R = \frac{(V_1 - v)(F+G)}{v} = \frac{(V_1 - v) G E}{v (V_1 - V_0)}$$

If an electrostatic or high resistance voltmeter is employed, A and D are connected by a resistance S, and the potential differences V between A and O, and V′ between A and D, are measured, then

$$\frac{V}{S+R} = \frac{V'}{S} \text{ or } R = \frac{S(V - V')}{V'}.$$

In this latter case the same result is obtained if the mains are on the three-wire system, and in the former case we have from (7)

$$\frac{E_2}{r_1} + \frac{E_2 + E_1}{r_0} = \frac{V_2 (F+G)}{F G},$$

and

$$\frac{E_2}{r_1} + \frac{E_2 + E_1}{r_0} = v_2 \left\{ \frac{F+G+R}{F(G+R)} \right\} = v \left(\frac{F+G+R}{F G} \right)$$

from which we get

$$R = \frac{(V_2 - v)(F+G)}{v} = \frac{G (F_2 + F_1)(V_2 - v)}{v (V_2 - V_0)}.$$

For this test also the high resistance voltmeter will generally be found more convenient, especially if fitted with two or three shunts, so that the value of S may be varied so as to get convenient readings. As any circuit or section of a circuit can be tested by disconnecting it for a few minutes from the live mains, this test can be employed to localise a fault, the existence of which has been indicated by the test of the complete circuit. For instance, in the case of a house circuit, each circuit leaving the distribution board can be disconnected and tested in turn, and the faulty circuit so found may be further divided up by removing the branch fuses. In a similar manner sections of a network of underground mains can be tested with very little inconvenience to customers, as each section is only disconnected for long enough to take two readings of the voltmeter.

PRESENTATION TO MR. F. H. WEBB.

It is not often that one is called upon to attend so pleasant a function as that which took place at the Whitehall Rooms on Monday evening. Still rarer is it to find an electrical gathering imbued with so marked an unanimity and with so conspicuous a desire to do distinguished honour to one associated with electrical engineering. The occasion was the presentation to Mr. F. H. Webb, the retiring secretary of the Institution of Electrical Engineers.

There was a geniality suffused over the whole proceedings, which may have been partly due to the event and partly to the presence of many fair women. There were many distinguished members of the Institution present, among them Sir Henry Mance, Mr. J. W. Swan, Sir William Crookes, Prof. Hughes, Major-General Webber, Mr. H. Edmunds, and Mr. E. Manville.

The proceedings were commenced by many of the subscribers dining together, with Mr. and Mrs. Webb as guests. Subsequently a reception was held, and shortly after 10 o'clock we proceeded to the real business of the evening.

Sir Henry Mance, as chairman of the Executive Committee of the Testimonial Fund, called upon the honorary secretary of the fund, Mr. H. Edmunds, to give a short account of the initiation of the testimonial. In setting forth the details of the scheme to present a testimonial to Mr. Webb, in recognition of his long and successful service in the interests of the Institution of Electrical Engineers, Mr. Edmunds pointed out the wide interest that had been taken in the proposal, and that it had received the support of members of the Institution in all parts of the world. They had practically received £750 as subscriptions, and in accordance with the wishes of Mr. Webb, it was proposed to invest this sum in the names of two trustees, Mr. Manville and himself. An illuminated address, having the signatures of the 1,000 contributors, was then referred to by Mr. Edmunds, the text of which is as follows:—

ADDRESS TO MR. FRANCIS HUGHES WEBB,

Secretary Institution of Electrical Engineers, 1878—1898.

February, 1898.

Dear Mr. Webb,—Upon the occasion of your retirement from the secretaryship of the Institution of Electrical Engineers, we, the undersigned members, foreign members, associates, and students of the Institution, desire to give expression to the deep sense that we entertain of personal and corporate indebtedness to you.

For 20 years you have devoted the whole of your untiring energy to that office with a single mind to the interests of the Institution; and the increase in the number of members during these years, from 800 to nearly 3,000, coupled with the soundness of the financial position to which the Institution has attained in the same period, sufficiently attest the value and the success of your labours.

In conducting the work of the office, your uniform and unfailing courtesy, tact, sympathy and kindliness, have endeared you to all with whom you have been brought in contact. And now, in presenting you with this address, together with a sum of money amounting to upwards of £600, and a diamond brooch, which we beg Mrs. Webb to accept as a token of our esteem, we earnestly hope that for many years you may be spared with her to enjoy the rest that you have earned so well, and we trust that the Institution may long be permitted to have the benefit of your experience, which has proved so valuable to it in the past.

We beg also that you will regard the autograph signatures in this album as those of true and sincere friends.

We are, dear Mr. Webb,

On behalf of the subscribers,

SIGNED BY THE MEMBERS OF THE EXECUTIVE COMMITTEE.

Major-General Webber, as one of the founders of the Institution, then spoke in eulogistic terms of the long services rendered by Mr. Webb. He had joined the Institution at a time when, as the Telegraph Society of Engineers, the number of members did not exceed 200 or 300, and when the society had not been commercially successful. The speaker briefly referred to the fact that Mr. Webb, even before he joined the Institution, had been connected with several branches of engineering. He concluded by making an eloquent tribute to the manner in which Mr. Webb had conducted the affairs of the Institution.

Then Sir Henry rose to make the presentation, and in doing so, referred to the fact that Mr. Webb had served under 19 different presidents. On all occasions he had been ever ready to listen to suggestions, whether from the council, from members, associates, or students. The chairman then handed to Mr. Webb a silver box containing a cheque, and the album containing the illuminated address and the signatures of the subscribers. In doing so, he wished the recipient many years of life to enjoy the rest he had so richly deserved.

The chairman then presented a handsome diamond brooch to Mrs. Webb.

Mr. Webb, who, upon rising to respond, was received with loud applause, referred to the difficulties of his position. He had been overwhelmed with kindness, and it was impossible for him to properly express his feelings. Speaking of his long connection with the Institution, Mr. Webb said when he accepted the secretaryship he did so with the knowledge that he was really going among friends, for many of the members of the Institution were known to him previously. He thanked the members of the committee and the members of the Institution generally for what they had done. He appreciated the honour more than he could say, and his sons abroad—and he had one in India, one in America, and one in Australia—would be proud to know of the honour done to him.

The proceedings were terminated by a vote of thanks to the executive committee.

At the conclusion of the ceremony, there was a wish expressed that arrangements might be made for the collection of a second volume of autograph signatures of members, associates, and students of the Institution, as it was felt that there must be, among the 2,000 members whose autographs were not included, many who would regret that they had lost the opportunity of expressing their sympathy with the movement. We understand that Mr. Edmunds, as honorary secretary to the Testimonial Fund, will be most happy to receive any further signatures and subscriptions that may be sent hereafter to his office, 39, Victoria Street, S.W. Both autographs and subscriptions will be handed to Mr. Webb, and the total amount received will, from time to time, be announced in the Technical Press.

CORRESPONDENCE.

Shoreditch Dust Destructors.

In view of the very kind reception accorded to me on two occasions at the Shoreditch works by Mr. H. E. Kershaw, the chairman of the Electric Lighting Committee, and by Mr. C. Newton Russell, the chief electrical engineer, I greatly regret that I should have felt compelled to offer any adverse criticism to the plan of combining dust destruction with electricity works as exemplified there.

That I am impressed with the advantages arising from the conversion into electrical energy of the heat generated in dust cremation is sufficiently evidenced by the fact that I am at present designing three such schemes.

When, however, under cross-examination on the subject by the members of the Gloucester Town Council, I felt bound to place among the *contras* the inconvenience arising from the entry of dust into the electricity works.

Hot bearings and scored commutators are very unpleasant incidents, and the visits to the Shoreditch works confirmed my opinion that in order to avoid them in combined works, extra vigilance, and, possibly, extra expenditure on cleaners, would be necessary.

Your condensed report of my hour's interview with the Gloucester Town Council is, in the main, most accurate, but one or two remarks are without their context, and I venture to supply in italics below the omitted and qualifying words.

"Personally he would rather not have the dust destructor next door to his electricity works, for the one reason that the dirt and dust made it more difficult to carry the electricity works on with a dust destructor in the immediate vicinity. Besides, they could not keep the machinery and building so smart and tidy as they could if the dust destructor was half-a-mile away. . . . . At Shoreditch the dust considerably interfered with the machinery. The works there were ill-designed *for keeping out the dust*, and if he were asked to draw up a scheme of combination he should take care that the dust destructor portion was entirely closed up from the electricity works, instead of being connected by windows and doors as at Shoreditch. . . . . he would rather not run the risk of having his smart machinery interfered with, but still he believed those difficulties might be got over, and the saving undoubtedly would be what had been stated. Mr. C. G. Clark asked if there was any possibility of the dust interfering or damaging the machinery providing the works were properly constructed . . . . the nearest approach to the works not being interfered with was at Cheltenham. There the destructor was separated from the electricity works by a promenade. They had plenty of room there, more than they wanted to take in Gloucester. He knew of no place where a certain amount of dust did not come in. When he recommended the combination he had, of course, considered the pros and cons, and if they had it they must put up with the disadvantage of some amount of dust, and that would require greater care in cleaning the machinery, because there was nothing so dangerous to electric plant as dust. At Shoreditch, *on the occasion of his two visits*, some of the machinery was disabled from that cause, but as to whether he could keep it out he would be able to tell them better when he had erected the Gloucester works."

I now learn from the two gentlemen best qualified to judge that I was mistaken in supposing that the motors driving the fans to which I referred had been disabled through the dust, and I must express my regret that I made a false inference; but when I noticed that first one and then another was dismantled, I could attribute the cause to none other than "dust," of the presence of which in the electricity works there was other evidence, rather than suppose that the plant had failed from any but extraneous causes within a few months of completion.

Robert Hammond.

The Yarrow Home.

You were kind enough in your issue of May 15th, 1896, to publish a description of the Yarrow Home for Convalescent Children at Broadstairs.

I have the pleasure to report that since the opening of this institution a little over 2 years ago, no less a number than 1,299 children have been benefitted by a stay there. It will be remembered that the Home is fully endowed and no subscriptions are required, also that it is not intended for the very poor, but for children who have been well brought up and whose parents cannot afford to send them to the seaside entirely at their own expense.

During the summer months the applications for admission are far in excess of the capabilities of the Home, but in the winter it is only partly filled, and the trustees are most anxious to maintain its utility equally throughout the year. There is little doubt that the falling off in applications during the winter may arise from the fact that the Home is thought not to be a very desirable resort during the inclement part of the year, but such is not the case. The building is thoroughly warmed and ventilated, a healthy temperature being maintained throughout; and there are play corridors within and playgrounds without.

The grounds are planted and well sheltered, and there are but very few days in the year when children cannot enjoy the fresh air even when the weather debars them from going to the sea front.

T. Fredk. Myers,
Secretary of the Yarrow Home.

73A, Queen Victoria Street, E.C.

A Protest.

I notice in your issue of February 18th, an advertisement for a shift engineer, at the princely salary of £50 a year. It certainly appears to me that the unfortunate shift engineer of the future will not only be held responsible for the working of £10,000 worth of machinery for eight hours every day, but will also be expected to "tip the chief engineer" for being allowed to do it. No doubt Mr. Boot is very proud of that passage in his report which runs: "Tunbridge Wells is the only station working on the high tension system which has not made a call upon the ratepayers in the first completed year's working." It seems probable to me that the staff were called upon instead of the ratepayers. Possibly the air of Tunbridge Wells is so invigorating that shift engineers require no dinner; or, perhaps, as it is near springtime, the happy successful candidate will lightly turn his thoughts to love—and live on that. Is it not time that, in these days of successful stations, junior electrical engineers should receive a fair day's pay for a fair day's work? Mr. Boot is evidently more successful in drawing up high-sounding reports than in learning what constitutes a "living wage." My hearty sympathies are with the successful candidate.

Disgusted.

I note in your issue of the 18th that a *shift engineer* is required at Tunbridge Wells at the enormous *salary of £50 per year*, but the applicants must have had experience of high tension working.

It is, I think, an enormity that the managers of an undertaking such as Tunbridge Wells should make such an offer. The results of last year's working show a net surplus of £887, and yet this Corporation thinks that £50 a year is sufficient salary for an experienced man in such an expensive place as Tunbridge Wells. There is no excuse of poverty or a station on which losses are being made, and I think that a stand should be made against such barefaced offers. The pity of the whole business is that they will get a man (?) at the price, and I can only hope that he will give them no more than value for their money.

Some months ago I answered a private notice at the Technical College, Finsbury, for an engineer experienced in high tension work to take charge of the running, and be responsible to the chief engineer for the satisfactory working of the plant at this station. Everything went on very well until the question of salary was reached. I ventured to hint that say 35s. a week, with a good prospect of a rise would meet the case, and received in reply a *post card* from the chief engineer, if you please, stating that they could not think of paying as much as that. I afterwards heard that they had two assistants fresh from a technical college, whom they were paying *nothing*. No wonder that the station shows such good results. I believe I could make a high tension station pay if I received labour and material gratis. But, seriously, is £50 per annum sufficient for an experienced man who has to work through the night, and has such heavy responsibility on his shoulders?

I would venture to suggest that you should refuse all such advertisements in future, and by so doing you will help to break this ring of low prices, which are less than a road-scraper can obtain from the parish.

W. Fennell.

8, Ferndale Road, Leytonstone.

NOTES.

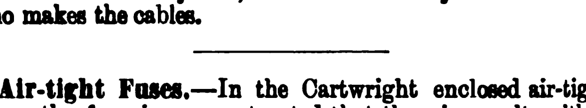
Improvements in Storage Batteries.—By means of certain improvements in battery plates, a new cell has been completed by Mr. Rankin Kennedy, which gives, we are informed, a very much greater output per pound weight than is usual. This cell has been under experiment for two years, and the object of the improvements have been to do away with the heavy grid used in battery plates, so as to render the whole of the active materials useful. Recent tests by Dr. William Peddie, D.Sc., F.R.S.E., Physical Laboratory, Edinburgh (whose figures, by the way, we should like to see for ourselves), result in the conclusion that the capacity of the new cell is 13 watt hours per pound of battery, and 32·8 watt hours per pound of positives at normal rates of discharge. The active material is not in the form of plugs, which are always liable to fall out or loosen; it is held securely in contact with conductors ramified throughout the mass. Careful tests have been made up to discharge rates equal to five amperes per pound of positives, without the least signs of buckling. The new cell will be shortly put in the market in two types, one for traction purposes, and the other for stationary wants. We hope Mr. Kennedy's battery will turn out as well commercially as it looks on paper, and if the long years of experience and knowledge of what to avoid go for anything, we anticipate that a real advance in accumulators has been made.

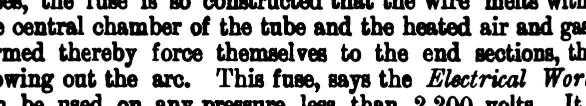
Advice to Boiler Attendants.—We are in receipt of a new issue of advice to boiler attendants, issued by the Manchester Steam Users' Association, over the signature of their new chief engineer, Mr. Chas. E. Stromeyer. In the sheets at one time issued, it was stated that the best advice the Association could give in regard to the occurrence of low water was "not to let it occur," which reminds one of *Punch's* advice to those about to marry; but there was always some, if an unconscious humour, about the Manchester Steam Users' Association, and the strain remains to-day. After a few remarks on what to do with collapsed furnaces and bare crowns, it is naively stated that, in face of these dangers, the boiler attendant may prefer to retire. Among the warnings is one to ease the safety valve before opening the manhole cover, so as to be quite sure there is no steam in the boiler. This advice is dangerous, being insufficient. Easing a safety valve is understood to imply lifting, and, perhaps, propping the lever, but the valve itself ought to be lifted; it is often heavy enough to confine steam in a hot boiler quite sufficient to lift the unbolted manhole cover and rush out in a scalding torrent. We have seen it happen.

High Speed Sentinel Steam Engines.—Messrs. Alley and Maclellan, of Glasgow, have forwarded us a copy of their new steam engine catalogue. In it are particulars of the firm's make of Westinghouse type, simple and compound engines. There are now 6,000 simple engines at work—an encouragement to the firm to build compound engines on similar lines up to 250 H.P. They have now some 12,000 H.P. of compound engines at work. The catalogue is well arranged, and the engines it describes are all shown diagrammatically, with all leading dimensions tabulated. Copies of indicator diagrams are given; these show good adjustment. All engines are made strictly to gauge and interchangeable throughout.

Dublin Cables.—In connection with the "scare" in rubber cables to which we referred in our last issue, it will be interesting to review the reported facts in connection with the underground mains in Dublin. After a number of years working without trouble, the arc light mains broke down in several places, this cable, we are informed, being small and unsuitable, apparently, for the mechanical strains it was called upon to bear from time to time. Extensions were contemplated, and the two matters were dealt with together, the Board of Trade being asked to hold an inquiry on a loan for "renewals of cable," the superintendent reporting that a complete renewal was absolutely necessary, and Prof. Kennedy, F.R.S., whose advice was sought, acting on the report of the superintendent, and, no doubt, on his appreciation of other reports on similar cables, agreeing that a complete renewal was a matter of necessity. When the Board of Trade inquiry was held it was ascertained that the money was not required for renewals of cable, but for extensions. The title of the demand was no doubt based on the theory that it would have been easier to get the loan for renewals as being pressing than for extensions, and, during the course of the inquiry, the superintendent is reported to have said that, although the cables had failed here and there, the real loss on the old cables would only be £1,300 out of the £20,000 applied for, as they wished to take out some of the old cables to enable them to change the "system." On being pressed, he admitted that an expenditure of £500 would restore the faulty cable, and they could be used again. It is difficult from the reports to reconcile these different statements, and Mr. Thompson, T.C., apparently could not, as in his examination he stated that the whole cables had been condemned by the Council, and there was never a word said about mere repair. Surely some more light should be thrown on this matter, since it would appear from the facts before us that the report of the superintendent on which Prof. Kennedy, in part, at least, would naturally rely, was not made at all in accordance with the evidence he finally gave when the question of renewals became for other reasons, no doubt, subordinated to that of extensions. The only explanation we can suggest at present is, that it was the "system," and not the type of cable, that was condemned. Still, as reported in the electrical press, the cables were stated to be in fault, possibly because the engineers who make technical reports select the system, whereas it is only the contractor who makes the cables.

Air-tight Fuses.—In the Cartwright enclosed air-tight fuses, the fuse is so constructed that the wire melts within the central chamber of the tube and the heated air and gases formed thereby force themselves to the end sections, thus blowing out the arc. This fuse, says the *Electrical World*, can be used on any pressure less than 2,200 volts. It is stated that it will not maintain an arc between its terminals when short-circuited on the mains of a 2,200-volt composite alternating dynamo. The cut-out consists of two parts, namely, the base and tube. The base is made of the best quality of Monson slate, and the tube is made of black or grey





fibre. Owing to the peculiar construction of this device, the fuse in a 3-inch tube will, it is stated, open the circuit, where other cut-outs require twice that length of fuse to operate under the same condition. This fuse has a definite length, cannot come in contact with any foreign substances, and will open the circuit in a pre-determined time on a given current. After a fuse has blown it is replaced by a new tube. Each fuse is marked with the maximum number of amperes it will carry indefinitely. These fuses are manufactured by the Shawmut Fuse Wire Company, of Boston, Mass., under license from the Goodhart Electric Company.

The Electric Migration of Colloids.—A little time ago some researches were initiated by Cöhn with a view to throwing some light upon the subject of electric migration, especially of colloids. In the first stage of the research the conclusion was arrived at that coloured ions exist, because coloured fluid follows the direction of the current during electrolysis. Nernst has also studied this subject, and our readers are familiar with most of his work. They may remember an experiment which he described in which, during the electrolysis of permanganate of potash, the MnO_4 ions moved towards the anode, and it is generally recognised now that a substance which is free to move will move in or against the direction of the current if it be electrically charged. Fine suspended solid particles, suspended in water or in turpentine, will, by reason of the static charges which they bear, move towards the oppositely charged electrode, whilst the liquid particles move towards the other electrode. More recently Cöhn, working in conjunction with Euler, found that such substances as caramel, starch and tannin, which are colloidal in character, and non-electrolytes, behave in a manner exactly similar to the behaviour of the solid particles suspended in water or turpentine; they actually move in the water towards the anode. Of course this fact has already been noticed in the case of tannin, and is the foundation of the process of electric tannin. Cöhn has also investigated the behaviour of colloids in which electrolytic dissociation might possibly take place, for example, in dialysed ferric hydroxide. The hydroxide was first purified by means of electrolysis with a silver anode, and was then submitted to a current between two layers of water. It was then observed that a dark layer moved towards the anode, whilst a lighter coloured layer moved towards the cathode. Now the layer would not pass through a parchment membrane, and hence could not contain iron ions. These observations are exceedingly interesting, inasmuch as they throw light upon a subject which is very obscure, and concerning which information is really demanded. We are glad to hear that the subject is being more fully investigated, and shall look forward to further results. The present research is described in the *Zeitschrift für Elektrochemie*, No. 4, pages 63—66.

Manufacturing Aluminium and its Sulphides.—An interesting application of electrolysis to the manufacture of aluminium, sulphide of aluminium, &c., has recently been successfully carried out by D. A. Peniakoff at Huy, in Belgium. The essential features of the process are as follows:—A single or double anhydrous aluminium salt, such as a fluoride or chloride, fused with the sulphide of an alkali or alkaline earth, together with a chloride or fluoride as a flux, yields a mixture containing aluminium sulphide, from which, in the same crucible, aluminium may be reduced, either by the action of an electric current, or by means of reducing gases (such as hyrocarbons, for example). The following formulæ present examples of the preparation of aluminium sulphide:—

(1) $Al_2 F_6 + 3 Na_2 S = Al_2 S_3 + 6 Na F.$

(2) $Al_2 F_6, 6 Na F + 3 Na_2 S = Al_2 S_3 + 12 Na F.$

(3) $Al_2 Cl_6, 6 Na Cl + 3 Na_2 S = Al_2 S_3 + 12 Na Cl.$

When the bath is constituted according to the reactions (1) or (2), if aluminium be reduced from the fused mass, the supply of aluminium sulphide is kept up by additions of aluminium sulphate and carbon; aluminium fluoride and sodium sulphate are first formed, according to the equation $Al_2 3 SO_4 + 6 Na F = Al_2 F_6 + 3 Na_2 SO_4$, and the sodium sulphate is reduced to sulphide by the carbon, with subsequent production of aluminium sulphide, according to equations (1) and (2). It is stated that even where the sulphide of aluminium produced in the bath is subjected to electrolysis, the sulphide alone may undergo the electrolytic action, and not the fluoride, as the latter requires for its electrolytic decomposition a far greater electromotive force than that which suffices to bring about the decomposition of the sulphide of aluminium. Besides, where electrolysis is resorted to, the sulphur separated from the aluminium serves, for the most part, to reduce the alkaline sulphate to the condition of alkaline sulphide, thus adding its effect to the action of the carbon.

(*Continued on page* 268.)

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending Feb. 22nd, 1897.	£	s.
Alexandria	122	0
Amsterdam	45	0
Antwerp. Teleg. mat...	30	0
Auckland	80	0
Bangkok. Teleg. mat...	90	0
Bilbao	170	0
Bombay...	139	0
Brisbane	72	0
Buenos Ayres. Teleg. mat.	76	0
Calcutta	300	0
Cape Town	484	0
Copenhagen. Teleg. wire	10	0
Durban. Teleg. mat. ...	151	0
East London	493	0
Gibraltar. Teleg. mat...	650	0
Gothenburg	26	0
Hamburg. Teleg. mat.	290	0
Hong Kong	247	0
Madras	71	0
Madeira...	97	0
Malta	101	0
Passages	831	0
Port Elizabeth	109	0
Rangoon. Teleg. mat ..	20	0
Rosario	50	0
Rio Janeiro. Teleg. mat.	350	0
Singapore ...	37	0
„ Teleg. mat. ..	15	0
Sydney	1,246	0
Vera Cruz	60	0
Yokohama	361	0
Total	£6,863	0

Week Ending Feb. 22nd, 1898.	£	s.
Albany	42	0
Amsterdam	84	0
Barcelona	10	0
Bombay...	70	0
Buenos Ayres	130	0
Calcutta...	74	0
Cape Town	183	0
Durban	126	0
East London	81	0
„ Teleg. mat.	2,747	0
Flushing	227	0
Fremantle	1,325	0
Gothenburg. Teleg. mat.	216	0
„ Teleph. mat.	875	0
Malaga	158	0
Monte Video	30	0
North Sea	5,843	0
Perth	320	0
Port Elizabeth	764	0
„ „ Teleg. mat.	421	0
Rangoon	1,575	0
Rosario	55	0
„ Teleg. mat. ...	61	0
Rotterdam	240	0
Singapore	45	0
Sydney	99	0
Trieste. Teleg. cable ...	2,050	0
Tahiti	6,000	0
Yokohama	10	0
Zanzibar. Teleg. cable	24,480	0
Total	£48,341	0

Bankruptcy Proceedings.—The first meeting was held last week at the London Bankruptcy Court of the creditors of John Dewhurst, electrician and sanitary engineer, 52, North End Road, S.W. The debtor, who presented his own petition, commenced business nine years ago at North Kensington, and removed about 1893 to his present premises. He attributes his insolvency to a loss of £250 sustained through the defalcations and misconduct of a former traveller. The accounts show unsecured debts £315 9s 10d, and assets £121 5s. 8d. An offer of 6s. 8d. in the £ was made to the creditors recently, but it was not unanimously accepted, and the debtor subsequently petitioned the Bankruptcy Court. No offer was now submitted, and the creditors left the estate in the hands of the official receiver to be wound up in the usual manner.

Dissolutions of Partnerships.—Messrs. F. Woolnough and H. A. Procter (Woolnough & Procter, electrical engineers, Surrey Grove, Norwich) have dissolved partnership. Mr. Procter will attend to debts.

Messrs. W. T. Burbey and H. A. Hutton (Burbey & Hutton, electrical engineers and manufacturers, 57B, Hatton Garden, E.C.) have dissolved partnership. Mr. Burbey will attend to debts.

Messrs. A. J. Fippard and C. J. Cooper (Fippard & Cooper, electrical engineers, Albert Road, Bournemouth), have dissolved partnership. Mr. Cooper will continue the business, and attend to debts.

Liquidation Notice.—A meeting of the Universal Electrical Fittings Company will be held at the office of Messrs. G. Franklin & Co., 18, Norfolk Row, Sheffield, on March 28th, at noon, to hear an account of the winding up from Mr. G. S. Greening, the liquidator.

Condensing Plants.—Messrs. Cole, Marchent & Morley, of Bradford, have issued a small pamphlet describing their standard surface condensing plants, with pumps driven by steam, electromotors, or belt. In cases where the space for the storage of water is limited the condensing plants are combined with evaporative condensers or water-cooling arrangements. There are several good illustrations of plant supplied by the firm, such as Bradford Corporation Electricity Works electrically driven centrifugal pumps, and the surface condenser and air pumps at the same station. An article by Mr. H. W. Morley on "Surface Condensers, Air and Circulating Pumps for Electricity Works," is reprinted from a contemporary. The list is a neat production.

A Directory for Exporters.—The Export Merchant Shippers' Directory for 1898, has been published by Messrs. Dean and Co., of 160A, Fleet Street, E.C. It has now reached its thirty-third year of publication, and has increased in size, until it now has nearly 1,300 pages. The contents are divided into three sections, viz., the Export Section, giving a complete list of the British exporters, with the names of their respective trading ports, and the class of goods shipped; the Trade Mark Section; and the Manufacturing Section embodying a list of traders who manufacture principally for export. There are separate sections for the various towns, Liverpool, Bradford, London, and so forth, and under these the names of exporters are given in alphabetical order. The extracts from the consular reports given under the title, "Notes on Trade," has been enlarged in the present edition by the insertion of some of the principle South American Republics, where the competition with British trade is especially keen.

Electric Drill.—On 17th inst. trials of a new electric drill were made on board the White Star steamer, *Nomadic*, at Liverpool. The Boiler Makers' Society lodged objections to its employment.

Electric Organs.—From the *Musical News* we learn that the Hope-Jones Organ Company has received an order for a large organ for St. Michael's Church, Chester Square. The instrument is the gift of a member of the congregation, and is to cost over £2,000. It will be fitted with all Mr. Hope-Jones's latest tonal and mechanical improvements. A new electric organ has also been ordered from the same firm for Ambleside Parish Church, at a cost of £1,000.

Electric Welding.—At a conversazione held at Finsbury Technical College on Friday, 18th inst., the Electric Welding Company, Limited, exhibited an automatic welding plant and a very fine collection of samples welded by their (the Thomson) process, including railway coupling links (lent by the Lancaster Railway Carriage and Waggon Company, Limited) and a complete collection of cycle parts.

Kaye v. the Croydon Tramways Company.—In the Court of Appeal on Wednesday, before the Master of the Rolls, Lord Justice Rigby and Lord Justice Vaughan Williams, the hearing was resumed of the appeal of the Croydon Tramways Company from an order of Mr. Justice Kekewich, who had granted an interim injunction restraining the carrying into effect of an agreement for the sale of the undertaking to the British Electric Traction Company. We have already referred to the case in the ELECTRICAL REVIEW. In his judgment the Master of the Rolls said that the appeal succeeded to a certain extent, and he thought the right course to adopt would be to discharge the order of Mr. Justice Kekewich, and to grant an injunction to restrain the defendant company from carrying this agreement into effect until duly sanctioned by the shareholders of the Croydon Company at a meeting duly convened for that purpose. If they chose upon proper notice, and understanding what they were about, to ratify the contract they were at liberty to do so, but it would not be right to allow this agreement to stand until that had been done. The costs of the original plaintiffs and defendants would be costs with the action, and the costs of the purchasing company would be their costs in the action. Lords Justices Rigby and Williams concurred.

Lists.—Messrs. P. C. Middleton & Co., of Aberdeen, have sent us a neat pamphlet which they are circulating, setting forth the advantages of electric over gas lighting, and giving general statements for the benefit of those contemplating the use of electric motors, electric heating and cooking apparatus, &c.

Messrs. Laing, Wharton & Down's new list of "Whardown" track tools gives illustrations and prices of track drills for drilling bolt holes, tie holes, and electric bond holes, rail saws for cutting rails quickly and accurately, and lifting jacks. These devices are being introduced for economising time and expense in track work—especially in connection with electric tramways—and at the same time considerably increasing the quality.

Messrs. Ball, Wylde & Co., of 9 and 10, Fenchurch Street, E.C., have taken up several agencies for American pumping machinery, turbines, steam and electrical machinery, &c., and have also been appointed sole agents for Great Britain by Eugen Seeligmann, of Köln a. Rh. Hansaring. We have before us a catalogue, printed in German, of the firm's manufactures in the way of electrical accessories. Prices and numerous illustrations are given of lampholders, switches, lamps, plain and fancy brackets, electroliers, insulators, casing, and a great variety of small fittings and articles.

Messrs. Handley & Shanks, electrical and general engineers, of Cork, Dublin, and Limerick, have sent us their list of electric light engines, coupled to dynamos, also gas and oil engines for electric lighting, Waverley turbines, "Taunton" dynamos, electric motors, Jandus lamp, and the improved glow lamps.

London Office.—Messrs. Henry J. Rogers & Co., of Watford, have just opened branch offices in London at 4, Bloomfield Street, London Wall, E.C. Mr. H. J. Spencer is the manager for the London district.

New Zealand Electrical Syndicate, Limited. — A petition was brought before Mr. Justice Stirling in the Lord Chancellor's Court on Wednesday for the reduction of the capital of the New Zealand Electrical Syndicate, Limited. Mr. Carson explained that the case was before his Lordship before Christmas, and was adjourned. His Lordship had expressed the wish to see some of the witnesses whom he had examined. After this he had thought proper to direct reference to an expert on certain points. It was suggested that terms might be suggested for this reference. Counsel now brought the terms before his Lordship. After counsels' speeches, his Lordship ruled that an expert electrician should be appointed as referee, and that before making his report he should hear both sides. Perhaps it would be desirable to put that direction in the order for the guidance of the referee. Counsel thanked his Lordship for his assistance in the matter, and agreed on the terms of reference of the matter to an electrical expert.

Photographic Exhibition.—The International Exhibition at the Crystal Palace, 1898, will be opened by the Prince of Wales, on Monday, April 25th—not Wednesday, April 27th.

Sell's Press Directory.—*Sell's Dictionary of the World's Press* for 1898 is before us. As usual, it is a very bulky publication, of about 1,200 pages. As the title denotes, information is given regarding the newspapers, technical journals, magazines, &c., of home and foreign countries. The newspaper man finds much of interest and utility in this directory. Not only is he informed on matters affecting national and international trade, tariffs, treaties, &c., but he has placed before him an anecdotal history of journalism, some important notes by Dr. Gordon Stables on how to keep in health, and a note of the year's events in the newspaper world. The newspaper, as an investment, and the life of the foreign correspondent, are matters which have an interest for those not connected with the journalistic profession.

Workmen's Compensation Act, 1897.—The *Western Mail*, Limited, has issued a fifth edition, revised and enlarged, of Mr. M. Roberts-Jones's handbook on the above Act. The price is 2s. 6d.

The Yorkshire College, Leeds.—The twenty-seventh annual report, 1896-7, of this college, has been issued. It gives details of the classes held and lectures given in various subjects, along with the average attendances, and notes on the financial progress.

ELECTRIC LIGHTING NOTES.

Aberdeen.—The electric lighting accounts for last year show that the income amounted to £5,707 12s. 5d., and after deducting working expenses, there was a balance of £3,111 0s. 7d. That sum had been applied—In paying interest on mortgages and loans, £1,150; in writing off as depreciation on plant, £1,024; carrying to sinking fund, £767; and leaving a surplus (carried to the reserve fund) of £169 5s. 2d.

Messrs. P. C. Middleton & Co., of Aberdeen, have been entrusted by the Town Council with the contract for the lighting of the Municipal Lodging Houses. There will be 300 lights.

Barnsley.—Mr. T. C. Miller has been instructed by the Town Council to report on electric lighting, and if such report is satisfactory, he will later design and superintend the work, subject to the approval of Mr. Bromley Holmes.

Basingstoke.—The Town Council recently referred to a special committee a suggestion to apply for electric lighting powers.

Bedford.—The electric lighting accounts just submitted show as follows:—By sale of current at 6d. per unit, less bad and doubtful debts (£12 19s. 1d.), £3,200 4s.; by sale under contracts, £13 15s. 6d.; rental of meters, £110 3s. 2d.; by public lighting to December 31st, £1,391 13s. 5d.; miscellaneous receipts, £2 8s. 11d.; total, £4,718 5s.; balance carried to net revenue account, £1,593 7s. 1d. The general balance sheet shows:—To capital receipts, £39,175 11s. 6d.; to sundry creditors, £165 2s. 8d.: to balance due to treasurer (less cash in hand, £25), £10,348 15s. 8d.; total, £49,689 9s. 10d.; by capital expenditure, £46,389 19s. 11d.; sundry debtors for current and meter rents, £1,890 19s. 11d.; net revenue account—balance at debit thereof, £1,200 4s. 6d.; stores on hand, December 31st, £208 5s. 6d. If the demand continues to increase, reductions will be made in the charges at the beginning of next year.

Brighton.—The Lighting Committee recommends that Montpelier Road and the north part of Preston Road, from Stanford Avenue to the Drive, should be lighted by arc lamps instead of incandescent, as at present, at an increased annual charge of £400.

Broughty Ferry.—The Police Commission has appointed a sub-committee to collect information *re* electric lighting.

Buxton.—Prof. Kennedy has submitted his report on electric lighting, and his estimate for the proposed municipal plant is £18,000.

Calcutta.—The Secretary of State for India recently sanctioned the appointment of an electric lighting inspector for Calcutta.

Cardiff.—The Lighting and Electrical Committee considered last week the electrical engineer's report on the condition of the cables and mains. He stated that the renewal of the cables for the arc lights, which should be carried out at once, would cost about £400. It was resolved to invite tenders for the supply of new cables.

Chester.—The minutes of the Electric Lighting Committee, which have been approved, show that a reduction to consumers of the light might be made for the current year to 5d. per unit, and for motive power to 3d. per unit.

Crieff.—The electric lighting scheme put forward by Mr. Yorke has been further remitted back to a committee of the whole Council for further consideration.

Edenbridge.—The *Kent Messenger* says that a scheme is on foot to form a company to light the district electrically. It is estimated that £2,500 is required.

Edgbaston.—St. Augustine's Church has just been fitted up for electric lighting by Messrs. Veritys, to plans and under the supervision of Messrs. Henry Lea & Son. High voltage lamps are used, and they are arranged around the capitals of the pillars.

Edinburgh.—The Electric Lighting Committee has recommended the supply of watertight chambers for the underground switching apparatus. The Committee also recommends the laying down of a new "feeder" from Dewar Place along Grove Street, and on to Merchiston (cost, £1,400).

The Embankment Lighting.—The London County Council last week adopted a supplemental estimate of £3,300 for the electric lighting of the Embankment. An estimate of £22,000 was previously adopted.

Faversham.—The Town Council will not sanction Mr. McCreel's proposal to apply for a provisional order for electric lighting, and they state that when the time comes they will do the work themselves.

Glasgow.—The Electricity Committee submitted to the Corporation last week reports from the tramways engineer, the assistant electrical engineer, and the lighting inspector on the subject of lighting the Springburn tramway route. The assistant electrical engineer recommended that the mains should be immediately laid down for supplying current for private purposes to consumers along the line of Parliamentary Road to Springburn, and in the same trench a cast-iron pipe to carry arc lighting cables. He reported that the cost of supplying and laying down the feeders and network necessary for private lighting would be about £12,566, and the arc lighting mains £1,446, making a total of £14,012. That is if both were laid at the same time; but if street lighting alone were arranged for, the cost would be £7,022, and the cost of re-opening the trench and laying mains, &c., later on for private lighting would be £9,525; total, £16,547. The first course would, therefore, show a saving of £2,535, and the corporation approved of this scheme, and the work will go forward. The arc lamps will, with a few exceptions, be suspended from the poles on both sides of the route. There will be in all 104 lamps required. Certain designs and estimates submitted by Messrs. W. McFarlane & Co. have been accepted for bases, brackets, &c. The cost for current is estimated at £18 per lamp per annum.

Grimsby.—The Council has confirmed the Lighting Committee's recommendations to ask Prof. Kennedy to report on electric lighting.

Hackney.—The Vestry, after playing with the electric lighting question for the past few years, has just considered a number of proposals submitted by parties willing to take over the provisional order. Among those who made offers were Messrs. C. & A. Sax, Imperial Electric Lighting Company, Siemens Bros. & Co., Laing, Wharton & Down, Electric Extension Syndicate, County of London and Brush Provincial Company. The Electric Light Committee, after considering the various proposals, reported that the scheme submitted by the Electric Extension Company, Limited, covered all the points which the Committee desired to see included. "They offer to collect, destroy, and dispose of the dust at 4s. per ton, to supply public and private lighting at 3½d. and 5d. per unit respectively, and for power purposes only at 2½d. per unit. They satisfied us," say the Committee, "on searching and careful questioning, that they were able to undertake the work and carry it out promptly. They are practically manufacturing firms of the highest standing (the British Insulated Wire Company and Ferranti, Limited); and they were able to show us, from contracts actually carried out by them for more than 100 public bodies and lighting companies, that their experience in dealing with such matters is of a very wide and satisfactory character. No other company tendering impressed us with anything like the same confidence as the representatives of this company did. They undertake to deposit £5,000 with the Vestry—a guarantee for the carrying out of the work at 2½ per cent. per annum. They further undertake to pay the Vestry £500 towards their expenses in obtaining and transferring the order." It is estimated that this will mean a saving of £5,047 per annum to the parish in the collection and disposal of dust. The Vestry has rescinded its previous resolutions, and the Electric Extension Company's scheme will come before it again in a few days.

Hammersmith.—The Vestry has decided to construct two new sub-stations, one in Lime Grove, Uxbridge Road, and the other in St. Stephen's Avenue, Goldhawk Road; £150 is to be expended upon finishing and furnishing the electricity works' offices.

Hampstead.—The Finance Committee has recommended the Vestry to apply to the London County Council for permission to borrow £50,000 to meet the expenditure on the electric lighting capital account.

Harbour Lights.—The Clyde Trust and the Corporation Electricity Department have been conferring as to the lighting of the harbour by electricity. The question was remitted to the officials of both bodies, with special reference to the illumination of the Prince's Dock.

Kensal Town.—The Chelsea Vestry will oppose the Metropolitan Electric Supply Company's scheme to lay mains in Harrow Road unless the company undertakes to supply electricity for Kensal Town at 4d. per unit.

Kingswinford.—The District Council has resolved to make application for a provisional order.

Leamington.—Mr. Hammond has reported to the Electric Light Committee *re* electric lighting, and he advises that it would be to the interests of the Corporation to arrange that the works of the Midland Electric Lighting Company should continue their operations until the whole of the present consumers are transferred to the new mains. Mr. Hammond reports that with an installation of 15,000 lights at 6d. per unit, there would be a profit of £3,000, sufficient for interest and sinking fund, on £50,000 capital.

Lewisham.—The Great Western Electric Light and Power Company has followed up its previous letters to the Board of Works, by saying that it is prepared to undertake the destruction of dust at cost price, guaranteed not to exceed 1s. 6d. per ton; and, in connection therewith, to take over the dust destructor recently erected, at the price paid by the board to the makers for it, and work it at once, pending the erection of electric supply works, when the combined operations would be carried on. The company also propose to introduce the Brighton system. The public streets would be supplied with 16 C.P. lamps at a cost of about 33s. 4d. per annum.

Liverpool.—The electrical engineer (Mr. Holmes) has reported that during the month of January 62,681 electric lamps, equivalent to 16 C.P., had been supplied from the Corporation mains for private lighting, and 7,924 for Corporation lighting. This showed an increase of 2,944 for the month.

Luton.—The Electric Light Committee has discussed the report by Mr. Snell on electric lighting at great length, but considers that further information should be obtained from other towns before the matter is decided. A deputation is to visit several places. Application is to be made for an extension of the provisional order from June 27th, 1898, for 12 months.

Manchester.—A Local Government Board inquiry was held on 15th inst. regarding applications by the Corporation for loans for various purposes, including £16,000 for electric lighting. Alderman Higginbottom gave some details of the undertaking.

Mexico.—The Dresdner Bank communicates that, according to telegraphic advices received from Mexico, the central station of the Mexican Electric Works, Limited, has been so far advanced that the lighting of the City of Mexico was commenced on the 14th inst., and proved a complete success. The installations for the private lighting and the supply of electrical power are making rapid progress, and it is anticipated that these parts of the works will be opened in course of the summer.

Morecambe.—At the last Council meeting there was a long and somewhat heated discussion with regard to a site for fixing a refuse destructor in connection with the electric light generating station.

Morley.—The Corporation are wanting an electrician-in-charge and a junior. See our "Official Notices."

Motherwell.—A deputation has inspected the Whitehaven electric lighting plant, &c.

Newington.—The Vestry decided last week to proceed with the electric lighting scheme, of which plans and specifications had been submitted by Messrs. Kincaid, Waller & Manville. Application is to be made to the London County Council for a £40,000 loan.

Poplar.—The Board of Trade has been asking the Poplar Board what it proposes to do with its electric lighting order. The County of London and Brush Company had been corresponding with the Board of Trade on the matter. The Poplar Board has now decided to put its order into force at once over the compulsory area.

Rhyl.—Mr. Dale recently appeared before a committee to ascertain their views as to proceeding with the electric lighting of the lake, &c. The question was deferred for the present.

Shoreditch.—At the Vestry meeting held on 15th inst., Mr. Kershaw, chairman of the Electric Lighting Committee, informed the Vestry that an accident occurred at the electric lighting station on the previous Saturday, which resulted in the district being plunged into darkness for a while. Fortunately it was not attended by any loss of life or injury to limb, although the explosion was of a serious nature. By some unexplained reason a small quantity of water—probably condensed steam—found its way into the cylinder of one of the engines, which burst, doing about £300 worth of damage. The whole cost of the damage, Mr. Kershaw explained, would be borne by the contractors, and a further report would be presented.

South Shields.—The Board of Guardians have appointed a Committee to consider the question of electric lighting for the whole of the workhouse.

Swansea.—The disposal of the tramways and the introduction of an electrical company into the town have, according to a local paper, caused a stir in corporation circles in Swansea. A sub-committee recommends that action be taken at once to carry out the provisions of the electric lighting provisional order.

It is understood that the Council has decided to proceed with the provisional order, and is consulting Mr. Manville on the subject.

Winchester.—The City Council, after receiving Mr. Ruthven Murray's report on the Electric Lighting Company's scheme, has informed the Board that it has no objection to the proposal.

Yarmouth.—The income in January from the electric light was £531 5s., of which private consumers furnished £426. After meeting the costs of production, there is a surplus of £316 12s., out of which £190 has to be deducted for capital repayments and interest charges, making the monthly net profit £126 12s. There are now 258 customers, using 11,993 lamps.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Bournemouth.—By 13 votes to 8 the Bournemouth Town Council has again resolved to oppose the two electric tramway schemes which have been on foot for some time.

Bristol.—The Sanitary Committee have held several special meetings to consider the Parliamentary Bills of the Bristol Tramway Company with regard to the extension of their system and the use of electric power, have submitted to the company a statement of the conditions on which they will advise the Council to allow the extensions and the use of electricity. The committee abandon their former demand that the electricity shall be taken from the Corporation supply, but raise several other points which may prove subjects for debate. The company are required to agree that no employé shall be employed for more than 60 hours a week. Lines on which electric traction is to be used are to be specified and the system stated. The Corporation are to have the right to, but not to be compellable to purchase the proposed power station; if the power station be purchased, the company are not to have the right of jointly using it for working tramways not purchased by the Corporation, nor are they to have the right to use posts, rails, &c., of tramways purchased for conveying energy to lines not purchased. The Corporation are to retain powers with regard to the position of posts and overhead wires and other matters as in the 1894 Act. The company are not to supply electric current to other companies or persons within the city. The Corporation may use the company's posts for electric light purposes. The company are not to be entitled to require the Corporation to supply them with electricity. No alteration is to be made in the dates at which the Corporation's power of purchasing existing tramways will arise, and the date at which the Corporation may purchase the power station and proposed extensions are to be the same as for the present horse tramways. Additional capital is to be put up to auction instead of at present being issued to existing shareholders at a price determined by the company. Safe arrangement is to be made for payment to the Corporation of an annual sum and for reduction of fares. As to this last condition, no suggestion is made as to the sum or what reductions are desired.

Mr. Faraday Proctor, the Corporation electrical engineer, is to visit Liverpool, Manchester, Leeds, Bradford, and Sheffield, in search of information to lay before the Bristol Sanitary Committee to enable them to make up their minds on the proposals of the Bristol Tramways C. mpany.

Central London Railway.—At the Sheriff's Court, Red Lion Square, Holborn, last week, Mr. Burchell and a special jury had before them a claim by the trustees of the late Frederick J. Blake, against the Central London Railway Company for £539 for the purpose of repairing the residence, No. 2, Marlborough Gate, Hyde Park, which is alleged to have suffered damage by subsidence due to the works of the railway company. It was alleged that the house in question had been structurally injured by the works of the company either primarily or by reason of the bursting of a water main, owing to the tunnelling operations. On behalf of the railway company Sir Douglas Fox and others gave evidence. It was contended that the system of tunnelling with the Greathead shield prevented any possibility of injury to adjacent buildings, and that the subsidence must have been caused by the bursting of the water main owing to internal pressure. The jury returned a verdict for the railway company on the ground that the damage was done by the bursting of the water main, for which the railway company had not been shown to be in any way responsible.

Dublin.—A question having arisen between the Council and the three United Tramways Companies as to a power station at Ringsend, it is now stated by the *Irish Times* that an agreement has been arrived at by which "In consideration of permission being granted by the Corporation to the companies, or any of them, to electrically connect their system of tramways with the company's proposed generating station at Ringsend Road for the working of their system of tramways, or any portion thereof, in connection with their lines within the City of Dublin, the said three companies shall undertake not to employ the electrical current for any purpose other than the haulage of their cars and the lighting of them, and of the standards or posts wherever it may be found necessary to do so, within the City of Dublin, without first receiving the sanction of the Corporation in writing."

Dublin and Lucan.—At a meeting of the Dublin and Lucan Steam Tramway Company it was resolved to issue debenture stock and preference shares for the purpose of providing the electrical equipment for the lines.

Dudley.—It is stated that the Electric Traction Company has accepted a tender for converting the steam tram line from Dudley to Stourbridge into an electric line, and the work is to be executed within six months from the date of its commencement.

Edinburgh.—A proposal was before the Lord Provost's Committee last week for the construction of an electric tramway from Preston Street *viâ* Dalkeith Road and Niddim, to Portobello, returning by Meadowbank and Waterloo Place. The matter was deferred.

Kirkcaldy.—The British Electric Traction Company recently wrote stating that it would be willing to take up the question of electric tramways for Kirkcaldy. The Town Clerk reported that a representative of the company had visited the town.

Leeds and Bradford Light Electric Railway.—We have on several occasions given brief notes on the progress of this scheme which, it will be remembered, is being promoted by Power and Traction, Limited, who propose connecting the two towns by means of an electric tramway on the overhead trolley system—an inter-urban line over the main highway. The population of the districts affected is over 700,000, and five district councils are interested in the scheme. The proposals came before the Light Railways Commissioners (Mr. G. J. R. FitzGerald and Col. Boughey, R.E.) at the Leeds Town Hall on 17th inst., and there were present to oppose representatives on behalf of the Leeds Corporation, Bradford Corporation, the Midland Railway Company, and the Great Northern Railway Company. With such extensive opposition it might reasonably have been expected that it would go hard with the scheme. Mr. Arthur Graham Hopkins, electrical engineer, of Westminster, produced the plans of the proposed line, which had been prepared under his direction. He stated that for 15 years he had had considerable experience in the construction of light railways. The gradients involved in the present scheme were generally easy, with one exception at Stanningley, but this was trifling to what could be done by electric traction. The object of the project was to afford more convenient and cheaper facilities for intercommunication. Mr. W. N. Stewart, of Westminster, one of the founders of the American Association of Electrical Engineers, whose experience comprised 13 years with Mr. Edison, of New York, also gave evidence in support of the scheme, which he said would have an important effect in increasing the prosperity of the districts passed through. His experience had proved to him that a multiplicity of administration operated against the success of a scheme of this description. At the close of the inquiry the chairman said: "We consider the utility and convenience to the public of this proposed light railway to be established. But the objections of the two corporations to a private company undertaking the work and management within their respective areas most certainly require very serious consideration. In the absence of Lord Jersey, we shall not make any further statement or express any further opinion to-day, but we trust that the result will be a resumption of negotiations. If it is desired, we shall be very happy to do anything in our power to facilitate a settlement." It is believed that an electric tram service at short intervals and low fares is a very important improvement on the present railway service. The decision of the Commissioners in this case is of considerable importance. It shows that they are not disposed to let schemes fall through unless there is good reason, and their offering to aid the parties in arriving at a settlement is very satisfactory.

Light Railways.—In the House of Commons on Monday, in reply to Mr. Bainbridge, Mr. Ritchie said that up to the present time 16 orders had been made by the Light Railways Commissioners, and submitted to the Board of Trade for confirmation. Of these, four had been confirmed by the Board of Trade after modification, and five others would shortly be ready for confirmation. One order had been remitted to the Light Railways Commissioners for further consideration, and in the case of the remaining six orders the time for lodging objections had not yet expired. None of the undertakings authorised made any claims for financial assistance from the Treasury or local authorities. Grants, however, had been provisionally sanctioned by the Treasury in cases which were still under the consideration of the Light Railways Commissioners.

Liverpool.—The Tramways Committee has appointed a deputation to visit Hamburg for the purpose of inspecting the tramways, and the methods of working the service and the management of the workshops.

Middlesboro'.—The British Thomson-Houston Company, Limited, is pushing forward the construction of the electric tramways. The poles are being rapidly erected. The trucks for the car bodies are expected to arrive in this country by the end of the month from America. The car bodies (being constructed at Birkenhead) are also expected to be finished shortly. The three multitubular boilers for the depôt in Bridge Road, Stockton, are being rapidly fitted up in position in the power house. The overhead wire has already arrived, and is on the ground ready to be put up, but in the meantime the company are waiting for brackets.

Nottingham.—A deputation has visited Bristol to inspect the electric tramways and the power station. It is understood that as a result of this visit the deputation will recommend the adoption of overhead electric traction throughout Nottingham.

Paisley.—An extraordinary meeting of the shareholders of the Paisley Tramways Company was held in private last week, when a resolution was adopted ratifying an agreement between the company, Messrs. A. and J. Faill, Robertson Street, Glasgow, and the British Electric Traction Company, Limited, the effect of which will be to empower the last-mentioned body to work the present tramway system by electric traction, and to carry out alterations and extensions.

Peterborough.—A local paper refers to a proposed electric tramway scheme which is being promoted for the district by a syndicate.

Salford.—The report of the sub-committee on electric traction recommends that the Council should undertake the future working of the Salford tramways on the electric overhead wire system, and that the current for working the cars should be provided by the Electric Lighting Committee. By 33 votes to 1 the Council has instructed the committee to prepare estimates of the cost of carrying out a scheme put forward for Salford. The committee's report contained the following:—"In reference to the tramlines to

Eccles, Patricroft, Swinton, and other places reached through Salford, there would be no difficulty in providing electric power to work these lines from the power station required for the Salford lines; or electric power might be supplied from any electric power station within those districts. The reconstruction of the lines to adapt them to this system could either be undertaken by their respective owners or by the Salford Corporation under special agreements. All these points presented no mechanical or electrical difficulties, and no doubt could be arranged between the several authorities on terms mutually advantageous. In order to give an approximate idea of the structural work required for this proposed working of the Salford tramways, it must be remembered that most of the existing tramlines in the borough had been in use for many years; the rails were not of the strength found most suitable for either horse-car or electric-car work, and therefore it would be requisite to provide new rails throughout, except as to some lines very recently relaid. In re-organising the tramway system it would be well to change all the existing single track routes to double tracks, laying parallel lines in adjacent streets wherever the streets were too narrow for a double track, with side spaces for cart traffic. Some additional lines of tramway, in extension or in deviation of existing lines, were also advisable. The total result, according to a plan provisionally prepared, would be that in place of their present 8½ miles of double lines and 3¾ miles of single line and crossing loops, a total of 20¾ miles of single track, they would have 12·8 miles of double track, 4·3 miles of single track used like double track in parallel streets, and 2·5 miles of single track with crossing loops—a total of 32·4 miles of single track."

Stoke-on-Trent.—The Parliamentary Committee has recommended that the Town Clerk write to the British Electric Traction Company, and to the North Staffordshire Tramways Company urging them to carry out the arrangements which were come to at the time when the Tramways Extension Order (1896) was passed, and inform them that unless they carried out their several obligations the Corporation would take such steps as they might be advised to enforce the same.

Swansea.—Shareholders in the Swansea Tramways and Improvements Company have been notified that a meeting to confirm the sale of the tramways will be held to-day, and adds that the directors have entered into a provisional agreement for the purchase by the British Electric Traction Company, Limited, of the whole of the undertaking, property, and assets of the company, on terms which they believe will be acceptable to the shareholders. The purchase price will, if this agreement be carried into effect, provide for the payment of £5 per share to the holders of ordinary shares of tramway capital, and of £10 for each preference share.

The Power Distributing Schemes.—In the opposition to the Bill of the General Power Distributing Company for electric lighting powers, Bakewell will join with Belper, Matlock Bath, Mexboro', North Darley, and Swinton.

Yarmouth.—The Yarmouth and Gorleston Tramway Company are negotiating for the purchase of the Yarmouth 'Bus Company's undertaking, including horses, vehicles and premises, their intention being to make the Yare side stables, which are situated between Yarmouth and Gorleston, a station for the generation of electricity, in order that they may be able to run electric trams between Yarmouth and Gorleston.

York.—The chairman of the York Tramways Company told the shareholders last week that they looked forward to being able to give a better service to the public by the application of electricity, without materially increasing their expenses, and they hoped that the Corporation, with whom they were in negotiation, would meet them fairly. No progress had been made in the matter, because the Corporation had such difficulty in making up their minds with regard to the electric light.

TELEGRAPH AND TELEPHONE NOTES.

Australian Cable Delays.—A joint deputation from the Melbourne Chamber of Commerce and the Melbourne Chamber of Mines has waited upon the Hon. J. G. Duffy, the Postmaster-General, and strongly protested against the delays to which cable messages were liable. The deputation furnished evidence that these delays were almost entirely traceable to the South Australian lines. Mr. Duffy, in the course of his reply, announced that the Eastern Telegraph Extension Company had offered to extend the proposed new Cape cable from the Cape to Mauritius, and thence to Albany and Adelaide, provided the Australian Governments would agree to renew their present subsidy of £32,400 per annum for 20 years.

Replying to Mr. Hogan, in the Commons last week, Mr. Chamberlain said there had been no interruption in our cable service with Australia during the last two months, but the land service had been several times interrupted. He had nothing to report as to any alternative service, which was not being pressed at the present time by any colony.

Hawaiian Cable.—Mr. James A. Scrymser, president of the Pacific Cable Company, appeared at Washington, on January 18th, before the House Committee on Interstate and Foreign Commerce to advocate a contract with the United States, whereby the company would transmit all official messages for $175,000 a year, for 20 years, from San Francisco to Hawaii, China, and Japan, with a proposition to extend it to Australia for $75,000 additional per year. He said that during the Venezuela trouble it had cost the Government $5,000 for one diplomatic message, and no one knew what the Government's aggregate expense was in this connection. According to a New York exchange he said that it would take 8,000 miles of cable from San Francisco to Honolulu.

L.C.C. and Telephone Matters.—A statement by the Highways Committee on the telephone service of the National Company was before the Council on Tuesday. The matter will come up again before the first meeting of the new Council.

The Telegraph Service.—The Council of the Associated Chambers of Commerce recently requested the Postmaster-General to receive a deputation on the subject of telegraphic communication. The Duke of Norfolk, in reply, says that the Lords of the Treasury have been consulted, and they do not consider it advisable to propose the abolition of the separate account for telegraphs. With regard to the extension of telegraphic facilities in rural districts, his Grace has given the matter special consideration, and the concessions given on the occasion of the Diamond Jubilee were evidence of the desire of the Government for the increase of such facilities. In the course of the year many new telegraph offices have been opened and costly extensions are in hand. The total number of telegraph offices of all kinds now open to the public is 10,432.

Telegraphic Communication between Calais and Dover.—In the House of Commons last week, Mr. Hanbury, in answer to Mr. Cohen and Mr. Stuart-Wortley, with regard to the mail packet from Dover to Calais having left Dover in a storm on November 29th and having had to put back, when a telegram sent from Calais to prevent her from starting had been delayed by having to reach Dover through London, said the delay did not take place on that account. It arose from an interruption caused by the storm with the line between Calais and the French landing station, about six miles off, necessitating the transmission of the telegram by a circuitous route. There was not sufficient traffic to justify the allocation of direct wires between France and Dover or Folkestone. The transmission of the telegram through London did not involve any appreciable delay. The Postmaster-General was considering whether any arrangements could be made whereby the consequences of an interruption to the normal communications would be rendered less serious than on that occasion.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1898 ...	...
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Paramaribo-Cayenne ...	Jan. 27th, 1898 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Saigon-Hong Kong	Jan. 8th, 1898 ...	...
Emden-Vigo	Feb. 7th, 1898 ...	Feb. 18th, 1898
Cyprus-Latakia	Feb. 10th, 1898 ...	...
Bolama-Bissao	Feb. 19th, 1898 ...	...
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Cartagena-Barranquilla ...	July 4th, 1896 ...	...
Costa Rica landlines... ...	Feb. 10th, 1898 ...	Feb. 18th, 1898.
Saigon-Bangkok	Feb. 16th, 1898 ...	Feb. 17th, 1898.

Trunk Telephone Lines.—In reply to a memorial of the Associated Chambers of Commerce regarding the irregularities and delays in the trunk telephone service, the Postmaster-General has replied that the department is continuing its efforts to provide a widespread and efficient system; during the period from April 1st to December 31st, 1897, the construction of additional trunk wires, amounting to upwards of 3,000 miles, was undertaken. Some of these have been completed, and others are being rapidly constructed.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belfast.—March 8th. The Corporation wants tenders for the wiring of the new police cells, Chichester Street. Electrical engineer, Mr. V. A. H. McCowan. See our "Official Notices" February 18th.

Belgium.—April 1st. The Municipal Authorities of Seraing are inviting tenders for the concession for the supply of electrical energy in the town for public and private lighting purposes during a period of 30 years. Particulars may be had from, and tenders to be sent to, the College des Bourgmestre et Echevins, Seraing, Belgium.

Berlin.—March 15th. The Municipal Traffic Deputation of the Town Council has opened a competition for the construction of several new electric tramways in that city. Exhaustive details concerning this project are contained in the *Elektrotechnische Zeitschrift* of the 13th inst., which mentions that proposals will be received by the Stadtische Verkehrsdeputation Rathhaus III, Berlin, by March 15th.

Blackpool.—March 22nd. The Corporation wants tenders for a tubular boiler, superheaters, condensers, rectifiers, boosters, transformers, lead-covered cables, arc lamps and pillars. Borough electrical engineer, Mr. R. C. Quin. See our "Official Notices."

Carlisle.—February 25th. Tenders are being invited for the erection of the central station buildings in James Street. City engineer and surveyor, Mr. H. C. Marks, 36, Fisher Street.

Coventry.—March 8th. The Electric Light Committee wants tenders for the supply and erection of engine house, separate exciting and surface condensing plant, also pipework, switchboards and instruments for extensions of the municipal electricity works. Consulting engineer, Mr. Robert Hammond. See our "Official Notices" February 18th.

Denmark.—March 12th. Tenders are being invited for the supply of the engines, dynamos, accumulators, &c., required in connection with the new central station at Frederiksberg, near Copenhagen. Tenders to be sent to the Frederiksberg Sporveis-og Electricitets Aktieselskab, Gammel Kongerie, 140, Copenhagen V., from whom particulars may be obtained.

France.—March 31st. Tenders are being invited by the Municipal Authorities of Saint Chamond (Loire) for the concession for the lighting of the public streets of the town, either by gas or electricity. Particulars from, and tenders to be sent to, La Mairie de Saint Chamond (Loire).

Glasgow.—February 28th. The Corporation wants tenders for the hire or purchase of dynamos and engines, direct coupled or belt driven, capable of providing 1,100 B.H.P. and spare power equal to 25 per cent. additional, also two rope driven dynamos to run at a speed not exceeding 500 revolutions per minute, and capable of providing 200 H.P. each at a potential of 230 H.P. The plant must be delivered by August 1st. Engineer, Mr. W. A. Chamen. See our "Official Notices" February 18th.

Glasgow.—February 28th. The Corporation wants tenders for the supply of lead covered cables and accessories for twelve months, accumulators, motor transformers, motor driven boosters and switching apparatus. Mr. W. A. Chamen, engineer. See our "Official Notices" February 18th.

Italy.—March 1st. Tenders are being invited by the Municipal Authorities of Cassino (Caserta) for the concession for the electric lighting of the public streets of the town during a period of 30 years. Tenders to be addressed to El Municipio de Cassino (Caserta), Italy. Particulars from ditto.

Italy.—March 2nd. Tenders are being invited by the Municipal Authorities of Piacenza for the establishment of a central electricity generating station in the town for lighting and power purposes. Particulars may be had from, and tenders to be sent to, El Municipio di Piacenza, Italy.

Liverpool.—March 8th. The West Derby Board of Guardians wants tenders for supply and erection of boilers, engines, dynamos, batteries, wiring, &c., for the lighting of the Mill Road Infirmary. Consulting engineer, Mr. T. L. Miller. See our "Official Notices" for particulars.

Northwich.—March 5th. The Weaver Navigation Trustees are inviting tenders for the construction and erection of the necessary electric power plant for lighting and working the new swing bridges at Northwich. Current will be supplied by the Northwich Electric Supply Company. Engineer, Mr. J. A. Saner, M.I.E.E. See our "Official Notices" February 11th.

Pembroke (Ireland).—March 5th. The Lighting Committee wants tenders for the supply and erection of various plant, machinery, &c., for electric lighting. See our "Official Notices" February 18th for full particulars. Consulting engineer, Mr. Robert Hammond.

Roumania.—March 15th. Tenders are being invited by the General Direction of the Roumanian Post and Telegraphs in Bucharest for the supply of 56,000 metres of galvanised iron and steel wire.

Shoreditch.—March 8th. The Vestry wants tenders for the supply of electric cables and sundries, also engineers' tools, ironmongery, &c. See our "Official Notices" February 18th.

Sunderland.—February 25th. Tenders are invited by the Corporation for the supply of various cables, pipes, service boxes and stoneware casings for the year. Borough electrical engineer, Mr. J. F. C. Snell. See our "Official Notices" February 18th.

The War Office.—April 27th. The Secretary of State for War is prepared to receive offers, competitive designs and specifications for the supply of portable electric search light apparatus. Particulars from the Director of Army Contracts, War Office, Pall Mall, S.W. See our "Official Notices" February 4th.

Victoria.—March 21st. The Telegraph Department of the Victorian Government Railways is inviting tenders for the supply of alternating current transformers and one main switchboard. Tenders to the Telegraph Superintendent's Office, Spencer Street, Melbourne.

Wallasey.—March 17th. The District Council wants tenders for the supply of engine, alternator, exciter, two Lancashire and one water-tube boilers, and condensing apparatus. Engineer, Mr. J. H. Crowther. See "Official Notices" February 11th.

Warsaw.—The Warsaw Municipality is inviting applications re supplying the town with electrical power for purposes of lighting, tramways, &c. Further particulars, says *Daily Tenders*, may be obtained from, and applications to, the President of the town of Warsaw.

Watford.—March 16th. The District Council wants tenders for the supply and erection of various plant for the electric lighting of the district. For details of the seven sections see our "Official Notices" February 11th. Mr. W. C. C. Hawtayne, consulting engineer.

West Ham.—March 8th. The Council invites tenders for wiring and fitting up various buildings, including the Town Hall, police court, Corporation stables, fire stables, &c. Mr. J. Steinitz borough electrical engineer. See our "Official Notices" February 18th.

CLOSED.

Belfast.—The Electric Committee has accepted the tender of Messrs. T. Parker, Limited, to supply and erect a 200-kw. steam dynamo for lighting and traction. A sub-committee is preparing a summary of all that has been done by the Council in the way of investigating the electric traction question.

Bradford.—The Gas and Electricity Committee has accepted the tender of Messrs. Cole, Marchent & Morley, of Bradford, to supply additional condensing apparatus at the new electricity works for £1,600. In view of the complaints regarding meters at present in use, a new style at £2 per meter less is to be adopted.

Leith.—The contract for boilers and accessories for the electric lighting installation has been given to Mr. Geo. Sinclair, of Albion Boiler Works, for £3,313. Messrs. Carrick & Ritchie will supply an 8-ton travelling crane for £240. We have already mentioned that the contract for the engines, dynamos, &c., is in the hands of the India-Rubber Company at £8,844. Mr. W. A. Bryson is the Corporation electrical engineer. The cost of cables and laying same is estimated at about £8,000.

Walsall.—The number of consumers has increased to 102. The following tenders for extension of the plant have been accepted, viz.:—Messrs. Bumstead & Chandler, engine, £910; Thomas Parker, Limited, for supplying a continuous dynamo and a spare armature, £1,160; and Callender's Cable and Construction Company, Limited, supplying and laying on the solid system in a cast-iron trough, three new concentric cables at the price of 19s. 6d. per yard (exclusive of the cost of excavating).

Wimbledon.—The following is a full list of the tenders sent in for the municipal electric lighting scheme:—

		£	s.	d.
Buildings.				
Messrs. Manter		2,990	0	0
" Thomas & Edge		3,261	0	0
" Lorden & Sons		3,333	0	0
" Burgess	(accepted)	3,338	0	0
" Wall & Co.		3,578	0	0
" Buller & Co.		3,720	0	0
" Jerbury & Co.		3,984	0	0
Machinery.—*Section A, Boilers.*				
Messrs. Babcock & Wilcox	(accepted)	2,482	0	0
The Southern Cross Engineering Company		2,795	0	0
The Haythorn Tubular Boiler Company		3,397	0	0
Messrs. Hornsby		3,505	10	0
Section B.—Condenser and Pipes.				
Messrs. Babcock & Wilcox	(postponed)	2,681	0	0
Section C.—Crane.				
Messrs. Carrick & Ritchie		130	0	0
" Higginbotham		132	0	0
The Bedford Engineering Company		149	0	0
Messrs. Spencer		152	0	0
" Babcock & Wilcox		155	0	0
" Taylor & Hubbard		155	0	0
Section D.—Steam Engine and Dynamo.				
The Southern Cross Engineering Company		3,980	0	0
Messrs. Parsons		4,124	0	0
" Crompton	(accepted)	4,181	0	0
The Electric Construction Company		4,368	0	0
Messrs. Easton, Anderson & Goolden		4,575	0	0
" Mather & Platt		4,629	0	0
" Siemens		4,690	0	0
The Brush Company		5,170	0	0
The General Electric Company		5,615	0	0
Messrs. Fowler		5,981	0	0
Section E.—Switchboards.				
Messrs. Edison & Swan		454	18	0
" James White		568	10	0
The Electric Construction Company		570	0	0
Messrs. Crompton		621	0	0
" Siemens	(postponed)	692	0	0
" Sharp & Piper		721	10	0
The General Electric Company		750	0	0
Messrs. Fowler		755	0	0
" Ferranti		833	0	0
Mains.				
Messrs. Henley & Co.	(accepted)	15,793	12	9
" Glover & Co.		16,127	17	4
" Callender		16,537	8	4
" Siemens		17,417	11	3
The British Insulated Wire Company		20,833	19	2
The Western Electric Company		20,950	19	10

FORTHCOMING EVENTS.

1898.

Friday, February 25th, at 6.30 p.m.—The Institution of Electrical Engineers. Students' visit to the Shoreditch electricity supply station. Applications at once to the Students' Hon. Sec. (Mr. S. Grant, 28, St. Mary Abbot's Terrace, W.) as the number will be limited to 20.

At 8 p.m.—The Institution of Civil Engineers.—Students meeting. "The Problem of Train Resistance," by C. E. Wolff, B.Sc., Stud.Inst.C.E.

Sunderland Corporation tenders due to-day.

Saturday, February 26th, at 4 p.m.—Physical Society in the Chemistry Lecture Room, Keate's Lane, Eton College. The Rev. T. C. Porter will describe:—1. A new theory of geysers. 2. A new method of viewing Newton's Rings. 3. Experiments bearing on the sensation of light. 4. A method of viewing lantern projections in stereoscopic relief. 5. Winter observations on the shadow of El Teide, with a new method for measuring approximately the diameter of the earth. 6. Temperature of the water of Niagara.

Monday, February 28th, at 3 p.m.—The Institution of Junior Engineers. Visit to the Westinghouse Brake Company's Works, York Road, King's Cross.

Last day for Glasgow Corporation tenders.

Tuesday, March 1st.—Röntgen Society. General meeting at the rooms of the Medical Society, 11, Chandos Street, Cavendish Square, W., Prof. S. P. Thompson presiding. Paper on "The Photographic Activity and Penetration of Röntgen Rays at Different Vacua," by Mr. J. H. Gardner; other papers by Mr. Wilson Noble and Mr. Hall Edwards. Mr. Isenthal will show some new apparatus.

Wednesday, March 2nd, at 8 p.m.—Society of Arts. "Kites: Their Theory and Practice," by Captain B. F. S. Baden-Powell. Prof. W. Grylls Adams, F.R.S., will preside.

Thursday, March 3rd, at 8 p.m.—Chemical Society, Burlington House. Papers to be read:—"Note on the Preparation of Dry Hydrogen Cyanide and Carbon Monoxide." John Wade, B.Sc. and Laurence C. Panting, M.B. "Production of Some Nitro- and Amido-Oxylutidines." J. N. Collie, Ph.D., F.R.S. and T. Tickle. "Production of Some Nitro- and Amido-Oxylutidines, Part II." J. N. Collie, Ph.D. F.R.S. and Miss L. Hall. "The Interaction of Magnesium and Solution of Copper Sulphate." E. Divers, M.D., F.R.S.

Royal Institution. First of a series of five lectures on "Recent Researches in Magnetism and Dia-Magnetism," by Prof. Fleming.

Friday, March 4th, 8 p.m.—At the Westminster Palace Hotel. The Institution of Junior Engineers. Paper on "An Outline of Patent Law and Practice," by Mr. Arthur H. Stanley, Fel.C.I.P.A., Member.

NOTES.

(*Continued from page* 257.)

American Dynamos.—Our friends on the other side have been most active in developing the applications of the dynamo-electric machine. But few improvements have originated in America. The modern dynamo, with all its perfections, is the product of European, and mostly British, science, yet it finds a far greater field of application in the States; and some things, although well known here and not much used, are sometimes promoted in America as novelties, and meet with considerable acceptance. A case in point at present is the introduction of what is called the multi-voltage dynamo, a form of dynamo long ago patented in this country by Kennedy, brought out subsequently by Herr Rothert in Germany, and by Mr. Sayers and Mr. Kingdon in Britain. No doubt our friends will work this style of machine "for all it is worth," but at the same time it is only fair to point out that the construction of machines to give several voltages from one armature and one commutator is well known, its principles and methods of operation are well understood, and in this country, at any rate, any manufacturer is quite free to construct, and use, and sell such machines when they are wanted. In back numbers of the ELECTRICAL REVIEW several references will be found to these multi-voltage or multi-circuit dynamos.

Rail Bonds.—Not long ago we remember coming across a reference by some would-be learned authority in electric traction to the idea that heavy rails are necessary for the new method of traction because large currents are conveyed along them! It is, of course, quite true that 80, 90, and 100-lb. rails are now used where formerly a weight of 45 or 50-lb. was considered enough; but the notion that such an increase is required for improvement of the return circuit is strangely belied by the fact that engineers responsible for electric tramways are satisfied with bonding a 90-lb. rail with two No. 0 copper bonds! Assuming that the capacity of the bonds at any joint does not exceed 25 per cent. of the maximum capacity of rail, a 90-lb. rail would require no less than three No. 000 bonds at each joint. It is evident, then, that rail and bond capacities do not correspond at all, nor is it necessary that they should. The usual rail area is enormous for the current it has to carry, and the trouble as to resistance and waste is not here but at the joints, where insufficient and irregular contacts are, we fear, frequent. A single track of 90-lb. rail has a capacity in area of steel equal to at least 2½ square inches of copper. In the *Street Railway Journal* Mr. E. T. Birdsall touches upon this point, mainly for the purpose of drawing attention to a new type of heavy copper rail bond which he has devised, suitable for soldering to the under side of the rail base. It consists essentially of a number of copper wire horseshoes, placed one above the other to the number of, say, five, with a long flat-footed sort of elliptical base cast on to each vertical series of ends. The whole thing is claimed to be cheap—costing about 6s. put into position—and possessing great flexibility. With 60-foot rails, Mr. Birdsall gives the cost of bonding as £45 per mile, single track.

Different Men, Different Minds.—Some of our contemporaries do not think very highly of the promoting and financing interests engaged just now in the development of electric tramways at various places in this country, and profess to believe that these interests are very largely bent upon making great profits for themselves out of what are to be regarded as speculations instead of investments. We are glad, however, to note that the *Railway World* has a different view of the matter, and in its last issue comments upon this subject much more favourably. Our contemporary considers that so far, with scarcely an exception, every electric traction enterprise has been initiated by genuine investors who have desired to secure an enduring success for a useful industrial undertaking. As a special instance of this praiseworthy type of promotion there is brought forward the Oldham, Ashton and Hyde Electric Tramway, the share capital for which was lately offered to the public and subscribed several times over, and we think from such well based information as has been at our command, that the statements of our contemporary are justified. It is much to be hoped that this happy condition of affairs will long continue, and that we shall not in regard to electric traction see any of the disastrous methods only too common in the early days of horse tramways, when financiers bought or obtained concessions cheaply, sold them at high figures to subsidiary companies, and then left the latter to struggle on as best they could with enormously inflated capital accounts.

Electricity on Warships.—The following letter from "Velox" appeared in Wednesday's *Times*:—

The explosion on board the cruiser *Maine* has startled the world. No doubt it will lead to very full inquiry, but at this inquiry other considerations and tests beyond those which are commonly accepted should be brought into notice. Our modern war vessels are fast becoming threaded by wires, hidden away in every direction. Very large currents of electricity circulate through these wires and also in the dynamos. The common care is to see that all the electrical communications are well insulated, and with good insulation the matter and consideration ends. But ought it to do so? It is well known that insulation has no retarding effect upon induction, and that when large currents are in circulation, or meeting arrest, the induced electricity extends for many feet beyond the insulation. Hence we have only to supply some other material—such, for instance, as a length of wire rope, a length of chain, or even a collection of shell or other metal cases—suitably placed, and a spark may be obtained at many parts of the ship. The thought certainly rises whether these powerful currents ought to be employed on board vessels which carry gunpowder and dynamite. The latter is an unstable compound and may, beside, be affected by these induced charges. It certainly seems to me that our modern warships have as much to fear from these electrical actions as they have to fear from the enemies' shot.

Lectures.—On behalf of the Literary Society in connection with Marylebone Presbyterian Church, a lecture was delivered on Wednesday evening, last week, by Mr. F. Tandy, A.I.E.E., upon the subject of "Electric Waves," with special reference to signalling through space. Numerous experiments, and illustrations by limelight, demonstrating the possibilities of telegraphic signalling between two points without connecting wires, were shown by Mr. Tandy, assisted by Messrs. G. E. and R. J. Taylor. Interest was added to the lecture, by some actual recorded signals being on view, that had been transmitted recently between Alum Bay (Isle of Wight) and Madeira House, Bournemouth, an approximate distance of 14 miles, which had been kindly supplied for the lecture by Signor Marconi. Mr. Tandy had the loan of apparatus from W. H. Preece, Esq., C.B., engineer-in-chief at the Post Office.

Before the Shipley Textile Society on 14th inst., a paper was read by Mr. A. R. Foster, of Bradford, on "Will Electricity Advance the Loom?"

Before the Glasgow Technical College Scientific Society on 12th inst., Mr. E. H. Judd read a paper on "High Speed Engines for Electric Lighting." He gave interesting figures regarding the engines employed in London and the provinces. Taking London with 19 electricity stations, of 16 of which the lecturer had information, containing 176 engines, there were 116 Willans, 10 Belliss and 18 other types, giving a total of 32,182 H.P., or 70 per cent. of the total horse-power in these stations, supplied by high speed engines. In the provinces, of 604 engines in electric light stations, 357 were high speed.

Prof. S. P. Thompson lectured on "Electric Motive Power" at Carpenters' Hall, E.C., on Monday last week.

Under the auspices of the Dundee Institute of Engineers, Mr. A. G. Seaman lectured at Dundee, on 18th inst., on "Underground Systems of Electric Traction."

Electricity in Municipal Engineering. — Mr. R. Bowens, writing to the *Electrical World*, finds fault with the power department of municipalities. He finds, especially in western towns, that water supply is often obtained from distributed wells each provided with its own steam plant of the direct acting and therefore wasteful description. In place of so many separate plants and attendants he would collect all power at one central station with a minimum of attendance, and distribute therefrom electrical power to the outlying stations to drive the pumps. In many towns, especially where there is some water storage, the pumping can be chiefly done by day so as to provide load for the lighting plant of a municipal light station and a regular economical rate of work can be maintained. Electricity is also recommended for sewage sterilisation on the Hermite or Woolf systems. In one case, for a population of 30,000, the power required was only 15 H.P., and the cost per annum barely 13d. per head, and this would be halved if the electricity came from one central station. The necessity of regularity in burning refuse makes very convenient the use of power in pumping, so as to maintain a constant demand for steam the whole 24 hours through. For small towns, in which many things are municipalised, there is much to be said for the author's suggestions. Indeed, in London, there might be much done to economise fuel and expense all round, could men only agree to mutual economies. Could one only see all the power generation of London in the sweep of one's eye, there would be visible many men banking up boiler fires and doing their best to check steam raising. Others would be equally busy trying to keep steam against a heavy draught, there would be seen electrical station boilers lighting up at night and pumping stations shutting down, and generally about twice the fuel burned that need be, and quadruple the labour expended. There would be seen clouds of steam blowing to waste in the air, and thousands of houses half warmed by extravagant laborious fires that might be nicely warmed from waste heat. In fact, no one realises the economy that would be possible were municipal authorities half alive to their duties and responsibilities. Merely for pumping, sewage treatment and street lighting, our author considers that a refuse burner, perhaps assisted with good fuel, would find a fairly steady load for every hour of the twenty-four.

Institution of Mechanical Engineers.—On the second evening of the recent meeting of this Institution held in London, Mr. Johnson occupied the chair, and the proceedings were opened by Sir Douglas Galton moving a vote of thanks to Mr. Bache on his retirement after many years' service to the Institution. The speaker referred, says *Engineering*, in feeling terms to the devotion to his duties which, for so long a period, the late secretary had displayed, and he felt sure that the good wishes of all members of the Institution would follow Mr. Bache in his retirement and well-earned rest. For many years to come he hoped that Mr. Worthington, who, he was sure, would prove so able a successor, would be able to consult his predecessor in times of difficulty such as were sure to arise in the conduct of every institution. The motion was seconded by Mr. Jeremiah Head, who said that it had been his lot to become President at a crisis in the history of the Institution, the tiding over of which was one great turning point in its career. He was the first president who served after the appointment of Mr. Bache as secretary. There was, unfortunately, a great deal of friction at the time, and if there had been a secretary of less good feeling and of less common sense the results might have been disastrous. The position was so strained at one time that Mr. Head had almost despaired of grappling with it, and had thought of resigning his post. It was then that the loyal support accorded to him by the secretary was most felt, and, happily, by the good offices of their friends and by the exercise of self-restrain and sound common sense, they had passed through the crisis successfully. He had much pleasure in seconding the resolution. The President next invited any member from the body of the hall to speak on the motion. In reply, Mr. Bernard Dawson, Mr. Hawksley, and Mr. Oughterson added their recognitions to the valuable services rendered by Mr. Bache during his long career of 43 years as a servant of the Institution. The motion was then carried with acclamation. Mr. Bache thanked the members for the kind way in which they had passed this vote. The incident was one of a series of kindnesses such as he had constantly received from the members of the Institution. The work of his lifetime had been a great pleasure to him, and he would say now, that if he had to start in life again and could select his career, he would choose no other position than the one he had filled. He could not answer all the kind things that had been said of him by Sir Douglas Galton and Mr. Head in proposing and seconding the motion, nor to the no less gratifying remarks of Mr. Dawson, Mr. Hawksley, and Mr. Oughterson. He would, however, make one reference to what Mr. Head had said about the trying time they had passed through when that gentleman was president of the Institute. Mr. Head had attributed too much to him; and, indeed, it was the sterling character of the president that had carried the Institution through that difficult and trying period. He cordially thanked the meeting for the way in which the vote had been carried, and would be pleased to assist the Institution to the fullest extent of his ability, should his advice or assistance be required by Mr. Worthington, who, he felt sure, would so ably fill the position to which he had been appointed.

Old News.—Our French contemporary, *L'Electricien*, informs its readers that a Russian engineer, whose name is not very formidable—no worse, at least, than Romanow—has invented a new form of electric suspension railway. Moreover, he has devised three types of it—one for mails and parcels, a second for goods traffic of medium weight, and a third for heavier goods or for passengers. Figures as to cost of construction, working expenses, &c., are also given, but in a form which cannot be understood. However, they do not affect this remarkable discovery (!) of a "telpher" system; which is, apparently, exactly what could be seen at work in this country 10 or 15 years ago.

X Rays in Medical Work.—The statement that at a Liverpool hospital X rays were utilised in no less than 57 cases during the year 1897, is followed up by the treasurer of the St. Thomas's Hospital, Albert Embankment, who says, in a letter to the *Times*, that at St. Thomas's as many as 416 patients passed through the X rays department during the year. So great is the pressure of work, that an assistant to the officer in charge is about to be appointed.

To Battery Makers and Users.—An interesting offer now being made by an American house for the purpose of popularising the Willard storage battery is worthy of attention from battery makers in this country. The firm requests anyone interested in storage batteries for whatever purpose, and especially for large power or lighting plants, to investigate the mechanical and electrical construction of the Willard cell. Inquiry is invited and scientific tests courted, and the company undertakes to supply anyone with the means by which he may investigate for himself the merits of the battery, and for the purpose of such test and comparision a single cell of any size is offered at half the net price. An investigation of cells which have been in use from two to five years is invited. There is no better recommendation for apparatus than to place it before the public for free and full investigation, and our American friends appear to appreciate the truth of this in the present instance.

W. T. Glover & Co., Limited.—Under our "New Companies" this week will be found a notice of the registration of this company, with a capital of £200,000, to take over the business of the well-known cable and wire manufacturers, Messrs. W. T. Glover & Co.

Electricity Meters.—A course of five lectures on "Electricity Meters" is to be given at the Finsbury Technical College, by Mr. Louis J. Steel, A.I.E.E., commencing March 3rd. See our "Official Notices."

Personal.—We notice in the *Bulletin Hebdomadaire of Posts, Telegraphs, and Telephones*, that it is probable that M. Raymond, the actual administrator of telegraphs in France, will retire shortly from the public service, and will be succeeded by M. Wünschendorff, who is well known to the English telegraph world. M. Wünschendorff at present is one of the inspectors general of French telegraphs. M. Raymond will be a difficult man to follow on account of his knowledge, industry, and urbanity.

NEW COMPANIES REGISTERED.

International Engine Patents Development Company, Limited (56,144).—Registered February 17th with capital £3,750 in 1s. shares, to acquire the assets and liabilities of New and Mayne, Limited, to adopt an agreement with New and Mayne, Limited, and D. F. Basden, its liquidator, and to carry on the business of mechanical, electrical, and general engineers, engine builders, and manufacturers of oil, steam, or electrical motors. The subscribers (with one share each) are:—O. Lloyd, 38, Montpelier Road, Brecknock Road, N.W., gentleman; J. W. Baldwin, 39, Northway Road, Loughboro' Junction, S.W., clerk; J. P. Bennett, 274, Ivydale Road, Nunhead, S.E., clerk; A. M. Mallett, 47, Bawdale Road, East Dulwich, S.E., clerk; S. F. Patmore, 8, Alvington Crescent, Dalston, clerk; A. Robinson, 8, Stone Buildings, Lincoln's Inn, solicitor; J. Shinkey, 13, Model Buildings, Gray's Inn Road, W.C., clerk. The number of directors is not to be less than three nor more than five. The first are R. Hunt, W. Shrimpton, and A. G. New; qualification, 500 shares; remuneration, £300 per annum divisible. Registered office, 33, St. Swithin's Lane, E.C.

Gas and Electric Light Consumers' Protection Association, Limited (56,088).—Registered February 14th with capital £1,000 in £1 shares, to establish and carry on a system of periodically inspecting the registering indexes of gas and electric light meters. The subscribers (with one share each) are:—W. H. Robbins, 8, Linacre Road, Willesden Green, journalist; J. Cristol, 7, Richmond Road, Bayswater, financier; F. Thomas, Roeborough Park, Harrow, journalist; W. C. Daniels, 39, Chardmore Road, Stoke Newington, merchant; D. Davies, 50, Brondesbury Road, Kilburn, accountant; J. Cottrell, 83, Balmoral Road, Willesden Green, editor; F. C. Evans, 52, Queen Victoria Street, E.C., solicitor. Registered without articles of association by F. E. Evans, 52, Queen Victoria Street, E.C.

W. T. Glover & Co., Limited (56,124).—Registered February 16th with capital of £200,000 in £1 shares (100,000 £5 per cent. cumulative preference), to acquire the business carried on by H. Edmunds and G. B. Samuelson, at Springfield Works, Salford, Lancashire, as W. T. Glover & Co., to adopt a certain agreement, and to carry on the business of manufacturers of cables and lines for electrical purposes, electrical engineers, and contractors, manufacturers of electrical apparatus, and suppliers of electricity. The subscribers (with one share each) are:—H. Edmunds, 71, Upper Tulse Hill, S.W., electrical engineer; G. B. Samuelson, 7, Cadogan Gardens, S.W., electrical engineer; W. P. J. Fawcus, Derwent Bank, Keswick, engineer; J. Morton, 132, Waterloo Road, Manchester, manager; J. W. Moore, 28, Devonshire Street, Higher Broughton, Manchester, accountant; R. Taylor, 1, Weaste Road, Weaste, Manchester, cable maker; S. Hartford, 17, Woodland Avenue, Higher Broughton, traveller. The number of directors is not to be less than three nor more than five; the first are:—H. Edmunds, G. B. Samuelson, W. P. J. Fawcus, and H. P. Holt. Qualification, £2,000; remuneration as fixed by the company. Registered by Rowcliffes, Rawle and Co., 1, Bedford Row, W.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Salisbury Electric Light and Supply Company, Limited (41,414).—This company's annual return was filed on January 8th, when 1,307 shares were taken up out of a capital of £20,000, in £1 shares. £1,013 15s. has been paid, and £293 5s. is in arrears.

Railways' Electric Supply Syndicate, Limited (52,812).—This company's statutory return was filed on November 13th, when 7,000 shares were taken up, and issued as paid, out of a capital of £10,000 in £1 shares.

Silicon Electric Lamp Syndicate, Limited (47,238).—This company will not be proceeded with, as the patent for the acquisition of which the undertaking was formed have been otherwise disposed of, and the name of the company will be struck off the register.

Rand Central Electric Works, Limited (48,712).—This company's annual return was filed on January 7th, when the capital of £300,000 in £1 shares was taken up in full; 25,000 shares are considered as paid, and £275,000 has been received.

Single Wire Multiple Telephone Signal Company, Limited (16,857).—This company's annual return was filed on December 24th, when 374 shares were taken up and paid for in full out of a capital of £5,000 in £10 shares.

Smithfield Markets Electric Supply Company, Limited (53,354).—This company's statutory return, made up to November 29th, was filed on December 11th, 1897, when 73 shares were taken up out of a capital of £100,000 in £5 shares. £1 per share has been called, and £7 paid.

Taylor & Tucker Art Metal Company, Limited (28,892).—This company's annual return was filed on January 17th, when 4,400 shares were taken up out of a capital of £5,000, in £1 shares, and paid for in full.

Telescriptor Syndicate, Limited (47,685).—This company's annual return was filed on January 14th, when 39,507 shares were taken up out of a capital of £40,000, in £1 shares; 35,000 are considered as paid, and £4,507 has been received.

Sussmann Electric Miners' Lamp Company, Limited. (47,821).—This company's annual return was filed on November 30th, 1897. The capital is £80,000 in £1 shares (1,500 deferred, 39,250 preference, and 39,250 ordinary). 1,500 deferred, 27,073 preference, and 28,488 ordinary shares have been taken up. 1,500 deferred, 17,950 preference, and 17,943 ordinary shares are considered as paid. £1 per share has been called on the others, and £19,247 has been paid, leaving £421 in arrears. £191 has been paid on 376 forfeited shares.

Thompson, Ritchie & Co., Limited (35,835).—This company's annual return was filed on January 14th. The capital is £5,000 in £10 shares (200 preference). All the preference and 140 ordinary have been taken up, and 100 preference and 70 ordinary shares are considered as paid; £10 per share has been called on the rest, and £1,700 has been received.

Townsend, Tamplin & Makovski, Limited (53,914).—This company's statutory return was filed on January 6th. The capital is £20,000 in £10 shares (1,000 "A" and 1,000 "B"). 350 "A" and 401 "B" shares have been taken up, and 401 of the latter are considered as paid. £10 per share has been called on the rest, and £3,650 has been received.

Automatic Electric Railway Signal Company, Limited (37,636)—This company's annual return was filed on December 23rd, when 5,940 shares were taken up out of a capital of £10,000 in £1 shares; 4,300 shares are considered as paid, and £1 per share has been called on the others. £1,647 10s. has been received, including £7 10s. paid on 15 forfeited shares.

African Trans-Continental Telegraph Company, Limited (37,855).—This company's annual return was filed on January 4th, when the capital of £140,000 in £1 shares was fully subscribed. £116,450 has been paid, and £23,550 is in arrears.

Amazon Telegraph Company, Limited (44,532).—This company's annual return was filed on January 20th, when the capital of £250,000 in £10 shares was taken up, and paid for in full.

Electrical Copper Company, Limited (48,068).—This company's return was filed on January 18th, when the whole capital of £500,000 in £1 shares (150,000 preference) was taken up. The ordinary shares are considered as paid, and £1 per share has been called on the others. £148,266 10s. has been paid, and £1,733 10s. is in arrears.

CITY NOTES.

National Telephone Company.

The twenty-first ordinary general meeting of the National Telephone Company, Limited, was held on Thursday, last week, at Cannon Street Hotel, Mr. James Staats Forbes presiding.

In moving the adoption of the report, the Chairman said that knowing as they did the very great difficulties by which they were surrounded in carrying out the telephone business, they felt that the figures were exceedingly satisfactory, and they trusted that those present and those absent who had studied them as either affecting the past half-year or the past year, and who carried their knowledge back to former years, would be as satisfied as the board were with the progress the concern was making. They would observe that the growth of the business in the half-year had exceeded by £67,600 the receipts of the corresponding half of 1896. The working expenses had increased reasonably in relation to the large increase of the receipts themselves, and the accounts showed that the net result for the half-year, after deducting the Post Office royalties amounting to £46,000, was an increase of £23,474. In respect of subscriptions already received for services to be rendered in the coming year—that was to say, the year they were now in—they had the large sum of £473,586 in hand, an increase of £58,872. The available balance, £156,435, would enable them to do certain things, namely, to pay a dividend at the rate of 6 per cent. per annum, less income-tax, on the first and second preference shares, 5 per cent. per annum, less income-tax, on the third preference shares, and 6 per cent. per annum, free of income-tax, on the ordinary shares. That was really the long and short of the whole business; that was the outcrop of the working for the half-year. They would see by paragraph No. 6 that they proposed to transfer £40,0^0 to the reserve fund, and to carry the balance of £10,034 forward. That £40,000 that they carried to the reserve was £5,000 more than half-year than they had been in the habit of carrying to that fund for some time past. They next came to the capital expenditure—a very serious matter, but not unduly serious, seeing the progress of the business. They had expended the sum of £267,375 on capital accounts, which was a pretty good lump for one half-year; but it was only, after all, the embodiment of a growing business. In the half-year they had erected 5,633 additional exchange and private lines, and besides that there had been considerable expenditure in what really came to a transformation of the system from overhead to underground wires. The overhead system was attended with enormous difficulties, which rather increased. They imposed upon the company certain risks from time to time which not only caused a great deal of liability, but a great deal that was harassing in working the undertaking. The underground system was free from those contingencies. It was costly, of course, at the beginning; but as it secured greater efficiency in the conduct of the service, and at the same time safeguarded the company against serious risks, such as damage to the property from snowstorms, and dislocation of the service, they had come to the conclusion that the sooner they could substitute the one system for the other, the better it would be for the public and for the company. They had no powers over the streets, and had been confronted with great difficulties in making the change; but, happily, the difficulties experienced in that direction originally, had to a great extent been overcome, owing to patience, great diligence, and a great deal of interest, which the directors in various places individually exercised, together with the energy of the general manager, engineers and officials, and some of the more important centres had been enlightened enough to listen to arguments, and to enable them, upon something like reasonable terms, to carry out those transformations in those great centres. The result was that the moment these works were finished, there was a very perceptible improvement in the service, and an immediate decrease of the actual ground for complaint. They had to pay the great Corporation at Manchester the compliment of admitting that they were the first to realise that their duty was not to the company, but to the public, and several other places had followed suit. There were now many places where they were suffering greatly from the want of those facilities. London was one of them, but they were not without hope that London would follow the lead of Manchester, and also other great towns, in view of the great and growing importance of this service, and that they would grant reasonable facilities, without which it could never be made perfect. Between December 31st, 1896, and December 31st, 1897, there had been an increase of £113,800. They had paid the Post Office in royalties £89,238, being an increase of about £10,000 over the corresponding year, the net income had increased by £103,800, and the working expenses had increased by £74,900, which was rather a larger proportion of the gross income than was quite agreeable, although if challenged they should be able to defend it. The net result for the year showed an increase of £28,929. One was constantly being told how bad the service was, how costly it was, how extravagant the whole foundation was, and how much better it could be done by other people, and they justified the statement by certain figures. Either they must be living in perfect illusions, and must be absolutely densely ignorant of what they had to do, or else the other gentlemen outside must be somewhat ill-informed. He was afraid they were ill-informed. The popular theory was, that in London they could get a magnificent telephone service for about £20, and in the country for £5 or £6. That was not their experience, and they had had now a good deal of experience in the working of the business. In the year they had increased their subscribers' wires in London by 2,671, and, after all, wire was a factor. In all other centres of the United Kingdom the increase had been 9,110. That made the total increase in the year of 11,781 exchange wires, and brought the total, on December 31st last, up to the respectable number of 17,371 wires in London, and of 88,817 in all the other places, or a total of 106,188. That seemed a satisfactory progress. It was 18 per cent. in London and 11·43 per cent. in other places, or 12·48 upon the mean. The 1,219 wires in London cost, in actual cash, £53 12s. 8d. apiece to erect them, and the 4,414 in the country £45 16s. each, and that money had all to be found and buried in the earth, or put into the air, before they got a sixpence of return upon it. Now what became of those fallacies they had had drummed into them by a great many people—adventurous persons—and, what was more singular, by reputable organs which directed the public intelligence? Those figures could not be controverted, but they were inconvenient for certain people. Now, as to the awful rapacity of the company in regard to its charges: the average subscription in London for the whole year was £14 10s. 6d., and in the country £8 10s. 10d. That did not seem to be such a very extravagant charge, in any case, nor was the disproportion in London so great as they made it out to be, when they considered that London cost £53 12s. 8d. each wire, and more, to work, as against the cost in the country of £45 15s. The fact was, they wanted four or five years' subscriptions in hand to pay the first actual cost before a single telephonic message could be sent. The Post Office royalties came to no less than £89,000 of hard-earned sovereigns. What would be the effect if the Chancellor of the Exchequer could be persuaded to forego the royalties? Well, it would have the effect of taking £1 12s. 10d. off the London subscription, and thereby reduce it to a shade over £12, and it would take 18s. 2d. off the subscriptions in all other places. All that was conveniently ignored, and they were told that they should go to Stockholm or Norway, or some remote parts of the world for parallels. Circumstances had arisen which had seriously affected the comparison for the whole year, because in the year ended December, 1896, they had some portion of the trunk revenue, whereas that trunk revenue had entirely disappeared in the year ended December 31st last. They had, however, made up the loss sustained, which was a considerable figure. He did not know whether the substitution of the dual trunk system for their old one had improved the general convenience. In some places it had, but in other places they heard complaints that it was not quite so good as it used to be when the company was the sole worker of it. Of course, there was now a multiplication of delicate operations, anyone of which might fail and cause inconvenience or delay.

Lord Harris seconded the motion, which, after some remarks by Mr. Hastie, was agreed to.

The Kensington and Knightsbridge Electric Lighting Company, Limited.

The directors' report states that during the year the number of houses and shops connected with the system has increased from 1,325 on December 31st, 1896, to 1,620 on December 31st, 1897; while the number of lamps calculated on the usual basis of 8 candle-power has increased from 119,955 to 137,953. Additional capital required by the company during the year has been raised by the issue of £1,160 4 per cent. debenture stock, producing £1,240 and 2,000 second preference shares, offered to the shareholders at a minimum price of £6 per £5 share, were subscribed for, producing £12,219 12s. 6d. The directors have strengthened the renewal account by transferring to it £8,061 7s. 1d., making the total amount placed to that account £20,497 13s. 10d. After providing for the above amount, and paying the dividends on the 6 per cent. first preference shares to June 30th, 1897, on the 5 per cent. second preference shares to September 30th, 1897, and an interim dividend at the rate of 8 per cent. per annum on the ordinary shares for the first half of the year, the balance standing to the credit of the net revenue account for the year 1897 is £7,263 11s. Of the above sum, £1,450 has been appropriated to the payment of the first preference dividend to the end of the year, and £300 has to be set aside to meet the portion of the dividend on the second preference shares accrued to the same date, leaving £5,513 11s., out of which it is proposed to pay a further dividend on the ordinary shares, at the rate of 12 per cent. per annum for the past half-year, making, with the interim dividend paid to June 30th, 10 per cent. for the year. This will leave a balance of £1,163 11s.

Bristol Tramways Company.

The half-yearly meeting of this company was held last week, the chairman (Mr. W. Butler) presiding.

The Chairman, in moving the adoption of the report and the declaration of a dividend at the rate of 6 per cent., said: Our receipts from the tramways' department show an increase of £9,494; this is, of course, largely made up of receipts from additional lines opened during the half-year, though by no means an inconsiderable portion of it is contributed from the horse lines, on which in consequence of better weather and increased service we have received more money. On the expenses side we can hardly give any minute comparison, as the amount of work done during the half-year so far exceeded that of the corresponding period. Under the heading of "horseing and traffic expenses" you will observe that the one item showing a large increase of nearly £3,000 is "wages of staff," which now amounts for the half-year to over £20,000. With regard to the items under the heading of "general expenses," these too have increased somewhat, consequent upon the additional business: the same remark applies to "renewals and repairs." We shall find that the repairs and maintenance of our tramway permanent way and rolling stock will cost very much more now that we have a large proportion of our system worked by mechanical power. The balance of net revenue is £16,859, against £12,378 in the corresponding half, being an increase roundly of £4,500, but this is as it should be, seeing that our total capital expenditure is £100,000 more than it was at this time last year. We have now had between two and three years' experience in the working of electric lines, and to-day, out of a total route length of 20 miles, no less than 8½ miles are worked by us as electric lines, leaving 11½ miles of horse lines, so that we have got practical acquaintance in not only the receipts, but the expenditure side of the account. It will be seen from our balance-sheet that, notwithstanding this large proportion of electric lines, we are no more than holding our own in the way of dividend-earning capacity. Many who have been shareholders for years past know that the normal working expenses were about 80 per cent. Since the advent of electric traction on nearly half our system we have managed to reduce the average to 75 per cent. We are generally credited throughout the country—at least in tramway circles—with being able to work a tramway as economically as most people, but I may tell you that our experience of electric traction, after 2½ years, goes to show that our working expenses in that department cannot be reduced below 60 per cent.

The chairman then proceeded to criticise the attitude taken up by the Electricity Committee of the Corporation, and eventually the report was adopted.

G. R. Blot & Co., Limited.

A statutory meeting of this company was held at Cannon Street Hotel last week, Mr. Thomas Parker in the chair.

The Chairman said the future of the company was well secured owing to the fact that they had orders in hand and in view, and a very effective staff to carry out the requirements of the company. The capital of the company had been largely subscribed by English and French shareholders, and there were amongst both some very influential people. The French company, La Compagnie des Accumulateurs Electriques Blot, had been very successful, and has just received an order from the "Secteur" of the Champs Elysées, for a battery of 10,000 ampere-hours, discharging at the rate of 2,000 amperes per hour, one of the largest batteries in the world (if not the largest). Those who knew something of accumulators will understand the magnitude of this one, and he questioned if there was so large a one at present built. The company had 15 tons of plates to handle per week, so that we had every reason to hope that they will do quite as much at their factory at Wednesfield. The directors were proceeding as quickly as possible with the erection and fitting out of our new works near Wolverhampton, and in a few weeks would be able to commence delivery of accumulators on a large scale. The new company had everything in its favour: works admirably situated, with every facility for cheap transport by canal, railway, and the like. The freights being so reduced and rent so cheap, it was more than probable that handsome dividends would soon be paid. Situated as their works were right in the very heart of the electrical world, there was every reason to hope for a favourable result.

Elmore's French Patent Copper Depositing Company.

Mr. J. H. Duncan presided, on Wednesday, at Winchester House over a meeting of the first mortgage debenture holders of the above company to consider a proposal for the purchase of the founders' shares of the Société Française d'Electro Metallurgie, which constitute, practically, the main asset of the company. The sale of the shares would enable the sum of 6s. in the £ to be paid to the first mortgage debenture holders in discharge of their debt.

The Chairman said that for many months he had been trying to get an offer for the founders' shares of the French company which would be acceptable from their point of view. It had taken him many months to work from one figure to another until he got in the neighbourhood of £10,000, and then he thought it worth speaking to them about. They would remember that the company was taken out of liquidation at the time they sold to the French company under a scheme provided by the Court, which gave to them, as creditors, a first charge, represented by debentures for £35,000. Practically the one asset they then had in their hands was the bulk of 5,000 founders' shares, and certain rights upon the French company, viz., that after 10 per cent. had been distributed to the French shareholders, there should be a certain surplus coming over to them—he thought it was about 35 per cent. of the surplus profits to come to them. He did not know whether any of them was sanguine enough to think there would be any surplus coming. They took it simply as it was offered; they had had £60,000 from the company in other ways, and they had to take it. As a matter of fact, the Frenchmen had had to raise an immense amount of capital; they had had two increases of the capital, and were talking about a third, and had found that to work up a copper business, they had to pour a good deal of solid gold into it. A French company paying 10 per cent. was a *rara avis*, and it would be well to build a museum to put it in. He did not think that 10 per cent. would ever be put, and seeing a chance of getting something solid for the debenture holders, he thought it his duty to do so. They had a small amount of £600 in hand, and a few bonds, worth £1,000, and they had also £800 of shares in the company. Altogether, after paying certain liabilities and expenses, they would have left about £12,900. In the circular they suggested that 6s. should be paid to the debenture holders, but that would only take £10,300, and the sum they had would really pay 7s. 4½d. He would move that the 6s. be paid, but it was open for them to propose more.

Mr. Shummer seconded the motion.

Mr. Holmes moved that 7s. 4d. be paid.

Mr. Saunders said he would like to move that an honorarium be given to the chairman, who had worked so hard for the debenture holders.

After discussion, it was agreed that 7s. 4d. in the £ be paid, but that 5 per cent. should be divided for the amount to be paid to the debenture holders *pro rata*, and presented to the chairman for his valuable services.

The India-Rubber and Gutta-Percha Company, Limited.

An ordinary general meeting of this company was held at Cannon Street Hotel on Wednesday, the Hon. Henry Marsham presiding.

The Chairman said that, in accordance with the wish expressed by shareholders, the debtor and credit side of the balance-sheet had been expanded; the contingent liabilities were also set forth. The turnover in the general business had been greater than that of any previous year, and the first six weeks of the present year showed a still further increase. On the other hand, very keen competition was met, and the desire to keep up the quality of goods made their task an arduous one. The rise in the price of rubber had had the effect of compelling the principal manufacturers to notify increase of prices in rubber goods. Their steamers had been employed during the year, and the works at Silvertown and Persan were being kept in a state of efficiency. After referring to the strike, which closed one department of their works, the chairman said that the normal condition of things had been restored. The great fire at Melbourne had destroyed their agency there, but the agent had informed them he had secured fresh offices, and their claims would be shortly made on the fire offices.

He concluded by moving the adoption of the report, Mr. Silver seconded.

General Trevor objected to the form of the auditor's certificate, and asked if it could not be altered. After some discussion the board promised to bring the recommendation of the shareholders to the auditors.

The resolution was then adopted, and the retiring director and auditor re-elected.

W. T. Henley's Telegraph Works Company, Limited.

The report of the directors states that of the £50,000 additional capital authorised by the extraordinary general meetings held in the spring, the directors limited the present issue to £25,000, reserving the remainder for future needs. The whole of the £25,000 was taken up by the shareholders or their nominees at 60 per cent. premium, enabling the reserve to be increased by £15,000. After negotiations with the local authorities (protracted for several years), Victoria Road, which intersected the works at North Woolwich from east to west, has been legally closed, and its site added to the company's property, which now lies within a ring fence. This great advantage was not obtained without the payment of a sum of £2,000 to the Woolwich Local Board of Health to be applied to some purpose of public utility. The annexed accounts show that during the past year a net profit has been made of £29,584 19s. 7d. After payment of debenture interest and income-tax, and making ample allowance for depreciation of buildings, plant, machinery, &c., there remains £23,936 5s. 7d., making with £14,294 6s. 7d. brought forward from last year a total of £38,230 12s. 2d. From this sum has to be deducted the £500 voted to the directors at the last general meeting, leaving £37,730 12s. 2d. available for distribution. The directors have transferred £7,500 to the reserve fund (in addition to the £15,000 premiums above mentioned), and they recommend the payment of the following dividends, viz.: on the preference shares 7 per cent., including the interim dividend of 3½ per cent. paid on September 1st last. On the ordinary shares at the rate of 12 per cent. per annum, including the interim dividend of 3 per cent. also paid on September 1st last. These payments will together amount to £22,941 0s. 7d., leaving £14,789 11s. 7d. to be carried forward.

Manchester Carriage and Tramways Company.

A special general meeting of this company was held in Manchester last week for the purpose of considering a Bill proposed to be introduced into Parliament in the present session to enable the company to work their tramways by mechanical power, and for other purposes.

Sir J. J. Harwood said that the common sense of the Bill was that outside Manchester and Salford there were a number of local authorities interested in some way or the other in tramways. If they were to determine that their tramways should be worked by electricity, it would be necessary for someone to find the electric current. The authorities would probably not provide it themselves. If they did, he dared say it would be all right for those who were intending to work the tramways. The Manchester Tramways Company had a very large interest in tramways outside the city and outside the borough of Salford, and if it should be found necessary to put down appliances and erect buildings for generating electricity, this Bill would enable them to go to the outside authorities and say that if they did not intend to produce the power for themselves, the company had power to produce it for them, and they could enter into a mutual arrangement with each other. If the authorities, on the other hand, decided to create the power for themselves, the company might try to arrange to use it.

The Bill was approved by the meeting.

The Notting Hill Electric Lighting Company, Limited.

The directors' report states that the expenditure on capital account at the date of the last balance-sheet stood at £99,104 17s. 6d., and during the past year a further sum of £14,079 7s. 10d. has been expended, chiefly accounted for by £11,769 13s. 11d. for mains. The total capital expenditure is, therefore, £113,184 5s. 4d., which is £3,184 5s. 4d. in excess of the capital issued. The balance due at the beginning of 1897 on the preference shares, £3,160, was called up and duly paid during the year, thus making the whole share capital of £100,000 fully paid up.

As announced in the report of 1896, the sum of £10,000 was raised by the issue of 4 per cent. first mortgage debentures maturing in 1931, and redeemable in 1907 at the option of the company by paying the debenture-holder a bonus of 5 per cent. These debentures were issued at the price of 106 per cent., and the applications were considerably in excess of the amount required. In accordance with the debenture trust deed, the amount of these first mortgage debentures is limited to 50 per cent. of the share capital actually issued and paid up. At present, therefore, there are £40,000 of debentures available for additional expenditure. The capital expenditure during the current year is estimated at £7,000, for which further debentures will be issued.

The following table shows the progress of the company:—

				£	s.	d.
1891	Lamps	6,056	Loss	554	18	6
1892	"	9,438	Profit	112	6	1
1893	"	12,153	"	1,481	7	1
1894	"	15,669	"	2,101	17	8
1895	"	20,307	"	3,227	14	10
1896	"	25,716	"	4,736	9	8
1897	"	33,000	"	6,854	1	2

The directors have set aside £1,000 for the depreciation and reserve fund, and have paid a dividend of 6 per cent. on the ordinary preference shares for the year ending December 31st, 1897, amounting to £1,767 14s. 4d. After payment of interest and leasehold redemption a balance is left of £3,884 18s. 1d., out of which the directors recommend that a dividend be declared on the ordinary shares at the rate of 6 per cent., less income-tax, which will absorb £3,871 4s. The sum of £401 16s. 2d., being the premiums received on the issue of £10,000 first mortgage debentures, after deduction of the legal and other expenses, has been written off the preliminary expenses account.

The company has hitherto supplied current at the standard pressure of 100 volts, the price charged being 8d. per unit. In March last the directors decided to supply current at a pressure of 200 volts, at a charge of 6d. per unit, less the usual rebates for long hours. It is not proposed to disturb existing contracts on the old basis, but every facility is given to those desiring to change. A contract has been entered into with the National Electric Free Wiring Company, Limited, which will enable intending consumers to obtain current without initial outlay for wiring or fittings. This only came into force at the latter end of the year, and already 17 houses have been connected on these terms. Very considerable inconvenience has been caused to the engineering staff by the non-delivery of the new and additional machinery ordered in the early part of last year, owing to the labour troubles in the engineering trade. Fortunately the company were able to meet all demands on them without any accident or break-down. Great credit is due to the manager and the staff generally for their care and energy during this very anxious time, which happily is now passed.

Blackpool and Fleetwood Tramroad Company.

The half-yearly meeting of this company was held in Manchester last week, Mr. G. Richardson, deputy-chairman, presiding.

The Chairman said that the balance-sheet showed the company had expended £82,000 on capital account up to January 17th, and they had got a small amount back by the sale of materials. He hoped that at the next annual meeting they would be able to present a satisfactory revenue account from the receipts they would expect to get on the opening of the line. The progress of the works had been satisfactory so far, and they had every expectation that the line would be opened for a great portion of the summer traffic. They had got all the rails down from the Glynn into Fleetwood. The works that were not progressing so quickly were those which the Corporation had in hand. The weather had been very bad, and they had had to contend with it. When the line was finished they would have a tramroad at a very low cost. It was stated that by June the line would probably be open right from Talbot Road Station, Blackpool, to Fleetwood. The meeting authorised the issue of £40,000 debentures.

Telegraph Construction and Maintenance Company.

The report of the directors states that the accounts for the year show a net profit of £61,131, after charging the interest on the debentures. To this sum must be added £39,940 brought forward from last year, making a total of £101,071. From this amount is deducted the interim dividend of 5 per cent., paid July 20th, 1897, amounting to £22,410, leaving £78,661 to be dealt with. Of this sum the directors propose to distribute a dividend of £1 4s. per share, absorbing £44,820, being at the rate of 10 per cent., and making, with the amount already paid, a total dividend for the year of £1 16s. per share, or 15 per cent., free of income-tax, leaving £33,841 to be carried forward to the next account.

Scarborough Electric Light Company.

The sixth annual general meeting of this company was held last week at Scarborough. Mr. George Alderson-Smith, J.P., presided, and in moving the adoption of the report and balance-sheet, said the company during the past year had spent more money than previously, but it had had an effect which was satisfactory. In Scarborough they were handicapped by the price of coal. In Leeds £17,000 of current was produced with a coal bill of £875; in Scarborough the current amounted to £5,300, and the fuel to £1,138. Perhaps a small destructor might be placed on the premises of the company, and as it was only a matter of time before the Corporation purchased the undertaking, it would be doing something towards the future.

Mr. J. B. Simpson seconded, and the report was adopted.

A dividend of 5 per cent. was declared.

Cape Electric Tramways Company.

The statutory meeting of this company was held on Wednesday at Winchester House, Colonel Sir Charles Euan Smith in the chair.

The Chairman, in speaking of the history of the company, said it was formed for the purpose of taking over, as going concerns, the tramway companies then existing at Cape Town and at Port Elizabeth. The company took over these tramways in good working order, and has since made many extensions and improvements, and the whole system is now worked by electric power. Since July 1st, 1897, until the completion of the six months ended December, 1897, the Cape Tramways Company has carried 3,300,000 passengers, which aggregates about 30 times the total population of Cape Town and its suburbs. For July last the traffic receipts showed the gross total of £5,587, but since then the earnings have steadily increased, and the total traffic receipts for December last amounted to £8,815, and January's total shows a further increase, the receipts amounting to £9,400. After giving further details of the system, the chairman said, for the six months ended December, 1897, 869,559 passengers have been carried on the Port Elizabeth system, and they have paid £11,984 in fares. Their receipts for last July—the first month of their operations—were £1,397, and the total receipts for December amounted to £2,734. Having regard to the earnings of the tramways, the directors were able to declare an interim dividend of 2½ per cent. on the last six months' working, notice of payment of which will be given in the usual course.

After further remarks the meeting terminated.

County of London and Brush Provincial Electric Lighting Company.—The directors have decided to recommend payment of a dividend on the preference shares for the six months ended December 31st last, at the rate of 6 per cent. per annum, less income-tax, carrying forward £10,000 to next account. The transfer books and register of members will be closed from 1st to 14th prox., both days inclusive, preparatory to the payment of the preference dividend. The ordinary general meeting will be held on 14th prox., at 2 p.m., at Winchester House.

Buenos Ayres and Belgrano Tramways Company.—The transfer books will be closed on and after to-morrow for repayment at par with accrued interest on 1st prox., of the stock held by proprietors who have not accepted the option of conversion into the 5 per cent. debenture stock of the Buenos Ayres and Belgrano Electric Tramways Company, Limited.

Stock Exchange Settlements.—The Stock Exchange Committee has (1) appointed Wednesday, March 2nd, a special settling day in Electric Construction Company, Limited.—£111,100 4 per cent. perpetual first mortgage debenture stock, and has ordered same to be officially quoted.

Telegraph Construction and Maintenance Company.—The transfer books will be closed from the 21st inst. to the 1st prox., inclusive, preparatory to the payment of dividend.

British Electric Traction Company.—The letters of allotment and regret in the issue of 10,000 6 per cent. cumulative preference shares were posted last week.

TRAFFIC RECEIPTS.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending February 18th, 1898, were £2,399 2s. 8d.; corresponding period, 1897, £2,088 7s. 11d.; increase, £310 14s. 9d.

The City and South London Railway Company.—The receipts for the week ending February 20th, 1898, were £1,051; week ending February 21st, 1897, £1,044; increase, £7; total receipts for half-year, 1898, £8,565; corresponding period, 1897, £8,717; decrease, £152.

The Dover Corporation Electric Tramways.—The receipts for the week ending February 19th, 1898, £104 13s. 9d.; total receipts, February 19th, 1898, £747 17s. 11d.

The Dublin Southern District (Electric) Tramways Company.—The receipts for week ending Friday, February 18th, 1898, were £385 7s.; corresponding week last year, £484 1s. 8d.; decrease, £99 14s. 8d.; passengers carried, 65,874; corresponding week last year, 73,303; aggregate to date, £2,863 12s. 8d.; aggregate to date last year, £2,947 10s. 8d.; decrease to date, £83 18s.; mileage open, 8 miles.

The Liverpool Overhead Railway Company.—The receipts for the week ending February 20th, 1898, amounted to £1,320; corresponding week last year, £1,320.

The Western and Brazilian Telegraph Company, Limited.—The receipts for the week ending February 18th, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,819.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, Feb. 16th.	Closing Quotation, Feb. 23rd.	Business done during week ended Feb. 23rd, 1898. Highest.	Lowest.
137,400l	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	...	...	100 - 104	100 —104	...	...
25,600	Amazon Telegraph, Limited, shares...	10	...	...	...	6 — 7	6 — 7	...	...
125,000	Do. do. 5% Debs. Red.	100	...	...	...	93 — 96	93 — 96	...	...
923,960l	Anglo-American Teleg., Ltd.	Stock	£2 9s.	£2 13s.	3 %	60 — 62 xd	59 — 61	61⅛	58½
3,038,020l	Do. do. 6 % Pref.	Stock	£4 18s.	£5 6s.	6 %	110 — 111 xd	107½ 108½	110⅝	107
3,038,020l	Do. do. Defd.	Stock	...	...	...	12½ — 13	11¾ — 12¼	12½	11½
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	...	...	16¾ — 17¼	16¾ — 17¼	17⅛	16⅞
75,000l	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	...	...	112 — 116	112 — 116	...	...
44,000	Chili Teleg., Ltd., Nos. 1 to 44,000	5	4 %	4 %	...	3 — 3½	3 — 3½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	...	187 — 192	187 — 192	193	...
653,586l	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	106 — 108	106 — 108	107½	106¾
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	2 %	...	1/16 — 3/16	1/16 — 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	...	7½ — 8½	7½ — 8½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	...	17½ — 18½	15½ — 16½	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	...	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	...	10 — 11	10 — 11	10⅝	...
30,000l	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	...	103 —106%	103 —106%	...	...
60,710	Direct United States Cable, Ltd.	20	2½%	2½%	...	10¾ — 11¼	10¾ — 11¼	11 3/16	10 15/16
120,000	Direct West India Cable 4½% Reg. Deb.	100	...	...	...	98 —101	98 —101	99¾	99
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	...	18 — 18½	18 — 18½	18⅜	17⅞
70,000	Do. 6 % Cum. Pref.	10	6	6%	...	19 — 20	19 — 20	19½	19
89,900l	Do. 5 % Debs., repay. August, 1899	100	5 %	5%	...	100 —103	100 —103	...	...
1,302,615l	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4%	...	131 —134	131 —134	...	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7%	...	18¾ — 19¼	18¾ - 19¼	19⅛	18⅞
25,200l	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5%	...	99 - 103	99 - 103	...	...
100,500l	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5%	...	100 —103	100 —103	...	...
320,000l	Do. 4 % Deb. Stock	Stock	4 %	4%	...	130 —133	130 —133	...	...
51,100l	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5%	...	99 —103	99 —103	...	...
69,200l	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5%	...	100 —103	100 —103	...	...
300,000l	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1906	100	4 %	4%	...	102 —105	102 —105	...	...
200,000l	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4%	...	108 —111 %	108 —111%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	...	12 — 12½	12 — 12½	12 5/16	12⅛
180,042	Do. do. 6 % Pref.	10	6 %	6%	...	18 — 18½	17¾ - 18¼	18⅛	17 13/16
150,000	Great Northern Teleg. Company of Copenhagen	10	10 %	10%	...	27½ — 28½	27½ — 28½	28¼	27⅞
160,000l	Do. do. do. 5 % Debs.	100	5 %	5%	...	101 —104	101 —104	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10%	...	52 — 55	52 — 55	...	...
100,000l	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6%	...	108 —111	108 — 111	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	...	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5½%	5½%	6 %	6⅞ — 7⅛	6⅞ — 7⅛	7 1/16	6 13/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	15 — 17	16 — 18	17	16¾
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	14 — 16	15 — 17	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6 — 6½	6 — 6½	6 5/16	6⅛
130,766	Do. do. Nos. 119,235 to 250,000, £5 paid	5	...	...	5 % ...	6 — 6½	6 — 6½	6	...
329,471l	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	104 —109	104 —109	105¾	105½
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	⅝ — ¾	⅝ — ¾	...	...
100,000l	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	...	105 —108	105 —108	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	8 — 9	8 — 9	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	140 — 145	139 —144	142	140
58,900	United River Plate Teleph., Ltd.	5	4 %	...	...	4 — 4½	4 — 4½	4¼	...
146,733l	Do. do. 5 % Debs.	Stock	5 %	...	...	101 —106	101 —106	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	nil	...	4½— 4¾	4½ - 4¾	...	...
213,400l	Do. do. do. 5 % Debs.	100	5 %	5 %	...	103 - 106	103 —106	...	...
64,268	Western and Brazilian Teleg., Ltd.	15	3 %	2 %	...	10½ - 11	10½ - 10¾	10⅝	...
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	...	7½ — 8	7½ — 8	7¾	...
33,129	Do. do. do. Def. Ord.	7½	1 %	...	...	3½ — 4	3½ — 3¾	3½	...
362,230	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	105 —107	105 —107	106	...
88,321	West India and Panama Teleg., Ltd.	10	⅜%	1 %	...	½ — ¾	½ — ¾	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	8 — 8½	8 — 8½	8¼	8⅛
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	5 — 7	5 — 7	...	...
80,000l	Do. do. 5 % Debs. No. 1 to 1,000 ...	100	5 %	5 %	...	105 —108	105 —108	...	...
163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7%	...	105 —110	105 —110	...	...
160,100l	Do. do. 6 % Ster. Bonds.	100	6 %	6%	...	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share.	1895.	1896.	1897.	Feb. 16th.	Feb. 23rd.	Highest.	Lowest.
30,000	Charing Cross and Strand Electy. Supply	5	5 %	6 %	7 %	14 — 15	14 — 15	14½	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½xd	6 — 6½	6½	6⅛
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	...	11¾— 14¼	11½— 12	12¼	11¾
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	4½%	4½%	...	115 —117	115 —117	...	...
40,000	City of London Elec.Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	7 %	10 %	28½ - 29½	28½ - 29½	29½	28½
10,000	Do. do. Prov. Certs.	5	...	...	10 %	27½— 28½	28 — 29	27¾	...
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17½— 18½	17½ - 18½	...	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	129 —134	129 —134	131	...
30,000	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—30,000	10	*nil*	*nil*	*nil*	15¾— 16¼	15½— 16	15¾	15⅝
20,000	Do. do. do. 6% Pref., 40,001—60,000 ...	10	6 %	6 %	6 %	15¾— 16¼	15¾— 16¼	16	...
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5	...	...	...	10½— 11½	10½— 11½	11⅛	11 1/16
10,000	Do. do. 7 % Cum. Pref. ...	5	...	...	...	11½— 12	11½— 12	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	4 %	5 %	...	20 — 21	20 — 21	20 15/16	20½
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem. ...	10	...	...	...	19½— 20½	19½— 20½	20¼	...
220,000l	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	117 —121	117 — 121	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	2 %	4 %	6 %	18½ - 19½	19 — 20	19¾	...
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	7½%	10½%	14½%	18½— 19½xd	18½— 19½	19½	19
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	10 — 11 xd	10 — 11	...	...
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	4 %	107 —110	107 —110	...	...
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2⅞— 3⅛	2⅞— 3⅛	3⅛	3 1/16
79,900	Westminster Electric Supply Corp., Ord., 101 to 80,000 ...	5	7 %	9 %	12 %	18 — 19	18 — 19	18¾	18⅛

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked ¶ are for a year consisting of the latter part of one year and the of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation Feb. 16th.	Closing Quotation, Feb. 23rd.	Business done during week ended Feb. 23rd, 1898. Highest	Lowest
30,000	British Electric Traction	10	...	...	...	17½— 18	17½— 17¾	17½	16¾
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	2	...	...	...	2 — 2¼	2 — 2¼	2 1/16	2
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	...	...	2⅛— 2⅜	2¼— 2½	2 7/16	2¼
125,000*l*	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	...	...	...	109 - 113	109 —113	...	...
50,000	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	102 —105	02 —105	...	...
19,126	Central London Railway, Ord. Shares	10	...	...	...	10½— 11	10½— 11	10⅞	10⅝
143,106	Do. do. do. £6 paid	10	...	...	...	6½ — 7	6½— 7	6⅝	6¼
58,830	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1½ — 2	1½ - 2	1⅞	1 11/16
61,777	Do. do. Def. do. £5 pd. ...	...	...	...	...	4¾ — 5	4¾— 5	5	4 11/16
630,000*l*	City and South London Railway	Stock	1 3/16 %	1 3/16 %	1⅞ §	68 — 70 xd	66 68	68½	66
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	nil	...	...	2¼ - 2¾	2¼— 2¾	...	...
99,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 99,261	5	5 %	5½%	...	2⅜— 3 xd	2⅜ - 3	2 13/16	...
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5½%	...	4 — 5xd	4 — 5	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	5 %	6 %	...	2⅝ - 2⅞	2⅝— 2⅞	2 13/16	2 11/16
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 ...	2	7 %	7 %	...	3⅛ - 3⅜	3⅛— 3⅜	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	...	...	...	½— ¾	½— ¾	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,285, issued at 1 pm. ...	2	...	...	...	⅜ - ⅝	⅜ - ⅝	...	...
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	10½%	...	...	9 — 11	9 — 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	8 %	10 %	12 §	22½ - 23½	22½ 23½	23¼	23 1/16
8,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	19 — 20	19 — 20	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½ §	112 - 117	112 —117	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 §	22 — 23	22 — 23	22⅝	22⅜
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	103 —107	103 —107	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	2⅞%	2⅞%	3¼	10 13/16 - 11 1/16	10 13/16 - 10 15/16	...	...
18,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5	15¾— 16¼	15¾ - 16¼	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	15 %	15 %	39 — 42	39 - 42	40½	39
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105	...	...
54,000*l*	Waterloo and City Railway, Nos. 1 to 54,000	10	...	...	...	13¾— 14¼	13¾— 14¼	14¼	13⅝

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—6%; 1891—7%; 1890—8%.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

* Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅜, £5 (fully paid) 11.

Electric Construction Corporation, 6 % Debentures, 105—107.

House-to-House Company, 4½% Debentures of £100, 109—111.

Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 16¾—17¼; 1st Preference Cumulative 6 %, £5 (fully paid), 8½—9. Dividend, 1896, on Ordinary Shares 7 %.

London Electric Supply Corporation, £5 Ordinary, 4⅝—4⅞.

* T. Parker, Ltd., £10 (fully paid), 14¼.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8—8½. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount 3 per cent. (October 14th, 1897).

INSTITUTION OF ELECTRICAL ENGINEERS.

On the Manufacture of Lamps and other Apparatus for 200-Volt Circuits. By G. Binswanger Byng, Member. (Paper to be read February 24th, 1897.)

In the progress of electrical industry, manufacturers have become accustomed to sudden demands arising from a discovery or a successful experiment, and I propose to deal with apparatus which manufacturers are called upon to make to meet the requirements of the latest innovation—*i.e.*, the distribution at a potential of 200 to 230 volts. Central station engineers have thus arranged their three-wire system, relying upon makers to successfully alter lamps and minor fittings incidental to such a change. Their expectations have been fulfilled in a measure only. The ultimate success of the high-pressure system will depend largely upon the verdict of the consumer, and he will give it in its favour only if his fittings, in points of efficiency, economy, safety, convenience, and appearance, approach the standard which he can obtain by means of the lower voltage system.

It is, therefore, of importance that the central station engineer should assist the manufacturer to arrive at such perfection. His instructions, so far, have hardly gone beyond the demand to supply him with fittings to conform in appearance to the 100-volt system. It is true each central station has issued rules, but they are of little help to the manufacturer, and their very disconformity shows that there is neither unanimity nor correlation of ideas between the engineers in charge.

What is wanted is to have a thorough interchange of opinion of engineers, contractors, and manufacturers. The latter would then know theoretically how far they may satisfactorily depart from the present practice, and thus save much time and money in adventitious experiments; and this also might tend to produce some degree of standardisation—much to be desired in the interest of all who have the success of the new system at heart.

With this object in view I bring this paper before you, and I think I can best serve the purpose by describing the chief appliances now upon the market, or under manufacture at my works, pointing out the existing deficiencies, and giving you my views upon the attainment, as far as possible, of higher perfection.

Incandescent Lamps.

Most important in connection with this subject is the incandescent lamp.

The lamp manufacturers have been compelled to supply 200-volt lamps at a given candle-power and efficiency, in the same size bulbs as are used for 100-volt lamps. With flashed carbon the manufacturers meet with the great practical difficulty of properly disposing their long, thin, 200-volt filament in the same space as their shorter and thicker 100-volt filament, and therefore most of them solve this problem by resorting to a filament of much higher specific resistance than would be given by the flashing operation.

Unflashed Filaments.—Such a lamp is ready to the maker's hand by simply taking his ordinary carbon filament as it exists before being flashed—that is to say, before it is reduced by a fresh layer of carbon being deposited on the surface of the original filament.

The higher specific resistance of an unflashed carbon enables one to easily get over the difficulty of size of bulb, as such a filament will give the necessary resistance by taking a shorter length. Such filaments have also a greater emissivity, owing to the darker and rougher nature of their surface than that of flashed filaments; consequently they require a less amount of surface per candle-power, and therefore the mass of an unflashed filament, at a given candle-power and efficiency, is less than that of the flashed filament.

The filaments of high-voltage lamps largely used to-day are therefore, in other words, faster converters of energy into heat and light than flashed filaments of the same candle-power and efficiency, although the watts supplied to each be the same.

On comparing the behaviour of such 200-volt lamps with that of 100-volt lamps, the roughest of tests shows that there is a far more rapid falling off of candle-power during life with the former than the latter. At the same time the efficiency of an unflashed lamp decreases in a given number of hours by a far greater percentage than is the case with the flashed lamp. Mr. Robertson has made a series of life and efficiency tests on high-voltage lamps. They show that in the average unflashed 200-volt 16-C.P. lamp the percentage loss of candle-power in 600 hours is about 42 per cent., and the average drop of efficiency is about 35 per cent.

These two quantities seem to cover the chief practical merits desirable in an incandescent electric lamp—*i.e.*, the lamp which has the best percentage retention of original candle-power during its life, together with the best average percentage retention (or increase) of original efficiency during its life.

These tests show that these most desirable points, which have been worked on diligently for the last 13 years, have had to be thrown on one side in order to bring about the possibility of using the same sized bulb for a given candle-power at 200 volts as at 100 volts.

Tests of the behaviour of unflashed high-voltage lamps show that such lamps sometimes increase in candle-power during the first 100 hours or so. This also happens with badly carbonised or badly flashed 100-volt lamps (noted by Prof. Ayrton in some of his recent lamp tests), owing to the initial lowering of their resistance in consequence of their not having been properly carbonised in the first instance; and this is often accompanied by a great alteration in the character of the surface (emissivity) of the filament. The carbonising or baking progress is therefore still going on in the lamp, and the two above-mentioned changes coming together mask the fact that a great deterioration of the filament has taken place; but a period is quickly reached when this fact is no longer masked. This period is when there is no further decrease of resistance; but the surface deterioration still goes on, and thus soon brings about a large percentage fall of candle-power, and on the slightest increase of voltage there is now a tendency to increase resistance. These changes seem to be initially owing to the fact that the (unflashed) high specific resistance carbon is far more volatile than is the case with a good flashed carbon.

A microscopical examination of a flashed and unflashed filament, after each has been running 100 hours, shows that the surface of the flashed filament is still quite smooth and shiny, whereas the surface of the unflashed filament has become very dull, sooty, and often full of small pit-holes. These pit-holes and soot form a large increase of surface; which therefore increases the emissivity of the filament, and consequently lessens its candle-power, as the watts supplied keep the same.

The property of an unflashed filament becoming so rapidly less efficient (increasing in watts per candle-power) acts as a preservative, because the increased emissivity lowers the temperature. This lowering of temperature decreases both the tendency to volatilise, and also to further great change of resistance. This power of self-preservation leads to such a filament giving some satisfaction to the general public, for the latter is satisfied when it obtains a good average, or sometimes an excessively long-life lamp; but this is a very false economy, as it is only purchased by a very great falling off in actual efficiency.

Mr. Robertson's experience with carbon filaments seems to point to the fact that *it is impossible to obtain a carbon filament of high specific resistance without its being accompanied by at least the defect of greater volatility*. In other words, the lowest specific resistance carbon is the best, because it is less liable to evaporation, and therefore it gives the best retention of original candle-power and efficiency, and it is also mechanically stronger.

The specific resistance of many of the present types of 200-volt lamps is about 3,500 to 5,000 microhms per cubic centimetre, whereas it is easy to obtain flashed carbons whose specific resistance is as low as 2,400 microhms per centimetre; and even as low as 300 is possible, but not practicable.

Gases.—Another important consideration to bear in mind as to whether the high or low specific resistance carbon is the best, is that the high specific resistance filaments retain their occluded gases in a far more persistent degree than is the case with the low specific resistance flashed filaments.

It is probable that the occluded gases arising from the carbonisation of the filament are, by means of the flashing process, driven off to a large extent; and, in addition, the more dense and impervious nature of the flashed surface prevents the filament from absorbing the gases during its subsequent handling or treatment. This absorption is a property possessed by all carbon bodies in some proportion, varying with their density.

This greater power of unflashed carbon to absorb gases and to retain what it has absorbed, than is possessed by flashed carbon, leads in many instances to sudden deterioration of the vacuum in a finished lamp, accompanied by short-circuiting as soon as the pressure and the condition of the residual gases in the bulb has reached its most conductive point.

The consensus of opinion at the present day of the average types of high-voltage lamps undoubtedly points to the fact that a large percentage are expected to short-circuit as soon as they are put up, and I have heard several engineers say that they expect about one in twelve to go in this way.

From these causes, and others relating to the treatment of filament pointed out above, there seems to be no doubt that the average 200-volt lamps have a shorter life than 100-volt lamps. The above experiences have led Mr. Robertson to design all high-voltage lamps that are not restricted by size with well-flashed carbon filaments, and such lamps compare favourably with lower voltage lamps.

Horizontal Burning.—Another question which is very important in considering 200-volt lamps is that of horizontal burning, and contractors should take special notice of this. There is no doubt whatever that almost all the present-day 200-volt lamps are only suitable for burning in a vertical position. As soon as any other position is adopted defects become prominent. The long thin filament soon drops on to the bulb and cracks it. Also electrostatic attractions, owing to higher voltage, cannot be resisted by the long thin filament, and this is an additional cause of the filament approaching the bulb.

The effect of electrostatic attractions on long thin filaments is even noticeable with lamps burning in a vertical position. Such lamps have to be designed with the object of making their filaments more rigid, and to be thus able to withstand the effects of gravity and electrostatic attractions exerted by the charge on the bulb; and this is the chief point which makes high efficiency 200-volt lamps so difficult to produce. There is, therefore, a tendency, in trying to avoid the defects just mentioned, to make 200-volt lamps as low in efficiency as possible.

Leading-in Wires.—Another fault that exists with the bulk of the present forms of high-voltage lamps is that, owing to the same size bulb being retained, no greater separation can be given between the leading-in wires of the lamp. This is a special difficulty with high-voltage lamps which contain two filaments, as in this case the same size cap is used, and four wires are passed through the sealing point instead of two, and they are therefore more crowded together. This question of distance apart of leading-in wires is a vital one, both in the manufacture of the lamp and in its after use. In the case of unflashed carbons this becomes a still greater defect, owing to small distance combined with probably greater gaseous emanation.

The higher the voltage, the sooner are these defects made manifest. Even with 100-volt lamps there is, under certain conditions, a tendency for current to jump across from pole to pole, owing to the remanent gases in the bulb attaining a high state of conductivity. The greatest conductivity of the remanent gases which lead to sudden short circuiting appears to be when the pressure is about 0·01 mm. But, by reason of a continued discharge taking place in all lamps, there seems to be a tendency for the residual gaseous molecules to arrange themselves in a straight path between each pole. Through such a path discharge will take place even in a better vacua than 0·01 mm.

This leakage current (sometimes called the "Edison effect") which leads to short circuiting is very prominent during manufacture of high-voltage lamps, and to avoid it, greater care is required as the voltage increases.

If the size of a bulb for a high-voltage lamp is to be restricted to the present dimensions, there is no doubt that the best lamp would still be that which has a single filament, were it not that other vital questions step in.

Electrostatic effects also increase with the voltage, and several most promising patterns of lamps, from all other points of view, have had to be put on one side on this account.

As to the best forms of cap for high-voltage lamps, preference will naturally be given to those in which the poles can be kept furthest apart.

If a B.C. or E.S. cap were on a larger scale, there is no doubt that considerable benefit would accrue. The simplest holder, with the least moving parts and for always making the best contact, is undoubtedly the Edison screw, which, in the cases of excessive vibration, can be made with a locking device.

The slightest want of insulation in the cap between the poles eventally leads to a large leakage current between them or the cap and one of the poles, and in many cases this is suddenly established to such a large degree as to result in the complete fusion of the lamp cap, and sometimes the holder. In such cases a non-metallic lamp cap seems to offer great advantages, and has, in my experience, removed complaints on this score.

Standard Voltage.—From a lamp maker's point of view, a fixed standard of voltage and efficiency would only lead to an increased cost in manufacture, and the present practice of varying efficiencies with voltages, running in the case of low-voltage lamps from 95 to 120, and in the case of high-voltage lamps from 200 to 230, tends to keep the lamp at a lower cost than if these efficiencies or limits of voltage were more restricted.

On the other hand, voltages which lie outside these limits are a source of great expense to the manufacturer. It would, therefore, tend to cheapen lamps if a standard of voltage were adopted which lay exclusively between the above or even smaller limits, but at varying efficiencies.

Combination Filaments.—In order to get over the difficulty of size of bulb, &c., many filaments (beyond the unflashed pure carbon derived from cellulose in some form) have been introduced which have a high specific resistance. This can only be obtained by using a less dense form of carbon than has hitherto been found most satisfactory in low-voltage lamps.

A form of high specific resistance filament that has been tried is where the carbon has been admixed with various oxides, borates, and silicates of the earths. In addition to mixtures, electrolytic and chemical deposits of these bodies on the surface of carbon have also been tried; but, although it is a simple matter to obtain baked carbons containing these bodies, either incorporated with the carbon or on the surface thereon, it is quite another matter to obtain a finished lamp containing these bodies in a form to be of any practicable use. The difficulties met with are apparent as soon as the lamp is incandesced while undergoing exhaustion.

If such lamps be incandesced to a temperature exceeding about 5 watts per candle-power, there is a gradual separation by evaporation of these bodies from the carbon, and their resulting deposition on the surface of the lamp bulb.

The temperature of incandescence of the filament, in order to obtain any advantage which might be derived from the "luminescence" of the rarer earths is apparently greater than 5 watts per candle-power; and as, as above stated, it has been found impossible to so evacuate a lamp as to leave any of the "luminescent" bodies incorporated with the filament at temperature higher than 5 watts per candle-power, the object sought for is consequently defeated.

From the above, it seems that, with our present knowledge, the best form of 200-volt lamp is that which has a well-flashed low specific resistance pure carbon filament in a large bulb, with a well-insulated moisture-proof cap allowing the poles to be placed at a reasonable distance apart. It should consist of a single filament, and be so disposed in the bulb that it can withstand the disturbing effects of gravity and electrostatic charges on the bulb.

I wish to mention here that my co-director, Mr. Robertson, has given me great assistance in the remarks I have made upon lamps.

Switches.

I come now to the matter of adapting switches, wall plugs, ceiling roses, lampholders, and minor fittings.

I do not apprehend any difficulty in changing existing types from the present standard of use to conform to the higher standard, yet maintaining the same appearance and size, and, when sufficiently in demand, approximately the same cost. The chief alteration will be in the increased break, and better insulation of the two poles. In smaller articles, such as combined switches and lampholders, the difficulty, if any, is more apparent. A discussion bearing upon the subjects involving the use and construction of double-pole switches, length of break, standardisation of terminals, position of fuses, the carrying capacity of contacts, &c., would be, to my mind, of great value.

(*To be continued.*)

TESTS OF THE SYNCHRONOGRAPH ON THE TELEGRAPH LINES OF THE BRITISH GOVERNMENT.*

By ALBERT CUSHING CREHORE and GEORGE OWEN SQUIER.

(*Concluded from page 244.*)

Under the latter condition the synchronograph and Wheatstone receiver sent 666 words per minute, corresponding to 266·4 complete waves of current per second. The coils of the receiver were joined in parallel, and no condensers were used. Voltage, 175. In this line, where the mechanical limit of the Wheatstone receiver is reached before the speed is limited by the total value of K R of the line, it is seen how the perfect regularity, equality and shape of the sine waves materially increased the speed of the Wheatstone receiver.

With the synchronograph and chemical receiver the alternator was run higher than before, until a rate was attained of 1,446 single impulses per second.

With the line earthed the Wheatstone transmitter and receiver sent 360 words per minute with a voltage of 100. The synchronograph and Wheatstone receiver sent 540 words per minute, voltage 200. The receiver coils were in parallel, and a condenser was shunted across the coils. No limit was obtained in this experiment.

The longest line as yet tested, of 1,097 miles, was then made up, from London to Aberdeen *viâ* York and Edinburgh, and return *viâ* Glasgow and Leeds. A portion of the line north of Edinburgh was iron wire upon the same poles, going and returning. With no earth the total K R was 65,304.

Wheatstone transmitter and receiver sent over this line 185 words per minute, voltage 100. Synchronograph and Wheatstone receiver sent over this line 540 words per minute, voltage 215. Synchronograph with chemical receiver sent at frequency of 723 or limit at which it was safe to run the alternator. This result was higher than expected from the approximate law indicated by the preceding trials, and a reason for this was sought. The line was broken at Aberdeen, and records were still received. It was then restored at Aberdeen and broken at Glasgow, when, as before, no record was obtained. The cause of this was thought to be the inductive effect of that portion of the line beyond Glasgow, where the iron wires going and returning were unavoidably upon the same poles.

With an earth connection the total K R was 261,215, and the Wheatstone transmitter and receiver sent over this line 46 words per minute, voltage 100.

The synchronograph and Wheatstone receiver sent over this line 135 words per minute, voltage 85, coils in series $L = 3·46$, condenser of 5·75 microfarads shunted across coils.

The Transmission of Intelligence in Great Britain.

One of the reasons for going to England was to become conversant with the method of conducting the telegraph and telephone business in conjunction with the general postal service in a country where these three departments are under the control of the Government.

In the prosecution of this, as in the experiments themselves, every facility was afforded by the Government officials.

It is recognised that to draw correct conclusions upon the general subject of the transmission of intelligence requires men of experience in dealing with such matters, who give the subject their attention for a considerable period. Some of the principal facts, however, seem to be so clearly defined in their relation to others that we feel warranted in making some observations thereon.

The telegraph revenue and expenditures have increased with approximate uniformity. In 1872 the revenue was about $18,200,000, and the expenditure about $14,500,000, while in 1896 the revenue was $69,700,000 and expenditure $70,500,000. These two items have nearly coincided during 25 years, showing that the telegraph business is conducted on the whole to meet the expenses only and leave no profit. In some years the expenses are greater than the revenue, and the account shows a deficit. This has been the case for the last five years, but it has been gradually decreasing for three years, and in 1896 was only $168,000.

The number of telegrams forwarded from telegraph offices in the United Kingdom in 1871 was 9,850,177, and in 1896 was 78,839,610. In 1896 the ratio of the number of letters to telegrams was 18·5.

The charge for transmitting ordinary telegrams is a half-penny, or one cent per word, including the address, independent of the distance. The minimum charge is 6d., or about 12½ cents. The telegraph is used to a much greater extent for transmitting news in England than in any other country; for instance, in 1896, 5,915,646 telegrams were transmitted at the press rates for newspapers, clubs, &c. The average weekly number of words contained in these telegrams was about 13,650,000. The average length of each telegram is therefore 120 words. The explanation of this is found in the reduced rate given to the press after 6 p.m., which is at present but 6d. per 100 words. This press matter is handled almost entirely by the Wheatstone automatic system, automatic telegraphy being more advanced than in any other country in the world. There are as many as 447 sets of Wheatstone instruments in use in Great Britain, and for press messages pneumatic perforators are used, and a number of duplicate strips are prepared at once, and thus the same press news may be sent out on eight or nine different lines from London at the same time. Many of the lines, which are ordinarily operated by hand, are equipped with Wheatstone instruments. These are switched in whenever the traffic for the particular line becomes too great for hand transmission. They are also much employed for temporary lines where an unusual volume is to be handled in a short time, such as in sending the enormous amount of racing and sporting news required.

The telephone service in England is not entirely under the control of the Government. The trunk lines are so controlled and operated, leaving to private companies the service in local districts. Some of these trunk lines were transferred to the Government on March 25th, 1896, by an agreement with the National Telephone Company.

In a country where the three great branches of intelligence transmission, the mail, the telegraph and the telephone, are under one management, special advantages to the people are obtained which are not given when these departments are separated. In England messages may be telephoned:

1. For transmission over the postal telegraphs and delivery as telegrams.
2. For delivery as express letters.
3. For transmission and delivery as ordinary letters.

The telephone may also be used for obtaining the services of Post Office express messengers.

As indicating the increased demands for communication between England and the Continent, the following extract from the last report of the Postmaster-General is given: "The large increase in the number of telegrams passing over the Government cables to the Continent, and in the number of conversations on the telephone circuits between London and Paris, has rendered it necessary to consider the advisability of improving the means of communication. With the cordial co-operation of the German post office, experiments were made with a view to improving the carrying capacity of the cables to Germany by the method of duplex working, which has been employed with success on some of the Anglo-French cables; but, owing to the greater length of the Anglo-German cables the results obtained were not sufficiently successful to justify the adoption of the system for practical working. Arrangements have now been made for the laying of three additional cables to the Continent, two to France, and one to Germany. These cables, each of which will contain four conductors, will afford a much-needed relief to the traffic; and it is expected that this new cable to Germany will prove suitable for duplex working."

A YEAR'S BOILER EXPLOSIONS.

When the Boiler Explosions Act came into force some years ago the Board of Trade reports on explosions were looked on by experienced men as very amusing documents. "Iron bound in red tape" might have been humorously applied to these reports and to the inspectors responsible for them. How men supposed to have experience of steam boilers could make such reports was a matter that puzzled all of us, and it does not appear that the annual report—the 15th—is much better than of old. In the 12 months the Board of Trade rakes together 80 explosions, causing 27 deaths and 75 injured, a reduction on the average of the whole 15 years, though very near the average. Great Britain possesses the best record, we should imagine, but our allowable pressures are low, and the marvel is that explosions in the United States, where pressures are so very liberal, are not far greater than they are. Only 23 explosions out of the 80 were held to require formal investigation. We must add that very paltry matters constitute a boiler explosion in the eyes of the Board of Trade. We do not think they have included broken glass water-gauges, but they came very close to this and included blown fusible plugs.

Looking through the list only 12 explosions appear to be attributable to ignorance or neglect of attendants, which would seem a powerful argument against the folly of licensing attendants by examination. In this day we are examined to death. Educate—by all means educate—but do not shut out plain horse-sense as the Americans term it by examining. As well examine a sea captain in drawing-room manners because he dines with ladies at the saloon table as examine a boiler attendant to three places of decimals.

Steam pipes, both of copper and cast-iron, continue to give way. We cannot understand why copper should still carry so much credit. Either brazed or solid it does not seem so very reliable. The report advocates lap-welded wrought-iron pipe. It is advocated to hoop them or wire them when of copper. The *Engineer* would hoop or wire all pipes say at 2 inches intervals. If a seam opened it could not be longer than 2 inches. Pipes which burst seem

* Abstract of a report to the Postmaster-General of the United States, read before the Franklin Institute, January 19th, 1898, and published in the *Electrical World*.

so readily to tear for some feet and let out huge volumes of steam. A 2-inch hole gives the men a chance of escape and time to shut off the boiler stop valve. Why the Board of Trade should so insist on the hydraulic test is a marvel. The hydraulic test is something of a fool's test and cannot displace inspection or safeguards. Boilers tested to-day by hydraulic pressure are more than likely to pop off next day—being never strengthened by the test—often an excessive one. In New York policemen go round with a van and a pump, damaging boilers by pressure and giving safety certificates. Steam piping seems to have belonged neither to boilers nor to engines, hence the neglect to manufacture it properly and to put it in place properly with provisions against strains and against rigidity.

Steam piping ought to be as carefully laid out as the engine, and every proper provision made for its drainage. So many recorded explosions are due to that wasteful class of small vertical boilers, that we may well anticipate a considerable reduction of the now apparently irreducible annual minimum as soon as electrical power transmission has wiped out the need for small verticals. Of the 23 formal investigations there were nine of vertical boilers, three horizontal, one Rastrick, and four locomotive type. Obviously there is a field for electricity in abolishing some of the nine verticals. Next year the average will be much the same. Other nine verticals are getting ready to fill next year's bill. Doubtless one of them has gone already.

CONTRIBUTIONS TO THE THEORY OF ALTERNATING CURRENTS.*

By W. G. RHODES, M.Sc. (Vict).

[ABSTRACT.]

THIS paper is divided into two parts. Part I. deals with a method of finding the steady values of alternating currents in any circuits or systems of circuits, without having to perform integrations of differential equations which may be somewhat complicated.

It is assumed, however, that the electromotive forces and electric currents can be represented as simple sine (or cosine) functions of the time.

The method consists in applying the fact that if a simple harmonic function is differentiated twice in succession the result is proportional to the original function. By the application of this principle the determination of the steady values of the currents is reduced to solving a set of simultaneous *simple* equations.

After introducing the method by solving some simple problems, it is applied to the following:—

(a) The determination of the equivalent resistance, R, reactance and impedance, I, of a parallel circuit of n branches, taking into account mutual induction, when each branch may contain resistance, capacity, and self-induction.

The result is written

$$R = \frac{A_0 C}{C^2 + p^2 B^2}, \quad L = \frac{A_0 B}{C^2 + p^2 B^2}, \quad I = \frac{A_0}{\sqrt{C^2 + p^2 B^2}},$$

L being the equivalent self-induction, where A_0, C, B are certain functions of the resistances, self-inductions, capacities, and mutual inductions of the several circuits.

(b) The determination of the currents in the n circuits of an air core transformer having one primary coil and $n - 1$ secondary coils.

In addition to solving the problem, the conditions for resonance in the primary circuit are obtained and discussed, and special attention is given to the case of a transformer having only one secondary coil.

(c) The determination of the outputs of n alternators working in parallel on a non-inductive external circuit.

PART II.

This part is devoted to the consideration of the effects of higher harmonics in E.M.Fs. and currents on the values of the impedances and reactances of circuits.

The problems considered in Part I. are again discussed on the assumption that the impressed potential difference is of the form

$$E = E_1 \sin(p\,t - \theta_1) + E_2 \sin(2\,p\,t - \theta_2) + \ldots + E_m \sin(m\,p\,t - \theta_m).$$

It is also shown that periodic E.M.Fs. and corresponding currents can in all cases be represented by simple sine curves having the same root mean square values, and suitable phase positions depending on the time constants of the circuits and on the periodicities of the harmonics present.

* Communicated to the Royal Society by Arthur Schuster, F.R.S. Received January 4th—Read February 10th, 1898.

ANTHRACITE TESTS.

L'Industrie Electrique reports some tests made at the central station in the Place Clichy, Paris.

Numerous tests of all kinds of fuel have already been made with a view to smoke prevention. Coke has been tried and abandoned, both because of high price, and because its acid fumes damaged the tubes of the boilers. A municipal commission, which was appointed to consider the subject, has not yet rendered a report. Recently, however, M. A. Lalance has communicated to the Société Industrielle de Mulhouse, certain results obtained with English anthracite at the station in the Place Clichy. He had previously tried the Langer smoke preventer, so much used in Austria, and had furnished six boilers with this apparatus, using a coal named St. Charles from the Charleroi basin, which when considerably dampened, gave but little smoke, and no further complaints were made, but the mechanism necessary was delicate, and wear was so rapid as to necessitate regulation every second or third day. Searching for other and better means, he heard of the use of anthracite in London and arranged two boilers with grates of Richard's type, perforated with conical holes, and with a draught aided by three steam blowers in each closed hearth-pit. These grates are, in fact, simply perforated plates, and enable fine anthracite to be burned. The changes necessary to be made to a boiler are trifling. The fire thickness should be 3 to 4 centimetres. It is found easy to maintain pressure by draught regulation. Cardiff anthracite is described as burning quite smokelessly, and the management of the fires is easy, as with coal, and no dust is made.

The tests made by M. Heckel were for the purpose of seeing whether the numerous advantages of the coal were in any way counterbalanced in cost. The tests extended from April 5th to 16th last, and the arrangement of the plant was such as to permit either of two generators of 350 kw. each to be driven with steam from two boilers with the Langer smoke preventer, or from the two boilers burning the anthracite. No note needed to be made of water used or evaporated. So much electricity was manufactured, and so much fuel in each case was needed to do this. In fine, St. Charles coal, costing at works 28 francs per ton, was burned on the Richards grate, and anthracite, costing 34 francs per ton, was also used. The 34 francs was made up of cost, of octroi 7 francs 20 cents, and of cartage 3·50 francs.

The mean of three anthracite tests showed a fuel cost of 7,787 centimes per kw.-hour. The mean of three tests with the St. Charles coal on ordinary grates and with the smoke preventer gave a cost of 7,382 centimes per kw.-hour, and two tests with the same coal on the Richards grate with forced draught showed a mean cost of 7,458 centimes. The difference is not large, and evidently weight for weight the Cardiff coal is the better fuel, and if its price could only be reduced to 32 francs, it would stand even as to cost, and would besides have all its other advantages. Our contemporary would like to see a direct service from Cardiff to Paris, which would enable Cardiff anthracite to be not only the most pleasant fuel, but also it would show a small first cost economy.

THE DIESEL OIL ENGINE.

THE *Engineer* translates from *Zeitschrift des Vereines Deutscher Ingenieurs* a description of Diesel's oil engine or Rational Heat Motor. Diesel claims that his motor better utilises the heat supplied to it than any other motor. Thus while the best saturated steam engines give 12 per cent. efficiency, small condensing engines give only 5 per cent., which is not encouraging. This, however, is quite an unfair way of stating the case, and takes no account of the thermodynamic possibilities on which basis progress of steam engineering has not been so very hopeless. In a steam plant the boiler efficiency is 80 per cent., the engine cannot work without loss, and so a triple expansion Sulzer engine plant of 700 H.P. with steam superheated to 350° C., shows 13 per cent. mean heat efficiency, and this cannot be much extended for steam engines, for only 30 per cent. of the heat received by an engine can theoretically be turned to work.

The great drawbacks to steam are the heat lost in its generation, the low theoretical efficiency, a defect which cannot possibly be amended, the sensitive nature of steam in respect of its easy condensation, and the influence on it of its immediate surroundings as the cylinder walls.

The object of the author's research has been to improve the utilisation of heat. First, he experimented with ammonia at a large range of temperature, and found that wide temperature ranges required wide ranges for pressure also, to allow suitable expansion. This conclusion he applies to all vapours, for otherwise the vapour would be superheated at exhaust, and some portion of heat is thereby wasted. He considers it impossible, theoretically, to determine the pressures necessary to utilise the superheat, but approximates it at 50 to 60 atmospheres, and ammonia being difficult to handle at such pressures, air was tried as a simpler agent, and the same theoretical results were obtained and conclusions drawn. The air was first treated in closed vessels, with heat applied and withdrawn externally, but it became clear that the air could be compressed, and heat generated in the cylinder itself, as already performed in other internal combustion motors. In what he claims as a new process of combustion, Diesel emphasises the difference between the temperature of ignition and that of combustion. The temperature of ignition is lowered by pressure. Hitherto the temperature of combustion, which is higher than that of ignition, has been produced after ignition—by and during the process of combustion. This seems too obvious, at first sight, to gainsay, but Diesel has evolved a new system of combustion, which he calls "rational." It demands four essential conditions. First, the temperature of combustion must be produced before combustion, and independently of it, and it must be produced by the mechanical compression of air. This is seen to be in conformity with Carnot. Secondly, the air must be adiabatically compressed, and not isothermally, as demanded by Carnot, thus attaining to the temperature of combustion at 40 or 50 atmospheres—a much lower pressure than if compression be at first isothermal. By avoiding the theoretical 100 to 200 atmospheres required in the theoretical cycle, an impossible working cycle is replaced by a possible one. The air being now at the temperature of combustion, the combustible is injected into it in such manner that the heat developed by the combustion is at once converted into work. The piston, in fact, moves with the fuel ignition, and combustion adds very little or nothing to the temperature in the cylinder.

The fourth essential is somewhat contrary to preconceived ideas, which have been that excess of air for combustion should be minimised. Diesel's method, however, demands a large excess of air, but an amount carefully determined for each fuel. To carry out his system, Diesel proposed a four-cycle process, worked with three cylinders; the two outer ones being motor and combustion cylinders, and the inner one being for compression, expansion, and exhaust. The outer cranks are at 180° from the middle crank. Air is drawn into the central cylinders, partially compressed, and sent to the receiver. The two plunger pistons then draw in air on the first down stroke, and deliver it compressed to the requisite pressure on the up-stroke. On the next down stroke the combustible is admitted, and burns as the piston descends. Powdered coal has been proposed, but pulverised oil has been alone found practicable. Admission of combustible only lasts one quarter of the stroke, after which expansion occurs, exhaust then takes place into the central cylinder, the piston of which is driven down and compresses the air beneath it. On the return stroke the exhaust of this cylinder escapes to the atmosphere; thus the whole process is completed in two revolutions of three pistons or four strokes.

It is claimed that the boiler efficiency is equal to unity, the possible theoretical efficiency is from 50 to 70 per cent., and thus double that of the steam engine; the gases produced do not condense like steam—some of them must do, for they are steam—and there is no loss of heat in passages and pipes; but the mechanical efficiency must be lower, because of the high compression, and this has been argued to more than outweigh the advantages. But Krupp joined the supporters, and a 12-horse engine was made to test the question, and subsequently another and improved engine of same size, and as a result of the tests made, a 20-horse engine was next made, but it had a single cylinder only, and generally resembled an ordinary petroleum engine, being single acting and water jacketed; this latter being a source of loss not yet overcome, or apparently hoped to be overcome. This engine has undergone many tests by representations of Krupp, Sulzer, and Deutz, and by Profs. Schroter, Gutermuth, Sauvage, and others, and all seem to agree that the new motor has the highest efficiency of any motor, the efficiency being double that of steam and half as much again as other internal combustion motors.

The oil consumption is only ½ lb. per brake H.P.-hour under normal working conditions. An advantage is that no explosions are missed and combustion is complete so that no dirt collects on the internal surfaces. Nor is there ignition apparatus of any kind. The trials by Profs. Schroter and Gutermuth show a heat efficiency per I.H.P. of 34 to 35 per cent. It thus appears that Diesel's views have been confirmed, and the motor is a solitary example of an engine built to theory and living up to it, whereas in other things the theory is deduced after the practical man has shown a thing to be possible.

The exhaust gases were practically invisible and odourless, proving complete combustion, and their analysis showed for full power a mean air excess of 26 per cent., and at half power of 160 per cent.

The thermal efficiency is found to increase with lesser powers, and the economic efficiency only fluctuates between 22 and 16 per cent. The following table may be of interest. It is a summary of tests made in February last, and embraces four trials. The tests were made in Augsburg:—

Diameter of motor piston	...	9·8 inches.
Stroke " "	...	15·7 "
Diameter of air pump	...	2·7 "
Stroke " "	...	7·8 "
Calorific value of oil ...	...	18·370 B.T.U. per lb.

	Full power.		Half power.	
	I.	II.	I.	II.
Number of revolutions	171·8	154·2	15?·1	158·0
I.H.P. motor cylinder...	27 85	24 77	17·71	17 72
B.H.P. " "	19·87	17 82	9·58	9 84
Mechanical efficiency per cent. ...	74 8	75 5	57·8	59 6
Oil per I.H.P. hour pounds	0·40	0 39	0 16	0·16
Oil per B.H.P. " "	0·54	0 52	0·61	0 60
Exhaust pump	404° C.	378° C.	260° C.	260° C.

THE AMERICAN ELECTRO-THERAPEUTIC ASSOCIATION.

(*Concluded from page* 238.)

"A New Electrode for Use with the Static Machine," was presented by Dr. Lucy Hall-Brown, New York, who sent a communication on the subject. An efficient spray current could be administered by means of a wire brush on a handle, consisting of about 400 fine steel wires arranged like a small whisk.

Dr. Bergonié, of Bordeaux, France, sent three short communications, entitled:

(*a*) "A New Localising Electrode to Prevent the Diffusion of the Current."

(*b*) "Palliative Treatment of Tic Douloureux of the Face."

(*c*) "The Action of the Röntgen Rays on the Vitality and Virulence of Koch's Bacilli in Cultures."

These were translated and read by Dr. F. Schavoir, of Stamford, Conn.

The localising electrode consisted of eight or 10 narrow electrodes, connected alternately with the positive and negative poles. The current must have an extremely high intensity in order to become diffused.

In the treatment of tic douloureux, he uses a large electrode on the face, and an indifferent electrode to the dorsal region. A continuous current of 50 volts and 30 to 50 milliamperes is employed, and the periods of ascension and diminution last from seven to 10 minutes. The maximum intensity should be maintained for at least 20 minutes. As the cases had been kept under observation for several years, he could say positively that the treatment always brought relief from intense pain, and sometimes after a considerable time caused its permanent disappearance.

The author described in detail the manner in which his investigations into the action of the Röntgen rays on the tubercle bacilli had been conducted, and concluded, from his experiments, that the exposure of the culture for one hour did not destroy the virulence of the culture, but retarded its evolution, and also that the vitality of the cultures was not modified.

"Report of the Committee on Electric Light for Diagnosis and Therapy, and the Röntgen X Rays," by Dr. F. Schavoir, Stamford, Conn. With the static machine the rays produced were far more penetrating and steady, and the radiographs could be taken with a much shorter exposure than by other means; many and great improvements had been made in vacuum tubes, and that a marked increase in transparency had been secured in the fluoroscope by the substitution of barium platino cyanide for the tungstate of calcium.

The President read his address, which briefly reviewed the history of the Association, and suggested several changes which would increase the value and usefulness of the Association, and lessen the work of the executive. On motion of Dr. Charles R. Dickson, it was resolved that the Executive Council be directed to consider the suggestions contained in the President's address, and also the matter of the revision of the constitution and bye-laws; that their report be mailed to the members at least one month prior to the next meeting, and that notice of such amendments is now given.

On motion of Dr. R. J. Nunn, it was decided to hold the eighth annual meeting in the City of Buffalo, N.Y., and the second Tuesday in September and two following days were chosen as the date.

The following officers were elected for the ensuing year:—

President.—Dr. Charles R. Dickson, of Toronto, Canada.

First Vice-President.—Dr. F. Schavoir, of Stamford, Conn.

Second Vice-President.—Dr. Caleb Brown, of Sac City, Iowa.

Secretary.—Dr. John Gerin, of Auburn, N.Y.

Treasurer.—Dr. R. J. Nunn, of Savannah, Ga.

Executive Council.—Dr. Robert Newman, of New York, N.Y.; Dr. W. J. Morton, of New York, N.Y.; Dr. W. J. Herdman, of Ann Arbor, Mich.; Dr. W. T. Bishop, of Harrisburg, Pa.; Dr. G. Betton Massey, of Philadelphia, Pa.

The customary votes of thanks were passed, after which the retiring president appointed Drs. Newman and Nunn a committee to conduct the newly elected president to the chair.

Dr. Dickson, on receiving the gavel, addressed the meeting in a particularly happy vein, and requested the hearty co-operation of each member to make the meeting in Buffalo an unqualified success. He would announce his appointments of the committees on the investigation of scientific questions without unnecessary delay; he declared the meeting adjourned, to re-convene at the call of the executive council.

THE NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

The annual dinner of the Northern Society of Electrical Engineers was held at the Grand Hotel, Manchester, on Thursday evening. Mr. J. S. Raworth, the president of the society, occupied the chair. About 70 gentlemen were present, including Messrs. H. Edmunds, John Ely, W. P. J. Fawcus, J. Nasmith, Harry Pollitt, Alderman J. J. Meakin, T. Browett, J. F. L. Aspinall, J. H. Holmes, C. H. Wordingham, H. Lindley, H. Alabaster, Percy Rosling, J. Hardie McLean, J. Slater Lewis, E. L. Madgen, E. M. Lacey, J. B. Atherton, J. Atherton, S. V. Clirehugh, and Geo. W. Lowcock (the hon. sec. of the society).

The Chairman said letters of apology for inability to attend had been received from the Lord Mayor of Manchester (Alderman R. Gibson), Alderman Hopkinson, Mr. J. Taylor, and other gentlemen.

"The Queen" having been toasted with musical honours,

Mr. Aspinall, locomotive engineer of the L. and Y. Railway Company, in proposing "The President and the Society," said their society, he understood, was going to do something to help the locomotive engineers. The locomotive engines still existed, but they were, of course, to be superseded, and trains were to be run more conveniently than by the locomotives of to-day. He did not know how it was to be done, but that no doubt would be pointed out. Personally, he wanted to see the day when the chemist and engineer would provide a storage battery from which they could get out of it

96 per cent. of the work they put into it, and do what they did with a gas-holder. It was delightful to see the electric cabs running about in London. He did not believe in the oil motor. As had been said, "It barked like a dog, and stunk like a cat." He hoped the electric gentlemen would produce something that would get rid of the difficulties to which he had just alluded.

The President, in reply, said success depended entirely upon themselves. It was a very remarkable fact that a long spell of bad trade often did more good to the trade affected than a spell of prosperity. Should it happen in the spell of prosperity which he saw looming (he would rather say beaming, for he did not like the word "looming") in the distance upon them that they were not able to take it up and fulfil the demand, then the very fact that they would not be able to meet it would offer a chance to their competitors on the other side of the German and Atlantic Oceans to come in and show English customers what they could do in the very midst of Manchester. He did not think the locomotive engines would be done away with; he was of opinion that the locomotive engineer would be able to apply electricity himself, and not leave it to the electrical engineer to do it for him. He thought that the driving of railway engines by electricity was within practical range. In the black country the Pumping Commission, which did the pumping for all the pits, had held a meeting in Birmingham, and the promotors had said they could supply electric energy at 1d. per unit. That made those who had steam engines contemplate disposing of them for the new energy. It rather frightened local authorities who now supplied such energy at 8d. and 9d. per unit. Therefore, there was likely to be opposition, but they in Lancashire must reduce the cost of the electric supply. In Manchester, under certain conditions, they could get it for 1½d. per unit. (A Voice: "At Bradford for a 1d.") They, in this city, were getting down to that. With a sufficient output, there was no reason why they should not supply electric energy at 1d. per unit. They must follow the example of America. The public must be supplied with what the electrical engineers knew they wanted before they asked for it, and then a market would be created for their manufactures. It was also proposed that they should add associates to their Society in the shape of the principal cotton spinners and machinery manufacturers of the country, in order that they might put to practical use the knowledge which the Society possessed.

The toast list also included "The Retiring President (Mr. C. M. Dorman) and "The Guests," responded to by Alderman Meakin and Mr. Nasmith.

During the dinner, and afterwards, a glee party, under the direction of Mr. J. H. Greenwood, entertained the company with songs, glees and sketches.

THE TELEGRAPH TROUBLES.

The Clerks' Point of View.

By CHAS. H. GARLAND.

(*Continued from page* 167.)

There are two claims made by telegraph clerks with respect to the maximum salary. The first is that they have a right, under existing circumstances, to rise to £190 as operators and without the intervention of arbitrary and practically insurmountable barriers. The second is that this maximum should be raised, as it is insufficient under the changed conditions of service and environment. The point to which they wish it raised is £230 per year in London, and £200 in the provinces. The first claim I dealt with in my last article; the second I will now discuss.

This claim for £230 as a maximum in London is no fanciful claim, fixed with no consideration for the circumstances which regulate wages, but is a fair estimate of the value of a telegraph clerk's work at the present day. Quite apart from the question of changing environment, the work itself has so far changed that a higher degree of skill is required, there is a far greater strain on the operators, imposed by the tremendously increased mass of work to be dealt with, there is a demand for greater general intelligence and higher educational qualifications, and technical training is almost a *sine quâ non*.

Let us hear what Mr. W. H. Preece, F.R.S., the Engineer-in-Chief, has to say on this increased demand upon telegraph clerks. "The progress of telegraphy has been phenomenal. That progress has been marked by a steadily-increasing demand for the exhibition of technical knowledge and skill on the part of the artisans and operators engaged in the engineering and commercial branches of telegraphy in this country, and we are able to bear witness to the fact that those concerned have responded to this demand in a way that does them infinite credit. A standard of technical knowledge that was exceptional in the telegraph service a few years ago, is now the rule, and the time is not distant when we shall look in vain and without regret for the engineering or commercial employé who has no knowledge of the principles of the science."

The same high authority has also summarised in a form which I will not attempt to improve upon, the actual requirements. "We require that all telegraphists," he says, "at some time of their career should possess an acquaintance with the principles and the laws of electricity as applied to telegraphy and telephony, and with the mechanical construction of the apparatus that they handle. They should also comprehend the nature of faults that occur in apparatus, and evince the ability to remove these faults, and generally to secure the maintenance of the apparatus. There is no doubt that this knowledge on the part of the staff very much increases the efficiency of the service. In days gone by an immense amount of time was lost in repairing faults, owing to the fact of the only persons who could repair faults being the engineering officers, who had to be sent for; whereas now, owing to the advance of technical knowledge, the clerks are able themselves to remove slight faults at once; the result is, that delays are removed, the service has better supervision, the work is simplified, and generally the condition of our apparatus and our lines is very much better than it used to be. I should like to say this, that whatever tends to promote rapid service means increased business to the Department. There is no doubt that the number of messages that are sent by telegraph depends almost essentially on the rapidity with which they are sent and delivered, and, therefore, technical knowledge being acquired by the staff, means an addition to the revenue of the Department, and therefore justifies the Department in incurring some expenditure in improving the staff and service." These lengthy quotations are justified by the important and unimpeachable testimony they bear to the difference of requirements now, and at the time when Mr. Fawcett fixed £190 as a fair remuneration for the work of a telegraph clerk. The increase in the mass and complexity of the work is borne out by the Postmaster-General in his 41st Report. "The growth of the whole business (of the telegraphs)," he says, "since 1870 (from less than seven to more than 71 millions) has been more than 10-fold. The number of offices has increased from 2,000 to nearly 10,000. The system, including submarine cables, now consists of about 35,000 miles of line, as compared with 15,000 in 1870, and about 215,000 miles of wire, as compared with 60,000, while the number of instruments has increased from 4,000 to over 26,000." This was written in 1895, and the increase during the intervening period has kept pace. With all this development, the work and strain of the individual clerks has also vastly increased. Speaking personally, I can say that each man works immensely harder, and more continuously now, than 15 years ago, and the difficulty of remaining clear-headed and steady amid all the rush and whirl of these millions of messages, the manifold complexities of circulation, the mysterious faults and imperfections of the new and delicate apparatus, increases to an enormous extent the wear, tear, and worry of a telegraph clerk's life.

The greater amount of work turned out cannot be attributed to the improved apparatus alone. As Prof. Marshall justly observes in his "Principles of Economics" (p. 316), "The more delicate the machine's power, the greater is the judgment and carefulness which is called for from those who see after it." And from the single needle and the Morse inker of 17 years ago, to the Wheatstone transmitter, with an attainable speed of 600 words per minute, and a working speed of 400 words per minute (*vide* Postmaster-General's 41st Report), or the Delany multiplex of to-day, what an increase in this demand for judgment and carefulness. The percentage of nervous complaints demonstrates the truth of this.

What increased reward does the Department offer for this increase in the quality and quantity of the work? Does not the "model employer" set an example in this matter? Far from it. By what appears to us to be a tampering with our rights, our prospects have been actually reduced. I showed in my last paper how the obtainable maximum as an operator had been reduced from £190 to £160. What wonder, then, that telegraph clerks are discontented? and what wonder if this gnawing discontent should unconsciously affect the output? I can assert truthfully that no formulated intention of restricting the output has ever gained any power among the staff, and the Postal Telegraph Clerks' Association has always discouraged such methods; but does not discontent unconsciously militate against the highest results? And under the conditions I have detailed discontent is inevitable.

It has been the custom of those opposed to us to speak glibly of the market value of our work and to assert that the present salaries—that is, the salaries with the reduced prospects of promotion—are sufficient, nay, liberal. The market rate of a man's work, as I understand it, is the point at which it is fixed by the influence of open competition, and except where powerful unions stand in the way, it is the lowest rate at which men can be induced to perform the work. In the case of a State monopoly, where there is no open competition to determine the rate, it is hard to say how this market rate is arrived at. The best method of determining a rate appears to me to be a consideration of the salary which will attract a class of men and women sufficiently well educated to come up to the best requirements of the department in the matter of efficiency, and also a salary sufficient in amount to retain the services of the most highly-skilled and efficient men in the Department. Sir Lyon Playfair, speaking before the Ridley Commission on the question of the fixing of the rates of pay for civil servants, takes practically this view. He says: "One thing that guided us very much in the terms which we offered was, that we took a great deal of evidence as to what the outside world gave for positions somewhat similar, and we found that civil servants were on these terms paid more liberally, and we could get the *élite* of the men outside who did similar work." This is undoubtedly as it should be. The rate should be such as to get and keep the *élite* of the profession in the service of the State. The *Daily News* of January 29th, 1895, said: "It is now acknowledged that to give high wages, and thus attract the pick of the market, coincides with sound policy as well as with the humane principles which ought to guide our civil administration." The Rt. Hon. James Bryce, M.P., speaking to a deputation of Aberdeen telegraph clerks on November 24th, 1897, said: "The State . . . . . ought to go upon the principle that it would not pay more than the market rate, but, that it would pay the best market rate." The present salaries and prospects held out to telegraph clerks are not consistent either with keeping the *élite* of the profession in the service of the State when opportunities of escape are offered, nor are they consistent with the principle of paying the best market rate. Nor, as the conditions of service become known, and the real nature of the prospects exposed, does the fierce competition for the places continue. Since last year's public notice of the telegraph clerks' position the number and quality of the candidates for the position has fallen immensely, as the Civil Service Commissioners' returns will show, and when the case is more fully understood there will be a still greater falling off. The *élite* of the class which would otherwise become telegraph clerks know they can put their educational abilities to a better and more profitable use.

The cable companies' scales are much higher than the Post Office scales for similar work, with the result that the best men are attracted from the postal service whenever the opportunity offers. To take only one instance: the Eastern Telegraph Company offers a scale of £50 by £12 to £204, as compared with the postal scale detailed in my last article, with its slow progress to the practically insurmountable barrier placed at £160. In Germany, where the cost and standard of living are very much lower than here, and where the service is slower and less efficient there is a maximum for the lowest class of operators of £162, and in Holland, where the same cheapness exists, a telegraph clerk can get £183 by the time he is 40 years of age.

So far are the conditions of service in cable companies and Colonial Governments superior to the postal conditions, that the advertisement of a vacancy invariably secures a rush of the very best operators. In a small office, like Newcastle, for example, 50 of its best men will apply for four positions under the Transvaal Government. Nearly the whole of the Preston staff will apply for one position in the Eastern Company, and such examples could be supplied *ad nauseam*. The result of this is, that the companies draw off many of the best men, and much of their success is to be attributed to the class of operators thus obtained.

How are the Post Office authorities meeting this increased demand on their men and the increased pay offered outside? By lowering the prospects and increasing the hardships of service; by reducing privileges and curtailing leisure. These things I believe to be not so much the fault of individual administrators as the fault of the system. An administrative system is the strongest of conservative structures, and when that system has been built up on unsound economic principles it requires more than the ordinary reforming spirit to break through it. And the principles underlying the present postal management are not those sympathetic and humane principles which should guide an administration which stands in the position of model to all other employers.

The demands of telegraph clerks are no straining after ideals. The scale which they ask is as follows:—The present scale as far as £50 per annum, and then by increments of £7 10s. to £140, thence by £10 to £230. This is for London. For the provinces the scale is lower, with a maximum of £200. It is an eminently reasonable demand. In a further paper I will defend the demand for changes in the lower portion of the scale. At present, suffice it to say that the clerks only ask that the £230 maximum should be granted under certain conditions. Upon reaching the Fawcett maximum of £190 they say: "We will be submitted to a test in theoretical and practical telegraphy and telephony, and will pass an examination in magnetism and electricity." By this means the department can assure themselves that the men who advance have kept pace with the conditions essential to the performance of the highest class of work in the most efficient manner. It is possible to stop men of bad conduct at any point in the scale, and the demand is, therefore, that men of unimpeachable character and high merit only should pass the £190 point, which Mr. Fawcett fixed for operators pure and simple. On the suggested scale a clerk would not obtain £190 until after 19 years' service, and the maximum, after having passed the tests explained above, after 23 years' service.

By adopting this scale, the Department would ensure that essential factor in efficiency—a contented body of workers; it would put itself in a position to retain the *élite* of the profession in its service; it would make its scales nearly equal to the best market rate paid for telegraph operators, and it would approximate more closely to its proper position in the first flight of employers. Surely, with the evidences one can adduce of the immense advantages to the community of an administrative policy, guided by such principles, and attaining such results, the day should not be far distant when the reasonable demands of this important body of public servants will be conceded.

(*To be continued.*)

SOME NOTES ON SINGLE-PHASE MOTORS.

By A. C. EBORALL.

(*Continued from page* 173.)

In regard to the winding, it should have as small a self-induction as possible, and is preferably of copper strip placed edgeways in the tunnels. A three-phase star-connected winding is often used, the common junction being made on the iron work of the rotor. Apart from the question of self-induction, it is generally inadvisable to use more than one conductor per slot, because, in order to comply with one of the conditions stated above, such windings are frequently very irregular. That this is so may be seen from an inspection of fig. 10, which is a six-pole rotor winding with one conductor per slot.

The simple short-circuited form of rotor described above is only used for small motors, its employment above 6 H.P. for low frequency, and 4 H.P. for high frequency motors not being attended with satisfactory results. Imagine a single-phaser with such a rotor being started up by means of any phase-splitting device. With the rotor just beginning to move, the slip is equal to the frequency of the supply current in the stator, and the whole arrangement is practically a short-circuited transformer. Large currents circulate in rotor and stator, and the torque would be enormous if it were not for leakage. The presence of the air-gap directly promotes leakage, which means that the rotor currents have a great lag in regard to the stator induction, and hence the motor will have very little torque, although drawing large

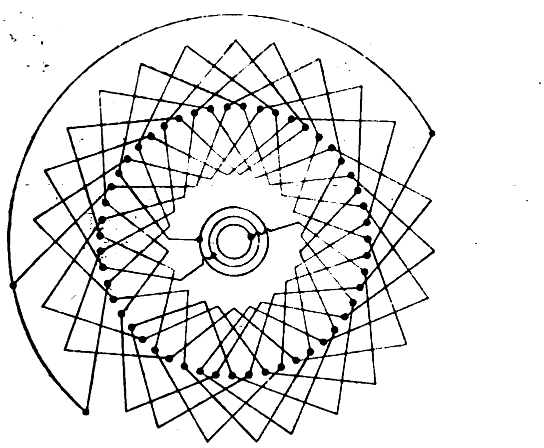


Fig. 10.

currents from the line. To sum up, then, the disadvantages connected with the employment of a simple squirrel cage rotor for motors of any size:—

1. A large wattless current is drawn from the mains, greatly disturbing the circuit on account of the voltage drop in the lines and generator, and also on account of the great demagnetising effect which it produces on the generator fields.

2. The large rotor current exerts a very powerful demagnetising effect on the stator, choking back the induction, and hence reducing the torque.

3. The rotor current being nearly wattless, it is out of phase with regard to the induction produced by the stator, and consequently the torque produced is insignificant.

4. Much of the impressed pressure may be lost in the stator coils to overcome resistance, and

5. The motor is liable to burn out.

Of course, as soon as the rotor begins to move, the rotor currents decrease, owing to the slip decreasing, and they will continue to decrease until the motor approaches its speed limit, determined by the stator poles and frequency of supply.

Thus for motors of any size, it becomes necessary to reduce these large wattless currents, both for the sake of the supply system, and to secure effective starting of the motor. The best way of decreasing the wattless current in amount, and also of bringing it more into phase, is to put a non-inductive resistance in series with the short-circuited part at starting, cutting it out as the rotor runs up to speed. This means that the short-circuited part must be wound with a regular winding, its ends being connected to slip-rings on the shaft, as mentioned above—or the ends may be connected to a resistance placed in the body of the rotor, which may be short-circuited by an external device when the rotor has got up speed.

The former plan of having the resistance exterior to the motor is on the whole preferable to the latter, as it allows the resistance to be varied, and gradually cut out, which does not disturb the circuit so much.

The resistance for this purpose must be as non-inductive as possible; if not, it may still further increase the lag. A three-phase winding is always employed on the rotor, this having the minimum of dead points, and the rotor resistance is generally star-connected, to correspond to it.

This insertion of a non-inductive resistance into the rotor is very effective. It cuts down the current in amount, and therefore limits the demagnetising effect, and at the same time this rotor current is brought more into phase (and hence the stator current also), and as a result a greatly increased torque is produced. The other harmful effects enumerated before are in consequence either greatly reduced, or obviated altogether.

Assuming the motor to be started with two currents o frequency, n, and differing 90° in phase, the *starting* torque is

$$\frac{2\, n\, \mathrm{K} \cos \phi}{\text{Rotor impedance}},$$

where ϕ is the lag in the rotor bars, and K a constant depending on the strength of the magnetic field, and on the winding of the rotor.

$$\text{As } \cos \phi = \frac{\mathrm{R}}{\sqrt{\mathrm{R}^2 + 4\, \pi^2\, n^2\, \mathrm{L}^2}} \qquad \text{(Fig. 6)}$$

the expression for the starting torque becomes

$$\frac{2\, \pi\, \mathrm{K}\, \mathrm{R}}{\mathrm{R}^2 + 4\, \pi^2\, n^2\, \mathrm{L}^2},$$

which is a maximum when $2\, \pi\, n\, \mathrm{L} = \mathrm{R}$.

Hence to get the best results, the value of the starting resistance plus the rotor resistance should be equal to $2\, \pi\, n\, \mathrm{L}$ ohms, and should be capable of being decreased as n decreases. Single-phasers are never started with two currents differing 90° in phase, and hence in practice it is usual to make the value of the starting resistance somewhat less than this.

The effect of resistance in the short-circuited part of a single-phase motor supplies the reason for several points of construction that might otherwise not appear. When describing the construction of rotors with simple short-circuited bar-winding, it was stated that the rings at the ends are made of considerably smaller section than the total section of the active bars. This is simply to enable the motor to start effectively, the resistance of the copper rings, with such large currents as they would carry at starting, being quite sufficient to enable this to be done.

There is, however, another factor entering into the case. At any given load on a motor, the torque is proportional to the product of the induction in the air-gap and the current in the rotor conductors; and therefore, the impressed stator pressure being constant, the rotor must run at such a speed that the slip allows enough pressure to be generated in the bars to overcome the resistance of its conductors. The slip is really somewhat greater than this, on account of leakage and pressure drop in the stator. It therefore follows that for a given torque the slip is nearly proportional to the resistance of the rotor, and hence that the effect of giving a certain amount of resistance to the rings, and of working with high current densities, is to cause a corresponding drop in speed of the motor, and must not be carried too far. To make a motor synchronous, all that has to be done is to put a lot of copper in the rotor conductors, and what is done in practice is to use very few bars, and work with a low current density. This construction of rotor implies a "notched" field, which further contributes to a synchronous tendency. Such motors must be run up to practically synchronism before they will go in, and take a large current, their no-load current also being high, perhaps 50—60 per cent. of the full-load current. They will carry but very little overload, their power factor also being small. Such motors are very rarely asked for—their only application would seem to be for driving rectifiers. The Pollak rectifiers running at Frankfort and Zürich are driven by motors of this type built by Messrs. Brown.

(*To be continued.*)

REVIEWS.

Formulaire Physico-Chimique. Par Donato Tommasi. Paris: Librairie Industrielle, 30, Rue du Dragon.

This book is a compilation of 475 pages containing a vast number of data, and much practical information, useful to physicists and chemists, and, in a less degree, to engineers and manufacturers. Chapter I. treats of fusion, solidification and vaporisation; Chapter II. of the solubility of gases, and of mineral and organic solids; Chapter III. is devoted to refrigerating mixtures; Chapter IV. to the expansion of solids, liquids and gases; Chapter V. to the phenomena of capillarity; Chapter VI. to the densities of solids, liquids and gases; Chapter VII. to thermo-chemistry and the law of thermal constants; and, lastly, in Chapter VIII, information will be found on the spheroidal condition of bodies, the dissociation of ammoniacal salts, the nascent condition of bodies, the electromotive force of the principle voltaic couples, the capacity of certain accumulators, and the composition of some varnishes, mastics and cements.

A table of great utility to the practical man in pyrometry, since it gives fixed points of temperature, at small distances apart, from 954° to 1,775° C, is that relating to the Prinsep alloys of silver with gold and platinum.

The data relative to the liquefaction of hydrogen, oxygen, nitrogen and atmospheric air are derived from the researches of Wroblewski and Olszewski. No mention is made of Prof. Dewar. The formula of Nordenskjold for the solubility of salts, in terms of their solubility at a given temperature, is quoted; but is not explained in such a way as to render it available to the non-mathematical worker. We notice that in the table giving the degree of cold produced by the mutual reaction of solids the minus sign is accidentally omitted in the case of the mixture of sodic carbonate and manganic nitrate, which is capable of lowering the temperature to − 26° C. The data given on p. 195 relative to the increased expansion of wires—excepting in the case of hard steel—when a given temperature is produced by the passage of a current, instead of by ordinary means of heating, may be useful to some of our readers. The same may be said of the table on p. 229 giving the weight, at 15° C., of one drop of various liquids, or the number of drops to 1 gramme, when 20 drops of distilled water weigh 1 gramme. The densities (or specific gravities) of alloys of lead and antimony are given on p. 240; and a knowledge of them may sometimes save the trouble of a chemical analysis.

The tables giving the percentage of real acid in solutions of hydrochloric, nitric, sulphuric, and chromic acids of given density, will be of value to the electro-chemist; but, even in this work, the mistake of omitting to state the temperatures to which the given densities are to be referred has in some cases been made. Nor, in regard to Anthon's table (p. 273) is it mentioned that the sulphuric acid, of which various proportions are to be added to 100 of water to obtain a dilute acid of a required density, must be of the very inconvenient specific gravity 1·86—inconvenient, because the density of oil of vitriol at 15° C. (59° F.) is 1·8455, whilst that of H_2SO_4 is 1·8426. Correct tables are given of the percentages of caustic potash, and soda, in solutions of various densities.

The chapter on "Thermo-chemistry" is unsatisfactory from the point of view of the electro-chemist, who may seek in vain for the heat of constitution of the compounds, such as $PbSO_4$ and PbO_2, in which he is most interested.

On p. 380 is given a table of the capacity in ampere-hours of 1 kilogramme of plates in various accumulators. For the Laurent-Cely elements this is given as 9 to 10 ampere-hours; for the Dujardin, 15 to 18; for the Julien, 15 to 20; and for the Tommasi, 25 to 30.

The work ends with a description of two kinds of electrolytic cartridge which, the author states, may be advantageously substituted for gunpowder or dynamite for blasting in oal mines.

Light: Visible and Invisible. A series of lectures delivered at the Royal Institution of Great Britain, at Christmas, 1896. By Silvanus P. Thompson, D.Sc., F.R.S., M.R.I. London: Macmillan & Co., Limited, 1897.

This publication, in book form, of Prof. S. P. Thompson's Royal Institution lectures on light is well worth reading. This most fascinating, as well as the most exact of physical sciences is treated by an enthusiastic and gifted lecturer; and though the conditions of a popular lecture do not admit of exact demonstrations, and an immense subject is skimmed over in a few pages, the reader is left keenly interested, and stimulated to seek more information elsewhere. No doubt the style suffers from its lecture-room origin, and the colloquial form is occasionally irritating; but, taken as a whole, it attains its object, and may well stand with Kempe's "How to Draw a Straight Line," Vernon Boys's "Soap Bubbles," and some other volumes which owe their origin to the same source, the theatre in Albermarle Street. Prof. Thompson's method of treating geometrical optics by considering changes in the curvature of a wave surface, is more philosophical than that by considering changes in the directions of rectilinear rays, and we accept his assurance that it is of practical advantage in teaching. Unfortunately, in teaching some sciences, notably mechanics, the most philosophical course cannot conveniently be followed. The chapter on rays emitted from vacuum tubes is particularly interesting, and gives a clear and concise account of the state of knowledge at the time the lectures were delivered; but the distinctions drawn by Prof. Thompson between many different kinds of cathode rays would not, we think, be generally accepted. As is often the case in books of this kind, the appendices, in which particular points of interest are discussed in detail, are the cream of the whole.

ON SOME RECENT INVESTIGATIONS IN CONNECTION WITH THE ELECTRO-DEPOSITION OF METALS.*

By J. C. GRAHAM.

So far as the author of this paper is aware, there has been no very satisfactory examination made into the conditions which are necessary for the rapid deposition of metals from their solutions by means of the electric current.

The experiments which are described in this paper appear to throw some light on the subject.

When an electric current is passed through a strong solution of sulphate of copper, the copper is deposited in a very perfect condition so long as the current density does not much exceed 200 to 300 amperes to the square metre. According to Donato Tommasi † the following are the figures:—

Poids déposé en grammes par heure et par $d\ m^2$.	Intensité du Courant en amp. par $d\ m^2$.	Nature du dépôt de Cuivre.
12	10·2	Très bon.
50	42·7	Sablonneux sur les bords.
124	106·	Mauvais sur tout le Contour.

And Tommasi adds, "Suivant H. Fontaine, pour bien opérer, il ne faut pas en pratique dépasser 1 ampère par décimètre carré de surface de Cathode, lorsque les anodes sont en cuivre chimiquement pur."

The deposit here spoken of appears to be the very good sort of deposit which is requisite for electrotyping and similar purposes, for it is beyond doubt that much denser currents can be used if the smoothness of the face of the deposit be not the principal object aimed at.

The author of this paper has made many inquiries of copper depositors for the purpose of ascertaining what is the maximum current density which is actually used by them in the practical deposition of copper, and has been unable to obtain any definite information. But so far as it is possible to form a judgment, the current density is not the same in all depositing trades, and very seldom exceeds about 300 amperes to the square metre of cathode surface.

The fact is, that the current density at which copper can be thrown down so as to obtain a good deposit depends very largely upon the thickness of the required deposit. A current density which would give a good deposit of $\frac{1}{1000}$th of an inch thick would give a very bad deposit $\frac{1}{50}$th of an inch thick, because every minute imperfection becomes enormously exaggerated as the process goes on. And this tendency to exaggerate original imperfections becomes much more marked as the current density is increased.

This effect, due to the time element, makes it very difficult to use exact language in speaking of the character of the deposit.

The effect of current density may be described in general terms as follows:—If the density be about 100 amperes to the square metre, the deposit is quite smooth and of a very pale salmon colour. If the density be increased, the surface, although still of a good colour, begins to get rough, and feels to the touch something like emery paper; if the density

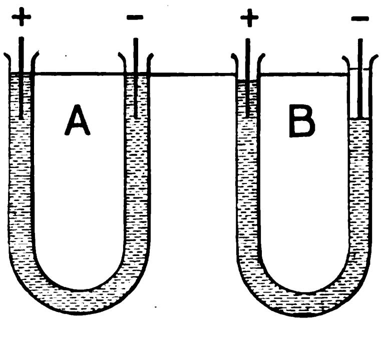
* Communicated to the Royal Society.

† "Traité Théorique et Pratique D'Electrochimie."

be further increased the deposit soon becomes discoloured, and if it be still further increased, hydrogen begins to appear in quantity on the cathode, and the copper is thrown down as a non-coherent chocolate-coloured mud.

The development of hydrogen may very well be accounted for, if it be assumed that the copper atoms in the electrolyte, which are immediately adjacent to the face of the cathode, are, in the case of dense currents, thrown down on the cathode more rapidly than they are replaced by the ordinary circulation of the electrolyte and by diffusion. If they are thrown down more rapidly than they are replaced, a time must soon come when the current has to force its way through the hydrogen molecules, which are adjacent to the cathode, and then hydrogen will be generated on the face of the cathode as well as copper.

It appeared to the author that it was not improbable that the generation of hydrogen was the most formidable obstacle in the path of rapid deposition, and that a rapid circulation



of the electrolyte over the surface of the cathode might possibly prevent the generation of hydrogen by maintaining a sufficient path for the current through copper molecules.

Some circulation is no doubt taking place in every bath where electro-deposition is in progress, and in some cases it is promoted by waving the cathodes to and fro, and probably also the atoms composing those molecules of the electrolyte which conduct the current change places and waltz round one another, according to the commonly accepted theorem, but the following experiment appears to point to the conclusion that this waltzing action is not accompanied by any movement of the waltzing atoms towards the electrodes.

A U tube was taken filled with an acidified solution of sulphate of copper, as shown in Diagram A, and a copper anode and a copper cathode were dipped into the electrolyte at the two open ends of the tube. This form of tube was adopted so as to prevent any circulation taking place. A very small current was then passed through the solution from the electrode marked + to the one marked −, and continued for two or three days. At the end of this period the electrolyte on the cathode side was in the condition shown in Diagram B. As far down as the cathode reached, all the copper in the solution had been taken out by deposition on the cathode, and immediately below the lowest point of the cathode the solution appeared to be unchanged. No change whatever had taken place round the anode so far as the eye could judge.

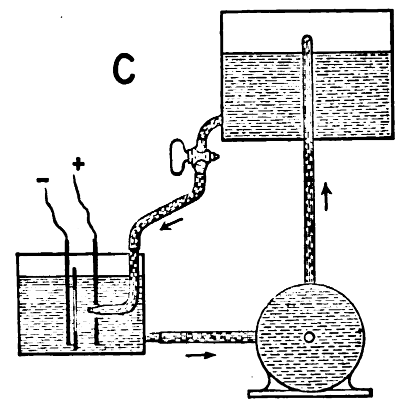
If the waltzing action had been accompanied by any movement of the atoms towards the electrodes, one would imagine that just as each atom of copper was thrown down on the cathode another atom of copper would have waltzed into its place, and consequently that no change in the electrolyte would have been expected in the neighbourhood of the cathode, but that a change might have been expected in the neighbourhood of the anode, especially if the anode had been made of some insoluble substance.

The experiment was, therefore, repeated with a lead anode substituted for a copper one. The same change was again noticed round the cathode, but no change was noticed round the anode, which could be observed by the eye.

The waltzing action does not, therefore, appear to have any appreciable effect in preventing the gradual exhaustion of the copper atoms on or near to the face of the cathode.

Mechanical circulation appeared, therefore, to be necessary to renew the copper atoms on the face of the cathode; and the next point which was investigated was whether the current density could be materially increased if, by means of a forced circulation, a continuous supply of copper atoms could be maintained on the face of the cathode.

To determine this, the apparatus shown in Diagram C was tried. In it the electrolyte was pumped up into a tank about



40 centimetres above the level of the electrolyte in the depositing bath. From this tank it was allowed to flow down a pipe, and out at a jet (below the surface) directed against the face of the cathode.

By these means a tolerably violent circulation of the electrolyte over the face of the cathode was obtained.

(To be continued.)

SOMETHING TO LEARN.

Englishmen do not, as a rule, know half as much of the United States as they ought to, advantageously to themselves; but we need not pride ourselves very greatly on our ignorance on this side. There is, or appears to be, quite as much amongst Americans with regard to conditions and facts in Great Britain; and we notice this more especially in connection with the prospects of electric traction on this side.

There is, no doubt, a great deal of business to be done, but some of the American technical papers give their readers very misleading information; and it seems a pity that garbled accounts should cause unnecessary trouble and expense. For instance, if a local authority in England considers the question of municipalising the tramways, a note on the subject probably appears in some of our trans-Atlantic contemporaries, implying that the said local authority is in the market for material. Forthwith circulars and price lists—perhaps even agents or representatives—appear on the scene, only to find out that two or three years must elapse before any orders can be given; and even then that home-made material will have the preference.

A recent example of this same "want of completeness," to put it mildly, occurs in the last issue of the *Street Railway Journal*, where a table is given purporting to comprise the principal cities of the British Isles and their tramway systems. Opposite to a number of these (perhaps 20) is printed the word "None"; and amongst those towns which are accordingly to be exploited for tramways are such as Hull, Salford, Bolton, Preston, Burnley, Huddersfield, Gateshead, Leith, Rochdale, St. Helens, West Bromwich, Bury, Wigan, Hanley, Devonport, Hastings, and Barrow-in-Furness. Out of all the lot, we believe that it can only be said of one that tramways do not yet exist, so we are somewhat puzzled to imagine where on earth the *Street Railway Journal* gets its information from.

It is, however, instructive to refer to some other figures supplied by our contemporary (with which we have no occasion to quarrel), to the effect that the British Isles possess about one mile of street tramway for every 40,000 inhabitants. In the nearest equivalent American area there is one mile of tramway for every 2,400 inhabitants, and the proportion of railroads is nearly the same, being one mile to every 1,800 inhabitants in Great Britain and one to 660 in the equivalent American area. We cannot, therefore, plead that many of the American street railways (*i.e.*, interurban and suburban lines), are represented with us by ordinary railroads.

Although the list of British towns without tramways drawn up by our contemporary is not to be relied upon as perfectly accurate, there is, nevertheless, nothing for us to boast about in the matter of tramway mileage.

THE NEW LYNN INCANDESCENT LAMP.

The *Electrical World* (New York) for January 29th, contains an article on an improved incandescent lamp which is being manufactured by the Lynn Incandescent Lamp Company, Mass. The mysterious commencement of the article leads one to expect improvements and novelty of a striking order. The company, has, in the course of its business of renewing burnt out lamps of different makes, taken note of all the weak points and defects of such lamps, and as a result of this special knowledge and observation, has turned its attention to producing a lamp which should embody all the good points of the best, without their defects. As might have been expected, the new lamp is pronounced to be unequalled "in the important qualities of uniformity, long life, and maintenance of candle-power."

Passing from the general to the particular, we come to a description of some of the special features and processes employed in the construction of this lamp—a description that is likely in places to provoke a smile on the faces of those acquainted with the details of lamp manufacture.

"In the construction of its new lamp, the company does not use cellulose filaments. It believes that the 'flashed surface' on the filament is the necessary factor, and therefore uses a material of higher specific resistance than cellulose, and one which admits of the greatest possible amount of 'flashed surface.' It has been the effort of the company to meet the demand from critical consumers for a uniform, efficient and high grade lamp, equal to its renewed lamp in life and sustained candle-power. One of the principal factors of the success of the Lynn Company in the manufacture of its lamps is its method of producing high vacua. On January 4th this year, Letters Patent were issued to Mr. E. F. Dwyer, the president and manager of the company, on a process of producing high vacua, which consists, substantially, of removing the main portion of the gases contained in the lamp bulb by pumping. A current is then passed through the filament and the exhaustion continued. A 16 C.P. lamp is run at about 32 candle-power, which brings the filament to an extreme white heat and excludes all the occluded gases contained in the filament. This is a new feature of lamp factory practice, the old idea being that the lamp would be strained if run above the normal candle-power; this would be true if the lamp were finished. The blackening of the bulb of the lamp is due to the condensation of the volatile carbon given off by the filament, and also from small particles of carbon thrown off mechanically, and by burning the filament to this extremely high temperature, all of these gases are thrown off and carried away by the pumps, the whole carbon becoming one homogeneous mass.

"But going back to the method of exhausting the lamps, the gases remaining in the lamp bulbs are mainly those which were purposely added during the process of exhaustion. As the lamp cools this remaining vapour condenses upon the cooler portions as a solid, leaving an almost absolute vacuum in the bulb. . . . . . . An important factor of the process is a mechanical pump which rapidly produces the necessary rough exhaustion. This pump in itself will, it is said, exhaust lamps equal to a mercury pump and can be used without the chemical process, but the latter saves much time and, as stated above, gives the almost perfect result."

From this not particularly lucid description of Mr. Dwyer's method of exhaustion, it is gathered that certain chemical bodies, which are capable of producing vapour at a high temperature, are introduced into the lamps whilst raised to high incandescence and during the running of a mechanical pump; and that by reason of the almost complete condensation of the chemicals on cooling, a peculiarly high vacuum is produced. This method of procedure is not new, however, having been patented in this country by Prof. Dewar in 1893—which patent, it may be remarked, anticipates in many important respects the now largely used Malignani process of chemical exhaustion. An article discussing this point was published in the Electrical Review last May. It may, of course, well be that Mr. Dwyer uses a different chemical, or chemicals, to those proposed or used by others, which gives him superior results. If so, no claim to this effect is made. It is to the principle of the process, so far as we can understand it, that attention is called.

NEW PATENTS.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents,* 322, *High Holborn, London, W.C., to whom all inquiries should be addressed.*]

3,032. "Steering torpedoes electrically." W. Jamieson and J. Trotter. Dated February 7th.

3,074. "Improvements in electric bells." P. Jenisch. Dated February 7th. (*Complete.*)

3,123. "Improvements in electric switches." J. M. Anderson. Dated February 8th. (*Complete.*)

3,136. "Electrolytic treatment of sulphides." J. Swinburne. Dated February 8th.

3,192. "Improved method for the electrolytic treatment of sugar juice." E. De Pas. (La Compagnie Electro-Sucriere, France.) Dated February 8th.

3,193. "Process for the electrolytic treatment of sugar juice." E. De Pas. (La Compagnie Electro-Sucriere, France.) Dated February 8th.

3,198. "Improvements in the manufacture of carbons for electrical purposes." C. L. Saunders. Dated February 8th.

3,204. "Improvements in electric arc lamps." C. A. Vigreux and L. V. Brillie. Dated February 8th.

3,207. "An improved guide for the carbon holder of an electric arc lamp." S. Bergmann. Dated February 8th.

3,209. "Improvements in electrical signalling apparatus." H. G. Leopold. Dated February 8th.

3,218. "Improvements in electric motors and dynamo-electric machines." H. H. Lake. (E. Cantono, Italy.) Dated February 8th.

3,219. "Improvements in electrical measuring instruments." A. C. Heap. Dated February 8th.

3,258. "New process for manufacturing objects, and specially cases for electric accumulators in unbreakable celluloid." E. Marckwald. Dated February 9th.

3,259. "Improvements in the construction of apparatus for producing and receiving Hertzian electric waves." E. Ducretet. Dated February 9th. (*Complete.*)

3,278. "Improvements in, or connected with, indicating electrically the changes of market prices of goods and other data." H. R. Meyer. Dated February 9th.

3,285. "Improvements in and connected with plates for electrical storage batteries." R. Kennedy. Dated February 9th.

3,313. "Improvements in electric motors." P. Isenloth. Dated February 9th. (*Complete.*)

3,316. "Improvements in a self-restoring annunciator, more particularly suitable for employment in connection with telephone switchboards." J. E. Kingsbury. (The Western Electric Company, United States.) Dated February 9th. (*Complete.*)

3,367 "Improvements in the production of acetylene light by electrolysis." D. D'Abbel. Dated February 10th. (*Complete.*)

3,368. "Improvements in secondary batteries." D. D'Abbel. Dated February 10th. (*Complete.*)

3,381. "Improvements in electric alarums." H. J. Blakeway. Dated February 10th.

3,412. "Improvements in combined fuse and switch boxes for use with high or low tension electric currents." A. J. Lawson and J. D. Dallas. Dated February 10th.

3,449. "Improvements in the electrical driving of machinery." J. R. Garner. Dated February 11th.

3,495. "Improvements in electric motors." J. S. Raworth. Dated February 11th.

3,496. "Improvements in electrical cut-out apparatus." L. Andrews. Dated February 11th.

3,501. "Improvements connected with apparatus for producing and utilising electric currents."

3,503. "Improvements in insulating materials." J. H. W. Stringfellow. Dated February 11th.

3,507. "Improvements in electric meters." Evershed and Vignoles, Limited, and S. Evershed. Dated February 11th.

3,514. "An electrical conducting boot or shoe for the purpose of bringing electricity from the foot into direct contact with the earth." W. Richardson. Dated February 12th.

3,555. "A combined switch and controller for electromotors." C. P. Elieson and W. S. Naylor. Dated February 12th.

3,563. "Improvements in or relating to electric arc lamps." F. Brown. Dated February 12th.

3,569. "Improvement in electrical apparatus for indicating or recording at a distance the position of an index hand or analogous movable object." A. Custodis. Dated February 12th. (*Complete.*)

3,573. "Improvements in submarine cable laying appliances." C. S. Snell. Dated February 12th.

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A STRIKE LESSON.

THE latest issue of the *Amalgamated Engineers' Monthly Journal* contains an article dealing with co-operation, which our contemporary considers to be worth more than passing notice. So far as we ourselves can learn, co-operation has not been a huge success in its principal home—Lancashire. We are at least aware that there is a good deal of surprise expressed by people generally as to the very considerable amassment of property by many managers of "co-op." stores, whose salaries could never account for a tithe thereof.

The article in question recognises the need of capital in any industry. No industry can be carried on without capital, nor is capital of the slightest use unless present in sufficient quantity, and backed by a sufficiency of patience to await fructification. The A.S.E. ~~writer~~ speaks of capital being banded together to do battle for privilege and monopoly, to control even Government, and boycott the small employer into subjection. *Engineering* thinks the words privilege and monopoly have got a bit twisted. The fight was rather over the question of the Union's privilege of ordering how employers should conduct their works. Any monopoly claimed was claimed by the A.S.E. for its own members' exclusive right to certain work, while boycott may be left to the reader's imagination.

The article urges men to become their own employers, to devote their surplus capital to co-operation—it is something that any surplus is admitted. Unlike *Engineering*, however, we do not quarrel with the quality of free spending of the working man, though we may quarrel with some of the directions of his expenditure. If a man saves and invests his savings, he helps on industry and reaps the benefit both directly and indirectly. If the workman does not save he must be helping trade very directly, but the huge prosperity of the big brewers seems to negative the idea that, as a rule, the free spender is helping himself very much, as there is very little labour in brewing. Few towns so small as Burton turn out so large a nominal value of product. *Engineering* recommends saving in beer and "baccy," in order to secure at once capital to start a works big enough to employ a fair proportion of the men in a given factory who should elect to go on the saving plan. Efficiently managed, and with profits ploughed in, men might soon all become their own employers. But jealousy and mistrust are great enemies to co-operation. Efficient management would demand a better wage than the ordinary workman, and the manager's post in a co-operative factory, owned by the men who would have to obey the, perhaps, servant manager, would not be a happy one. John Burns's saying that no man was worth over £500 a year was, says our contemporary, a very foolish saying.

We, ourselves, remember a case in Manchester where a man was discharged because his employers could not admit the propriety of "any servant of ours earning £3,000 a year." They discharged him, and the business simply died out. The *A.S.E. Journal* cites an instance of a co-operative engineering works at Leicester which is a success, but there is somewhat of a suspicion, however, that it is nursed.

There is also a South London Engineering Society engaged chiefly on bicycles, but it requires both shareholders and customers. We venture to say that if working men want to save and own works, there is no better way at the present time than that open by way of the Limited Liability Act. A limited company with a good board and an able manager, and articles of association forbidding any shareholder worker interfering, save in the meetings, might do some good. Railway shareholders are all part of a co-operative concern, and many railway servants, perhaps, own more shares than their superior officers; but this avails them nothing if they neglect their duties.

There are, however, various ways in which a working man may save without risk, and provide for a rainy day. He may keep up his trade union as a benefit society, and also have a share in the so-called war chest. The war chest ought to be used, however, for peace in place of being an incentive to fight, as the late fund of £350,000 so unfortunately proved to be.

Undoubtedly capital is apt to be greedy, and never more so than when it can use labour of either hand or brain to the best advantage, and to secure big returns. It should be the aim of both the hand and the brain worker to do the best possible for himself and for capital, while at the same time being able to refuse to be squeezed. The wilful waste of the A.S.E. fund was made when capital was not trying to squeeze labour, hence the folly of the strike. Why was not the £350,000 put into a modern factory to make, say, direct acting steam pumps on an eight hours' day, with none but members of the A.S.E. to do every piece of work, with none but A.Es. on machine work—with no half pay boys or youths, and with all the modern tools run at the same slow speeds allowed to employers? It is a bit foolish this call for co-operation from men who profess it proper to disallow a man to work more than one tool. We fear the writer in the *A.S.E. Journal* has little economic knowledge.

It is not a little strange to see how the working man can be persuaded out of large strike levies for months at a time. Say there are 80,000 members of the A.S.E. Then 4s. a week from each is £16,000, or nearly a million annually. Strike levies recently were as high as 6s. weekly. Every week a nice little business could be taken over. But this they will not do.

Is the Nervous System a Coherer?

In a note presented to the *Academie des Sciences* on December 27th last, M. Branly pointed out some striking analogies between the conductivity of discontinuous conductors, and the conductivity of the nerves for nervous currents. That physiologists have already recognised a general analogy between a nerve and an electric conductor, is proved by their use of the term "nervous current." Up till recently, however, they appear to have looked upon the nerve as a continuous conductor. But, in recent years, histological researches have shown that the nervous system is composed of discontinuous elements—*neurones*—without any cementing substance between them, and connected together by the contiguity of their ramified extremities only. It follows, that the nervous wave propagates itself by contiguity, and that it is arrested by any defect in the contiguity. If it is no longer possible to maintain that there is any analogy between the nerves and continuous conductors, it will be evident that a very striking analogy exists between the nervous system and a system of discontinuous conductors. Several results, deduced from a comparison of the working of discontinuous conductors, and the physiological action of the nerves, appear to point to some analogy between them. In the same way that a shock reduces or annihilates the conductivity of discontinuous conductors, *traumatism* produces anesthesia and hysterical paralysis, due to a suppression of nervous transmission either in the sensory or motor nerves arising from imperfect contiguity of the nerve terminals. On the other hand, electric discharges act most efficaciously as a cure for hysterical paralysis and anesthesia, just as electric oscillations augment the conductivity of discontinuous conductors. This points to the hypothesis that the effect is determined in both cases by the contiguity, or something equivalent to the contiguity, of the elements. The parallelism between the effects of shock and of sparks upon coherers and upon the hysterical nervous system may be recognised in the susceptibility to reaction under a feeble action which remains after a powerful initial shock. This M. Branly has shown to be true of coherers in his note to the Academy of December 6th, and it is well known to be a property of the nervous system. High frequency discharges, and the electrical oscillations which accompany them, are well adapted to render discontinuous conductors continuous; and these discharges have been shown by MM. d'Arsonval and Apostoli to exercise a decided therapeutic effect upon the affections due to defects in nutrition. If these affections are of a nervous order, and are capable of being attributed to an imperfect transmission of the nervous current, it is permissible to assume that electric oscillations act so as to re-establish between the nerve elements a contiguity which was becoming insufficient. Branly has shown, on a former occasion, that continuous currents of sufficient E.M.F. produce by their transmission through coherers the same effects as electric discharges at a distance. This action of continuous currents is subject to the same general laws as the action of electric discharges; persistence, disappearance with shock and heat, sensibility to less E.M.F. produced by the previous action of a battery of high E.M.F. Continuous currents also act upon the nervous system, and it will be an interesting subject for research to determine whether their action is analogous to that on coherers. M. Branly does not maintain that coherer and nervous actions are the same in every respect, but he considers that the similarity is sufficient to form a valuable guide to the electrotherapeutist in his future researches.

High Speeds on Electric Tramways.

To those accustomed only to the feeble crawl of horse tramways—pounding along at the enormous velocity of three to four miles an hour—it seems impossible that there should ever arise any danger of serious collisions between tramcars on dark nights, or in foggy weather, when running on a single track. The usual plan is for one to wait at a fixed turn-out until the other one comes, and sometimes the "wait" is considerable. With the introduction of electric traction, however, the entire service becomes speeded up, and the motor-men grow rather inclined to "steal a turn-out," especially if by any chance they should be late already. With frequent traffic and a more or less indefinite time table, it is, of course, advisable, if not necessary, to put in double track; but narrow streets may forbid this, and consequently the fact must not be forgotten that much greater care will need to be exercised with fast-running electric cars against the danger of collisions on the line than is now the case with horse traction. Several of these accidents have already taken place in the United States, though from the particulars published it would appear that sheer recklessness on the part of one or other (perhaps both) of the motor-men has been the cause of what should be termed "incidents" rather than "accidents." With a more serious loss of life than has hitherto been the case, they will become "catastrophes," and by that time tramway managers will make proper rules for their *employes* and see that they are carried out.

AN ELECTRICAL HYPOTHESIS FOR THE SOLAR AND PLANETARY SYSTEMS, AND SOME OF THEIR ASSOCIATED PHENOMENA.

By DELTA.

(*Continued from page* 141.)

III.

COINCIDENCE OF SUN SPOTS WITH MAGNETIC VARIATIONS

Reference is made in the first article to the coincidence of sun spots with magnetic variation; fig. 8 shows the coincidence in graphic form.

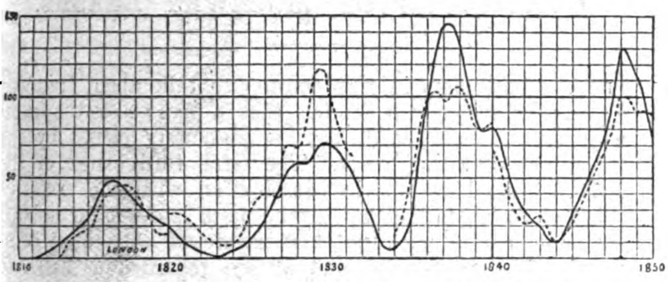
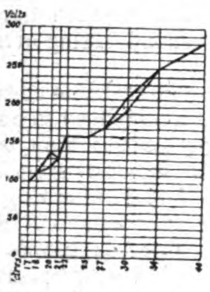


FIG. 8.—SUN SPOTS AND MAGNETIC VARIATIONS (From Langley's "New Astronomy").

In the diagram, for which we are indebted to Mr. Langley, the amplitude of the oscillation of the magnetic needle is shown by the dotted line, the full one being constructed from the relative number of spots.

FURTHER EVIDENCE OF THE INCREASE OF ELECTRICAL POTENTIAL WITH INCREASED DISTANCE FROM THE EARTH'S SURFACE.

Diagram, fig. 9, shows graphically the result of experiments made by Exner* with small balloons, with collectors in in open and free air.



Distance from the earth.

FIG. 9.

The same experimentalist obtained much higher result from observations made on the side of a mountain, *vid* diagram, fig. 10.

METHODS AND APPARATUS FOR EXAMINING THE ELECTRICAL CONDITIONS OF THE EARTH'S ATMOSPHERE.

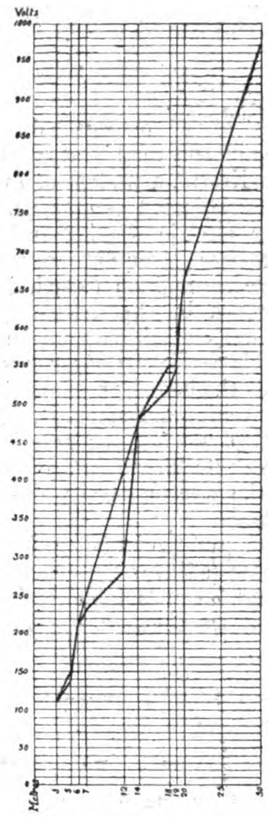
There should be little difficulty in devising means for the determination of the variations of electrical potential in mountainous districts, so that the barometric and electrical and thermal gradients can be recorded from day to day.

In France most excellent use has already been made of the Eiffel tower for the determination of the vertical barometric gradient. Here in England, unfortunately, we have no structure of equivalent altitude that can be readily employed for observative purposes, and we must, therefore, regret that the Wembley tower has not yet been completed.

In the absence of structures of high altitudes an alternative method has quite recently been employed, and with the best results as far as it was applied to the determination of barometric and thermal gradients.

This apparatus is shown by illustration fig. 11, and for which we have to thank *La Nature*. It will be seen to consist of a closed basket suspended from a kite of suitable carrying capacity and containing instruments of great precision and sensitiveness, and made of aluminium, for recording temperature and registration in mid air.

The apparatus registers variations of pressure of a fraction



Distance from the earth.

FIG. 10.

of a milim., and variations of temperature down to one-third of a degree centigrade. A check on the exact altitude can be trigonometrically determined by taking from two stations separated by a proper basis, two or more sights and their corresponding vertical angles, it is easy to determine the difference that exists between the height of the kite deduced from the barometric variation and the altitude determined mathematically.

The kite apparatus could be supplied with a multiple quadrant electrometer, with an automatic equipment for continuously recording the changes in the electrical condition of the atmosphere.

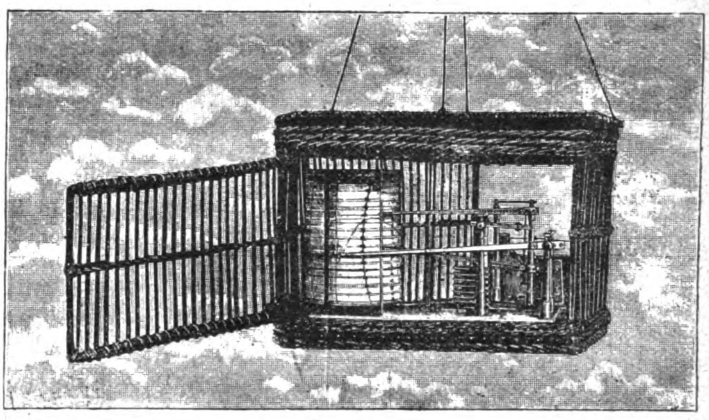


FIG. 11.—ALUMINIUM REGISTERING APPARATUS FOR STUDYING THE VERTICAL GRADIENT.

A suitable electrometer would record the myriad upon myriads of electrical lightning flashes, whose intensity is too slight to become luminously visible to the human eye.

It has also been suggested that Hertzian resonators, properly tuned, could be devised of sufficient sensitiveness to indicate all lightning discharges.

* Ursache und Gesetze der Atmos. Elec.

PROPOSED CONFERENCE OF EXPERTS.

The proper equipment of a perfectly equipped meteorological station that could satisfy the requirements—that the still almost unknown electrical condition of the atmosphere calls loudly for—is a subject that deserves the consideration of a joint conference of experts in the electrical, meteorological, astronomical, physical, and medical sciences.

THE DETERMINATION OF THE ELECTRICAL POTENTIAL NECESSARY TO PRODUCE LIGHTNING FLASHES.

The importance of a concentrated attention into the electrical condition of the earth's atmosphere could not be overstated. Even Kelvin, a student of over half a century, is still compelled to rely upon assumption in building up a calculation of the electric density and force of a given enclosure, representing a given displacement of air.

He says, on the assumption (which he is compelled to admit may be proved by experiment to be untrue), that electric density is uniform throughout the spherical shaped enclosure, each cubic centimetre of air experiences an electrostatic force towards the boundary in simple proportion to the distance from the centre and amounting at the boundary to nearly 10 per cent. of the force of gravity upon it.

Kelvin suggests the following form of calculation to obtain some measure of the electric density and force of a specific atmospheric enclosure.

Where V equals the potential indicated by the water dropper, a equals the radius of the spherical hollow (displaced by the water drop), ρ equals the electrical density of air at the distance r, from the centre of the spherical hollow; then we have

$$V = 4\pi \int_0^a \left(\frac{r^2}{r} - \frac{r^2}{a}\right) d\,r,$$

if ρ is constant

$$V = 2/3\, \pi \rho a^2$$

$$\rho = 3\, V/2\, \pi a^2.$$

Suppose $V = 38$ volts*

$\therefore \quad a = 50$ cm. and $\rho = 2{\cdot}4 \times 10^{-5}$.

The electrostatic force at a distance r being

$$4/3\, \pi \rho r = 10^{-4}\, r.$$

If we assume that a spherical conductor charged electrically—with a value of electricity equal to that possessed by a cubic centimetre of air—and placed at a point midway between the centre of the sphere and its surface, then $\frac{50}{2} = 25$ is equal to half the radius a.

Then between the surface and the centre of the enclosure, representing a given air displacement, there will be experienced a force equal to $2{\cdot}4 \times 10^{-9} \times 25$, equivalent, approximately, to $6{\cdot}10^{-8}$ grammes, or 4·8 per cent. of the force of gravity on a cubic centimetre of air of a density of 1/800.

Kelvin† applies this calculable hypothesis to the estimation of the electrical potential of a cloud constituted of air and watery spherules.

He says: "If a uniformly electrified globe produces a difference of potential of 38 volts between its surface and its centre, a globe of a kilometre diameter electrified to the same density reckoned according to the total electricity in any small volume (electricity of air and of spherules of water), would produce a difference of potential between its surface and its centre of 38,000,000 volts."

Kelvin, on this hypothesis, estimates that in a thunderstorm flashes of lightning show us differences of potential equal to millions of volts, but not as he says, perhaps of many times 38,000,000 volts, between places in the atmosphere distant from one another by half a kilometre, equal to 0·31 of a mile.

According to Trowbridge, to drive a spark across a gap between two terminals 4 feet apart requires a voltage potential of no less than 1,200,000, therefore a discharge of lightning one mile long will require the enormous pressure potential of over 100,000,000 volts; therefore 0·31 of a mile would require 31,000,000 volts, which is not far from Kelvin's calculated results. The voltage figure taken in the calculation is, however, rather too low, as is proved by Exner's determinations, see diagrams 9 and 10.

* See diagram, fig. 7, ELECTRICAL REVIEW, page 140.

† See Kelvin's paper, *Proceedings* British Association Meeting, 1894.

THE MOVEMENT OF FREELY SUSPENDED CONDUCTORS OF HIGH AND LOW POTENTIAL IN THE ATMOSPHERE.

McAdie makes the ingenious suggestion based on the well known fact that as the aluminium needle of the ordinary Thomson electrometer always moves from the region of high + to the region of low − potential, therefore a charged body, freely suspended in the atmosphere, will move from the place of high to the place of low potential. This may explain the movement of charged electrical conductors such as clouds, and thus produce the coloured aggregation effect, a common phenomenon of cloudland.

CONDITIONS OF TRAMWAY LEASES.

IT seems customary in this country to talk about tramway *leases*, even although it is a fact that in many cases the tramways are not leased at all, but are absolutely owned by the companies operating them. The fatal 43rd clause of the 1870 Act has however—in combination with the excessive spirit of socialism that has sprung up of late—so far imbued the popular mind with the brief nature of a tramway company's life, that they one and all are regarded as liable to early extinction; they are not, as the Americans say, "franchises"—involving almost absolute freedom for a long, if not an indefinite time—but are merely short "leases" or tenancies which will be terminated as soon as possible in favour of the local authorities concerned.

The latter have had their appetites in this direction considerably whetted by the development of electric lighting, and if only to help make their electricity works pay better, they will seize every opportunity of taking over the tramways and working them, or at least supplying current for them.

There are, however, very many existing interurban and other lines (whose number will without doubt largely increase) where the local authorities are practically obliged to grant fresh leases; and there are also the new lines projected as tramways or light railways which have similarly to be dealt with in regard to eventual taking-over by the local authorities.

It is much to be regretted that in such instances our local authorities are too little inclined to learn from the experience of others, but simply trust to their own crude and ignorant ideas of what is the most advisable course from their own very narrow point of view, squeezing all they possibly can out of the tramway interests and giving nothing in return. Such short sighted methods cannot be too strongly condemned: we do not advocate perpetual rights for tramways such as are common in the United States, but for a local authority to have the option of taking over a private tramway enterprise at break-up value, after a life of 20 or even 30 years, is as ridiculous as it is unfair and impolitic.

Such a condition simply means that the tramway is starved by its management, no public benefits are or can be offered, and no good is done to anyone, simply because the local authority is afraid of even a limited monopoly, and the tramway company regards the public body as a band of duly accredited robbers who steal not for private gain but for the public good.

If inquiries were made of other countries before imposing conditions of lease or franchise in regard to tramway lines, it would, we believe, result in valuable information being brought forward of a nature, if acted upon, to give satisfaction on all sides. For instance, the average "life" of a tramway on the Continent will probably be found to extend over 40 or 50 years at least, though, of course, the conditions of road maintenance, money payments, &c., vary in each case, and therefore also vary the value of the concessions apart from their actual length.

Some very interesting and useful particulars in regard to this question are contained in a pamphlet that has just reached us from the municipal engineer of Shanghai, Mr. Charles Mayne. This gentleman appears to have circulated a list of questions amongst the principal local authorities of the United States and Canada, as to the period of years for which tramway concessions have been granted; the amounts payable to the local authorities by the tramway companies for the right of user in regard to the public streets, and the works of paving, road maintenance, &c., to be carried out by the tramway companies.

Out of a total of 34 towns and cities ranging in population from 20,000 to 700,000, no less than 23 have granted perpetual rights to the tramway interests. One other system is almost as well off with a life of 999 years, another exists for 99, two for 30, two for 25, and four for 20 years; most of the short terms being granted by Canadian towns, so that we may credit the "public authority ownership" idea with being essentially British. Twenty-two out of the entire number pay the local authority in each case absolutely nothing for the privilege of using the streets, and 20 out of these 22 have a perpetual franchise. The other two are limited to 20 and 25 years respectively.

The majority are called upon to pave and maintain the roads, &c., between the rails and for 12 or 18 inches outside; but these conditions vary a great deal in each case, and no valid comparison can be made, but enough is given to show that English tramways suffer at present from disabilities of a much more serious nature than those inflicted by local authorities in any other country where tramways have developed at all.

PRACTICAL WORK WITH THE BALLISTIC GALVANOMETER.

By LAWFORD H. FRY.

The reflecting ballistic galvanometer has an unpleasant reputation for absorbing a great deal of time and temper in the making of measurements with it. A certain amount of this reputation is deserved, for the charting of the various ballistic constants, involving, as this does, a series of determinations of the coefficients of damping for different resistances in the galvanometer circuit, and their insertion in the somewhat unpleasant formula,

$$C_B = c\ \frac{T_0}{\pi}\ k^{\left(\frac{1}{\pi}\tan^{-1}\frac{\pi}{L}\right)},$$

is necessarily a lengthy proceeding. But this need only be done once, and by the adoption of the methods given below, work with the ballistic galvanometer will lose much of its slowness. In the formula above, the symbols have the following meanings:—

C_B is the so-called ballistic constant, which varies with the resistance in the galvanometer circuit, and which comes from the formula, $Q = C_B \cdot \alpha$, where Q is the quantity of electricity flowing through the galvanometer, and α is the corresponding deflection.

c is the ordinary constant of the galvanometer.

T_0 is the time of swing of the galvanometer in an open circuit.

k is the coefficient of damping of the galvanometer, and may be defined thus: if $b_1, b_2, b_3, \ldots b_n, b_{n+1}$, be the amplitudes of successive swings of the galvanometer,

$$k = \frac{b_1}{b_2} = \frac{b_2}{b_3} = \ldots = \frac{b_n}{b_{n+1}},$$

$$\text{hence } k^n = \frac{b_1}{b_2} \times \frac{b_2}{b_3} \times \ldots \times \frac{b_n}{b_{n+1}} = \frac{b_1}{b_{n+1}},$$

$$\text{therefore } \log. k = \frac{\log. b_1 - \log. b_{n+1}}{n},$$

L is the natural logarithm of k.

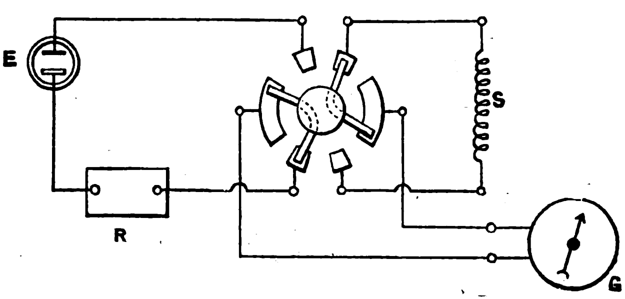
From this we see that, so long as the magnetic part of the instrument remains unaltered, the only factor in the formula that can change and alter the ballistic constant is the ordinary constant of the galvanometer, which will be altered by the shifting of the telescope and scale, which is a thing very likely to occur. Then to work in the most economical way, things must be so arranged that for the recalibration of the instrument the only measurement to be made is the determination of the ordinary constant. To accomplish this, a chart of the changes in the factor,

$$k^{\left(\frac{1}{\pi}\tan^{-1}\frac{\pi}{L}\right)}$$

of the ballistic constant must be made and preserved; this factor changes with a change of resistance in the galvanometer circuit, but is unchanged by shifting the telescope. The form of this chart will be a curve having as its abscissæ the resistances in the galvanometer circuit in ohms, and for its ordinates the values of the expression,

$$k^{\left(\frac{1}{\pi}\tan^{-1}\frac{\pi}{L}\right)}$$

Then to recalibrate the galvanometer all that will be necessary will be to determine the ordinary constant for the then position of the telescope, and to multiply it by the value of the other factor obtained from the curve by measuring the length of the ordinate to the curve, which passes through the point on the axis corresponding to the resistance of the galvanometer circuit with which the measurement is to be made. If, however, such a chart is not in existence and the ballistic galvanometer is to be used for some measurement, as for instance, the determination of the coefficient of mutual induction of two conductors, the following method will



enable the instrument to be calibrated and the measurement to be made with as small an expenditure of time as may be. The idea of the method is to determine the ballistic constant for the one galvanometer circuit resistance with which the final measurement is to be made. For such a determination the following quantities have to be measured. The ordinary constant of the galvanometer, c, the time of swing of the galvanometer in an open circuit, T_0, and the coefficient of damping of the galvanometer for the circuit with which the final measurement is to be made, k. These first measurements will be best made in the order in which they have been enumerated. In all work with the ballistic galvanometer it will be practically necessary to have two workers. In the present case we shall consider two men working as quickly as may be, so that one man changes the connections while the other is making observations; usually, however, speed will not be such an object but that it will be well to work out the results of each step before changing the connections to those for the next step, thus giving an opportunity for checking the work if the first result does not appear right.

To proceed with the measurements:

For the determination of the ordinary constant there will be needed a Clark element, or other standard cell, a resistance box containing resistances up to at least 30,000 ohms, and a two-way switch. These must be connected up, as shown in fig. 1, the switch allowing the galvanometer to be connected up in series with the element and resistance box, or to be short-circuited through the wire, S. This last is to bring the galvanometer to rest quickly between measurements, or if set swinging accidentally. The measurement of the constant is made in the usual manner.

If e be the E.M.F. of the cell,

r be the resistance in the box,

g " " of the galvanometer,

C " current in the "

α " deflection of the " due to the current C,

and c " constant " "

$$e = C\,(r + g)$$

but $$C = c \cdot a$$
$$\therefore e = c\,a\,(r + g)$$
$$\therefore c = \frac{e}{a\,(r + g)}$$

now, e, r, and g are known, hence observing a gives c. With the ballistic galvonometer a steady deflection, a, can, of course, not be obtained; but the swing being noted the distance of the mid point of the swing from the zero of the scale gives a. This measurement having been made, the galvanometer must be set swinging sufficiently vigorously to enable the time of swing to be determined. This may be done by opening and closing the battery circuit periodically, the period being chosen to correspond to the swing of the instrument. Having set the galvanometer in motion, the switch must be turned open so that the swing continues undamped. Then to measure the time of swing. Measure the time taken for, say, 10 swings, divide the time by the number of swings, thus finding approximately the time of swing. Then let the galvanometer swing for a longer time, making, perhaps, 100 swings, note whether the number of swings is odd or even, divide the time by the approximate time of one swing as determined above, this will give the number of swings made during the whole time; the division will not give a whole number, but, of course, a whole number of swings has been made, here make use of the knowledge as to whether the number of swings was odd or even, if it was odd take the odd number nearest the quotient obtained by the division as the number of swings made, if, however, the number was even take the nearest even number, then divide the whole time of swing by the number of swings thus obtained. The quotient will be the accurate time of one swing. While one observer is watching the swing of the galvanometer, the other can be removing the element and resistance box and substituting for them the circuit in which the final measurement is to be made. To find the coefficient of damping of the galvanometer. Set it swinging, this may be done by sending the same current through which is finally to be measured, if this does not give a sufficiently wide swing several impulses may be given to help each other. The galvanometer being set swinging, turn the switch so that the galvanometer is damped by the circuit in which the final measurement is to be made. Note the amplitude of a number of successive swings, the number of swings will depend on the damping of the galvanometer, if the resistance is small so that the coefficient of damping is large, only a few swings will be wide enough to be read with accuracy, if, on the other hand, the damping is low, through a large resistance, more swings can be taken. Eleven swings will be found to be a convenient number to take, only the amplitude of the first and the last need be noted, for these are all that occur in the formula

$$\log k = \frac{\log b_1 - \log b_{n+1}}{n}$$

With 11 swings, n will be 10, a convenient number to divide by.

To avoid unnecessary work in the determination of the factor it will be well to obtain the value of

$$k^{\frac{1}{\pi} \tan^{-1} \frac{\pi}{L}}$$

by interpellation, from the accompanying table, which is taken from Kohlrausch, Leitfaden der Praktischen Physik.

The advantage of using the circuit in which the final measurement is to be made, in the determination of the damping coefficient, is that then only the one measurement of this coefficient is necessary, and no measurement need be made of the resistance of this circuit; thus a possible source of error is avoided, and a considerable amount of time and trouble is saved. The operations described above give all that is needful for the calibration of the galvanometer.

The use of a standardised induction coil will reduce the trouble and calculation in the determination of the ballistic constant to a very small quantity.

For if M be the coefficient of mutual induction between the spools of the coil,

C the current in the primary spool.

e_m the E.M.F. induced in the secondary spool by the disappearance of the current C.

c_m the current in the secondary spool.

t the time of change of current.

Q the quantity of electricity flowing through the secondary spool, and

R the resistance of the galvanometer circuit,

then $$e_m = M \frac{d\,c}{d\,t}$$

and $$e_m = R \cdot c_m$$

$$\therefore M \frac{d\,c}{d\,t} = R \cdot c_m$$

$$\therefore M \cdot d\,c = R \cdot c_m \cdot d\,t.$$

$\therefore$ By integration $$M \cdot c = R \int c_m \cdot d\,t$$

but $$Q = \int c_m\,d\,t$$

$$\therefore M \cdot c = R \cdot Q$$

again $$Q = c_B \cdot a,$$

$$\therefore M\,c = R \cdot c_B \cdot a$$

$$\therefore c_B = \frac{M \cdot c}{R \cdot a}.$$

Hence, if M and R are known, all that is needful for the determination of the ballistic constant is the measurement of C and

TABLE.

Log k.	$k^{\frac{1}{\pi} \cdot \tan^{-1} \frac{\pi}{L}}$	Log k.	$k^{\frac{1}{\pi} \cdot \tan^{-1} \frac{\pi}{L}}$
00	1·0000	·13	1·1510
·01	1·0115	·14	1·1626
·02	1 0231	·15	1·1743
·03	1 0347	·16	1 1859
·04	1·0463	·17	1·1975
·05	1·0578	·18	1·2091
·03	1·0694	·19	1·2208
·07	1 0811	·20	1·2324
·08	1·0927	·21	1·2440
·09	1·1044	·22	1·2555
·10	1·1160	·23	1·2670
·11	1·1277	24	1·2785
·12	1 1393	·25	1 2900

the observation of a. That is by the use of a standardised induction coil, the determination of the ballistic constant may be effected by a simple current measurement and mere multiplication and division.

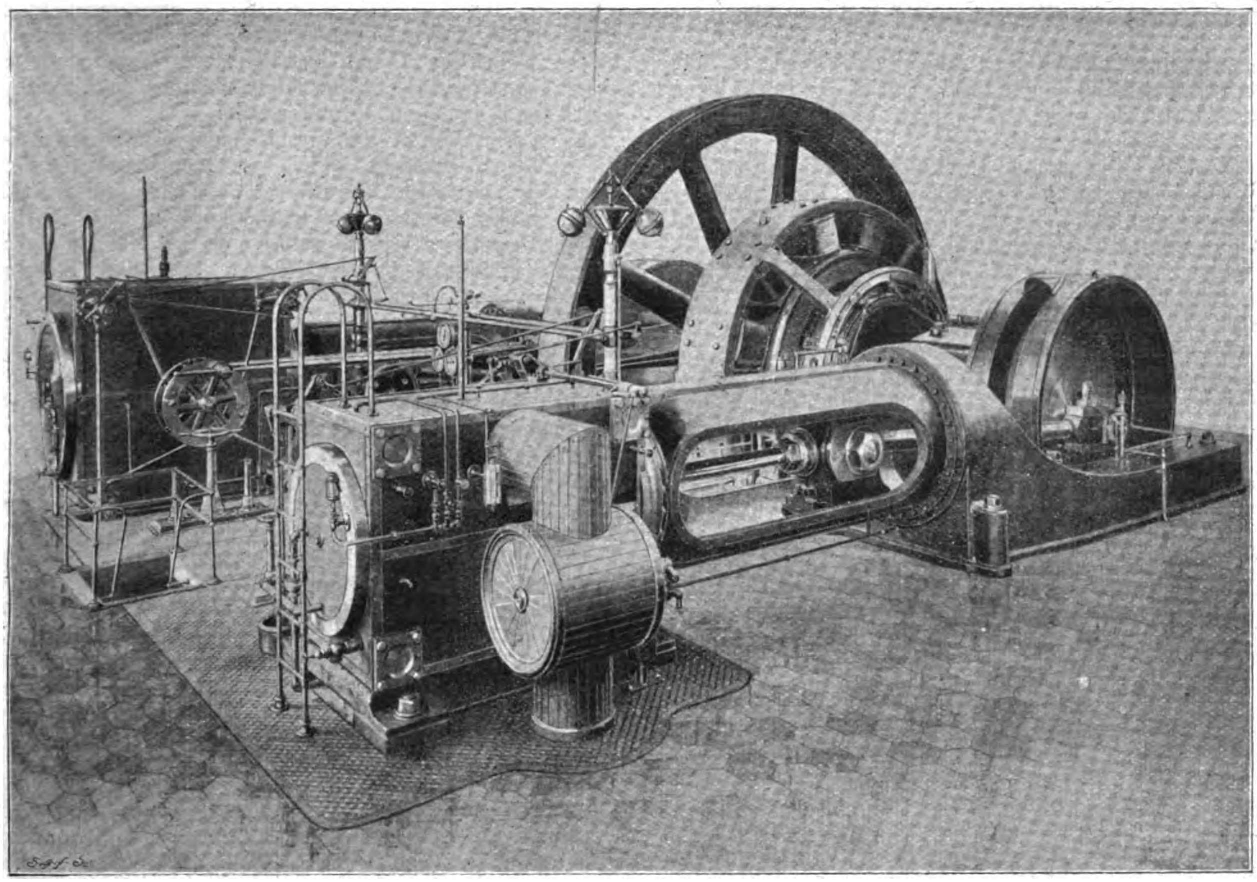
In the final measurement for which the galvanometer has been calibrated as above, it will be advisable to leave in the two-way switch, with a short circuit between two of the terminals, as this affords a very handy means of bringing the galvanometer quickly to rest between the measurements.

THE CENTRAL LONDON RAILWAY.

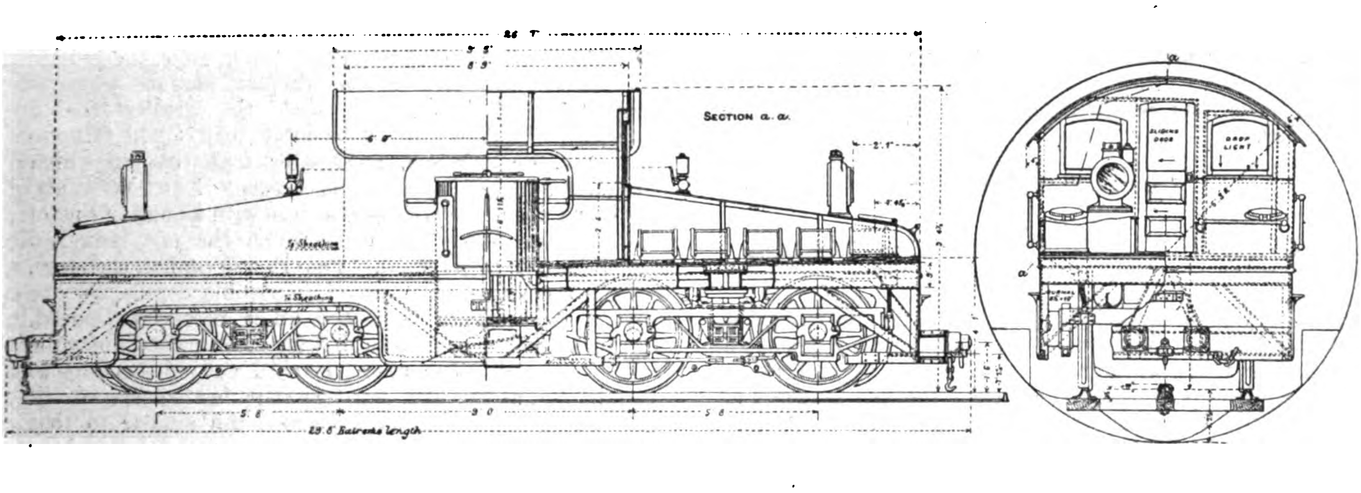
GREAT progress has been made with this gigantic undertaking, and last week of the total length of 22,880 yards of tunnelling, only 6,000 yards remained to be driven. Few people realise the enormous difficulties that have arisen in driving the tunnels. The work has necessitated not only the diversion of the sewers in many places, but round about the Bank the whole of the gas and water pipes had to be taken up and placed in different positions. Up to the present the energies of the railway company have been mainly directed to completing as far as possible that portion of the line that lay outside the City boundaries, and this to some extent, though not all, accounts for the somewhat backward state of the Bank subways. The foundations of the company's generating station at Shepherd's Bush have been begun, and no doubt this section of the undertaking will be completed about the same time as the other. It is perhaps hardly necessary to remind our readers that all the station lifts, some 49 in number, will be worked by electricity. On other electric lines in London the engineers have favoured the hydraulic system, and it will be interesting to compare the performance of the two methods.

We are able to give a few interesting details of the plant which is to be used on the line. The total length of continuous railway over which electric traction is to be provided, is about 6½ miles, exclusive of crossovers at stations and sidings.

It is intended to run a 2½ minutes' service, with trains of seven carriages each, with a total seating capacity each of 336 passengers, and weighing 105 tons loaded, exclusive of the locomotive. The average speed of the trains is to be 14 miles per hour, including stoppages at stations.



The electric plant, which is to be installed by the British Thomson-Houston Company, is on the three-phase system, and has been designed by their consulting engineer, Mr. H. F. Parshall. There are to be three sub-stations in the



lower portion of the lift shafts at the Davies Street, Notting Hill Gate and Post Office stations. Additional plant is to be installed at the Marble Arch station, but will at present be only of the nature of a spare plant.

The boiler plant will consist of 16 Babcock & Wilcox boilers, in eight batteries of two each. The evaporating power of each boiler is to be 12,000 lbs. per hour; the heating surface 3,580 square feet, and the pressure 150 lbs. per square inch. The boilers will be fitted with Vicars mechanical stokers, which will be supplied with coal by a conveyor from a storage tank on the top of the boiler house, having a capacity of 1,500 tons. The coal conveyor also serves to remove the ashes, and will be driven by electric motors.

Each engine is supplied with an independent combined jet condenser and air pump of sufficient capacity to take the maximum quantity of steam. The condensing and injection motor will be forced to the top of four Barnard cooling towers, each tower being furnished with two fans driven by electric motors. The engines are six Reynolds-Corliss cross compound condensing engines running at 94 revolutions per minute, to give 1,300 I.H.P. each, with cylinders 24 inches and 46 inches diameter × 48 inches stroke. The engines are capable of being run non-condensing, and either high or low pressure side can be run independently. Steel fly-wheel is to weigh 100,000 lbs., and is built up in eight segments. The engines are guaranteed for a consumption of 13¼ lbs. of steam at 1,000 I.H.P. when run condensing with 26½ inches vacuum. We are able, by the courtesy of Mr. Blackwell, who represents the makers, the

Edward P. Allis Company, in this country, to give an illustration of the exact type of engine which is to be employed.

The three-phase generators will have 32 poles, and a capacity of 850 kw., 500 volts, and 25 cycles. They are of the revolving field type. The coils of the stationary armatures are held in slots, there being ventilating ducts through the body of the armature, similar to the standard armature construction of the British Thomson-Houston Company. The total weight of each generator is 80,000 lbs. It is assumed that four of the six units will be sufficient to take care of the average load, and this will, therefore, provide a margin of 50 per cent. over the present requirements of the plant.

The switchboards have been specially designed, the high tension switches being double break, half of the break being on each side of the panel. The high tension contacts in every case are mounted on ebonite.

The Notting Hill Gate and Davies Street sub-stations will contain one rotary converter in each station, with necessary transformers and switchboards. At the Marble Arch and Post Office sub-stations, there will be two rotaries in each. Each rotary has a capacity of 900 kw., and will be of the 12-pole type, running at 250 revolutions per minute. They are capable of being run up either from three-phase, or the direct current side. As these are rotary converters in the exact sense of the word, that is to say, an alternating current of 330 volts pressure, passes into the machine, and is converted into a continuous current of about 500 volts on the other side, it is necessary to provide step-down transformers which reduce the line potential from 5,000 volts to 330 volts. These are of the air-blast type, but instead of following the usual plan of forcing the air through the transformers, the air is drawn through, and the hot air is expelled through sheet-steel pipes, running up the centre of the spiral staircase of the stations, thus providing ample ventilation for the sub-stations, as well as effectively cooling the transformers. The weight of each transformer will be 8,000 lbs.

The cables connecting the power-house with the substations, will be carried through the tunnels on brackets. They are of the British Insulated Wire Company's standard paper insulation type. The third rail will be of steel, weighing 80 lbs., to the yard of channel section supported on creosoted wood insulators, each joint being bonded with four flexible crown bonds. The rails of both up and down lines will be divided into four sections, and interconnected by circuit breakers.

The locomotives, of which drawings are shown on the previous page, will be mounted on two trucks, each truck carrying two motors of 150 H.P. The total weight of the locomotive is about 42 tons, the total length of locomotive being 29 feet, and the total height, 9 feet 8 inches.

There will be four gearless motors on each locomotive, one on each axle, and these will be controlled by series parallel controllers, provided with magnetic blow-out, which will place the four motors in series, two in series, and two in parallel, or all four in parallel, as desired.

The trains will be fitted throughout with Westinghouse air brakes.

THE EMPIRE AND TELEGRAPH CABLES.

In the varying accounts of a new and important scheme of telegraph cables, which have lately been widely circulated among the press, throughout the Colonies as well as in England, there is to be found sufficient internal evidence to warrant us in concluding that all of these emanate from a single source. Although differing somewhat in the manner in which the statements are presented, as well as in the style of treatment, still, in the main body of these paragraphs and articles, the recurrence of the same prejudiced and garbled statements all point to a common source of origin. We have frequently dealt in detail with the numerous points raised, but, as the subject has assumed a more interesting aspect lately, owing to the aggregation of errors which are now being so widely disseminated, it is, perhaps, well that the more important of these should again be treated of at the present time.

The subject of a system of submarine cables, which, starting from England, would be carried on to Cape Town, touching only at the various British possessions on the way, is not a new one, nor is the proposed continuation of such a line from Natal to Australia, *viâ* Mauritius, Rodriquez Island, and the Keelings, a new conception. A somewhat similar scheme was fully dealt with by Mr. Hofmeyr, when representing the Cape of Good Hope at the Imperial and Colonial Conference, held in London in 1887; and was recommended by him as an addition to the scheme for a cable across the Pacific Ocean from Canada to Australasia, which was one of the principal subjects before the Conference. This additional scheme, which, as a supplement to the Pacific cable, it may be remembered, was rendered necessary by the inefficiency of, and frequent interruptions to, the then existing system of cables, has lately assumed an importance which ten years ago it did not possess.

About the time of the first Colonial Conference it was the cables to Australia which were continually breaking down, but latterly the cables to the Cape have deprived them of the record for frequency of interruption, and, therefore, the supplementary scheme referred to by Mr. Hofmeyr is strongly advocated by the Eastern Extension Telegraph Company, the Eastern Telegraph Company, and its off-shoot, the Eastern and South African Telegraph Company; the latter of which suffers both in purse and reputation owing to the frequency of interruptions to the Cape cables.

The point to which we take most serious objection, is that the popular advocates of Mr. Hofmeyr's project hope to advantage their cause by a continuance of the system of inaccuracy in figures and statements advanced, and by so doing to prejudice opinion against the Pacific cable route. For example, it used to be roundly asserted that the depth through which a Pacific cable would have to pass was "estimated at 12,000 fathoms (or 14 miles) in some places." This assertion was contained in a note from the Postmaster-General of South Australia to his Government, and coming from such a source aroused a natural objection on their part to examine any further into the matter; more especially when the same authority further asserts, in the same note, with a courageous confidence worthy of a better cause, that "as the Government are aware, I have given this subject very great and careful consideration, more so, perhaps, than anyone else." We are glad to see that this figure (an utterly imaginary one) is now reduced, by others better informed, to "a depth of 5 miles"; it is not, however, made clear by these recent critics, that this latter depth (which really does exist) occurs in an isolated depression which is more than 600 miles away from the proposed Pacific cable route. We may mention here that there are two cables lying in West Indian waters which were laid within 60 miles from a similar depression, more than 4½ miles in depth, and one of them has been working for over 25 years without giving any exceptional trouble. An unbiassed examination of the Admiralty charts will prove to anyone, that along the proposed route of the Pacific cable, the general depth to be expected in the deepest sections averages about 2,700 fathoms, and that the greatest depth would in all probability not be more than 3,200 fathoms —a depth, we may say, no greater than that in which a cable has recently been laid between New York and Hayti, and about the same as that met with along the line of the Government-supported cable which has just been laid from Bermuda to Jamaica. The Pacific cannot, therefore, be looked upon as an ocean of impossible depths, nor one where a cable cannot be picked up if necessary; indeed, experience teaches us that a cable has been picked up at the depth mentioned. The route sketched out *viâ* the Cape to Australia has, as yet, been but very imperfectly surveyed it seems, however, to have an average depth similar to that through the Pacific Ocean, and in one place at least, along the Cape line, there is a depth of nearly 3,200 fathoms. Thus it will be seen that, as regards depth of water, the supplementary route has absolutely no advantage over the Pacific line.

It is true that a cable between Vancouver and Fanning Island would be longer than any one length suggested for the supplementary route, but the length required would exceed by less than 250 miles that of a cable at present being laid across the Atlantic; and would in reality be about 250 miles less in length than the advocates of the Cape route make it out to be. The following quotation from an Australian paper is another sample of the class of information circulated. Referring to the Vancouver-Fanning Island section, we are told: "This section is practically twice the length of the longest section of the 'Cape' proposal." Now, this is an utterly misleading statement, as the real length of the section spoken of is here increased, for the purpose of condemning it, by some 1,200 miles. As the writer in this case illustrates his article by a map on which the proposed lengths of "the Cape route" are all carefully set down, it seems incredible that he should be so ignorant, as he would appear to be, regarding the original scheme, which he criticises adversely. It has also been said that being a "single line" the Pacific cable has no alternative in case of interruption, but those who, in their anxiety to furnish objections, advance this as an argument, seem to forget that, if correct, the same objection also applies to the proposed single line from the Cape; and that should either of these single lines break down the already existing cables to Australia would afford more or less useful alternatives to one, as much as to the other, of these proposed single lines.

(*To be continued.*)

THE INSTITUTION OF ELECTRICAL ENGINEERS.

At the meeting of the Institution of Electrical Engineers, held on Thursday last, February 24th, Mr. G. Binswanger Byng read a paper on "The Manufacture of Lamps and Other Apparatus for 200-Volt Circuits." The author must have given to this paper a good deal of trouble and thought, and it is apparently written with a view mainly to arrive at some standardisation useful to manufacturers. Those who note the points in the different sections and discuss the views held by the author, are certain to help the object which he has had in view, and will benefit not only the members of the Institution but all electrical manufacturers.

We hardly agree, however, with Mr. Binswanger Byng that station engineers are neither unanimous nor possess co-relation of ideas as to the kind of fittings and accessories suitable for 200-volt circuits. On such matters as the desirability of ventilating fuse boxes, there may be divergencies of opinion; but the principle and more important details of design and construction are recognised and agreed upon, while experience has shown the wiring contractor—who, after all, is the most difficult person to move in the matter—that certain types of fittings will satisfy his client, the insurance office, and the supply company, as well as suit his pocket. Perhaps the most difficult thing to get to-day is a good long-break switch for currents above 5 or 6 amperes at 230 volts continuous, which combines the desiderata upon which a consensus of opinion exists. We trust, therefore, that switch and fuse design will receive more attention in the discussion than the mere question of high voltage *v.* low voltage.

The discussion was opened by Mr. Crompton, who, however, preferred to reserve his remarks until a later meeting, as these were to be confined to the arc lamp question, and he was not quite ready to speak. Mr. Boot, of Tunbridge Wells, took the opportunity of impressing the importance of minor matters, too often ignored, upon those present; one of these to which he attached importance as concerning manufacturers was the necessity of adopting standards in design, and keeping to them. One point he considered noteworthy is the undoubted economy effected in cost of cable required on a 200-volt as compared with a 100-volt job; and he had known of several cases where firms had made a mistake, and tendered for work under the impression that supply would be given at 100 volts, whereas, on this being corrected, and the pressure having been ascertained to be 200 volts, a revised offer at a reduced price had been made; the saving in cable more than compensating for the extra cost of fittings and lamps. While a standard length of fuse should be agreed upon for manufacturers to work to with different currents, where fuses are used on alternating circuits there is less necessity for great length than on direct current circuits.

This fact, although well known, does not seem to be so generally recognised as it might be. From the author's paper Mr. Boot thought one is rather led to infer that high voltage lamps are decidedly bad; that is, that it is impossible to make lamps as satisfactory all round as with lower voltages. He admitted the life of the former was not so long as the latter, also that the candle-power sometimes falls off rapidly, but the author had certainly made out a very good case for engineers using the Robertson lamps.

He considered that engineers would find that a good case had been made out for the adoption of the higher voltage. At Tunbridge Wells the supply had been changed entirely over, and the higher voltage generally adopted. It was a general practice to connect two 100-volt lamps in series, as many fittings allowed of this, and in a number of cases customers had two-light fittings, both lights being controlled by one switch. Cheap lamps were the rule nowadays, if those of 100 volts were wanted, as those discarded by 100-volt supply were to be obtained at a low price.

Mr. Mordey felt much obliged to the author for the mention of his name in the paper in connection with a type of fuse he had designed some years ago. He was afraid he had not had much experience with 200-volt lamps, but watched with very much interest the progress of their manufacture and use. He considered the author had done a great service in bringing up this subject at the present time, and regarded what was read as an excellent practical paper. In a few remarks on the specific resistance of carbon, he stated that this ought to be considered in relation to its specific gravity, differences in specific resistance have to do with the mechanical state of the material. An unflashed filament under the microscope showed itself to be a long string of cinder, and the particles were connected together in the fashion of what was, in the early days, called microphonic contacts. Flashed filaments become very much more a solid. On the first occasion he spoke at the Institution, in 1882 or 1883, experiments were cited, showing that carbon differed from metals in its behaviour, depending upon its mechanical state: finely-divided carbon behaves the same as finely-divided metal. It would be interesting to know if the pendulous filaments of carbon found in the gas retort of a gas-works, have been ever used for lamp manufacture, or if any attempts have been made to employ them.

Then advocates of high voltage supply must not forget that the question is practically being tried by jury, and speakers should give actual costs of different voltage lamps on circuit. Engineers must not imagine that the jury has been asleep; he had heard entirely unsatisfactory remarks from users of high voltage lamps, other advantages may balance the disadvantages; but the satisfaction of the public is the question. Central stations might take on their shoulders the whole burden, and thereby obtain control of the energy sent out for a given candle-power.

Mr. Mordey then referred to Mr. Robertson's paper in the Electrical Review, where the difference of effect of alternating and direct currents on the life of lamps was discussed. In Vienna, where the conditions enable reliable comparative tests to be made, it was found that there was a very decided gain where lamps were used on alternating circuits. There might be a commercial advantage in the supply of lamps to customers at a certain contract price.

With respect to arc lamps, his experience was that the getting out of the light from the arc was the important point, and with high volts the light gets out; but small current lamps at high voltage were very poor things, although even from a small crater the light can get out if the length of arc be considerable.

Mr. Binswanger Byng mentioned in his paper a novel "cut-out" for extinguishing the arc in an arc lamp automatically when required, but Mr. Mordey held that the cut-out in the old Brush lamp complies with all the conditions laid down.

Mr. Robertson stated that he had nothing to add to the information he had given the author when assisting him in the preparation of the section of his paper on incandescent lamps. Mr. Raworth thanked the author for his very excellent paper, and remarked that Mr. Boot and his friends would not be quite so happy if they had to make the lamps they use, or live with them. At the present time Mr. Raworth had to live with them, and had the opportunity of creating an enormously fine cemetery from the selections that lamp makers were good enough to send him free for trial. Some engineers state that they look for one in every dozen going wrong at the commencement of life, but he had 25 per cent. in a dozen, and in another dozen only two were left. Certain of the peculiar qualities of high voltage lamps—such as not burning horizontally with satisfaction—were rather important things to consumers and contractors, where the angle at which fittings were set might have to be altered to obtain decent results. Another point is that these high voltage lamps do take more current per candle-power than the lower voltages, a rather important matter to the consumer who resents an increased bill for lighting.

Mr. Shoolbred believed that the 100 and 110-volt lamp in the early days of electric lighting was quite as much an experiment as the 200 or 220-volt lamp is at the present time, and felt sanguine that the latter will prove equally successful, owing to the very large number of indirect advantages attending its use. There are many things to be considered besides the lamps, such as motive power, &c., and 400—500 volts can be utilised in many applications of electrical industry besides lighting. The author referred to the difficulties he had met with; many of these were due to not having had the advantage of discussing the question of standard pressure at an earlier date, when an attempt might have been made to avoid the existing discrepancies. The opportunity was lost then, but it would have been very much better to have arrived at something like unanimity in the matter while possible. We may emerge from seeming chaos to the best in the end.

The results attained so far are by no means discouraging. The restriction to a small size of bulb need not always apply, and there seems to be no insuperable difficulty in using a larger sized cap, particularly in starting in new localities. A reversion to olden time again is the expedient of using two lamps in series. Many years ago two 50-volt lamps were so connected, to enable the best lamps then extant to be connected on a 100-volt supply.

In horizontal positions lamps of high voltage are weak, but anchored and zigzag filaments can be used, while Mr. Shoolbred had certainly not experienced much trouble with such lamps in a horizontal position.

At this stage the discussion was adjourned until the first meeting in the current month, which will be held on the 10th inst., and we may expect a lively and useful discussion. It might not be out of place to again point out that the title of Mr. Binswanger Byng's paper is practically precise, and his intention obvious; a much better purpose would be served by dealing with the paper than by roaming all over the subject of supply pressures, and repeating what has already been said at the Institution when Mr. Addenbrooke's paper was read, at the Municipal Electrical Association on Messrs. Barnard and Couzen's papers, and at the Northern Society of Electrical Engineers, when Mr. Gibbings described his procedure and experiences at Bradford with the increased pressure. It is really time that it was made clear to wiring contractors and consumers what precautions are essential, and in what particulars wiring must be altered from the old fashion when 200 volts pressure is to be used.

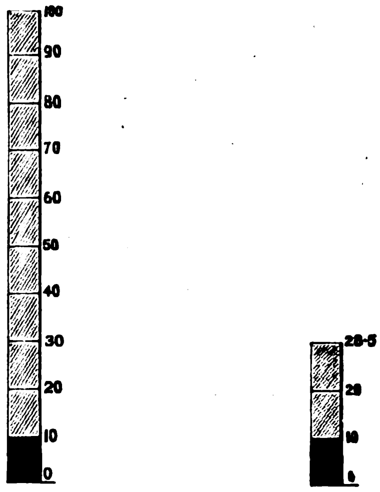
CORRESPONDENCE.

"The Burning Question."

Your recent articles on the above subject hardly do justice to the filter press as an aid in the burning of sludge. I notice calculations based on the assumption that the press removes one-third of the weight; and you have also expressed doubts whether sludge containing 65 per cent. of moisture can be considered pressed at all.

Now, 65 per cent. is not an excessive proportion of moisture in pressed sludge, and to reduce the percentage to this from the 90 per cent. in the original wet sludge requires the removal of about *two-thirds* of the bulk. The appended diagram (an old-fashioned affair now) will make this clear at a glance. The dark portion shows the solids, and the light portion the water. In the first case (unpressed) there are 90 parts of liquid to 10 of solids; in the second 18·5 parts of water to 10 of solids. That is to say, more than seven-ninths of the water have disappeared. If the solids are to be burnt, the press is plainly a valuable adjunct in the process—excepting always the case of Ealing.

Ordinarily, pressed sludge is not very combustible. You may drop a lighted match on a heap of it without any risk of a conflagration. Spontaneous heating does sometimes occur, running up the temperature to somewhere between



Unpressed Sludge with 90 per cent. of Water. The Same Pressed with 65 per cent. of Water.

110 and 120° F., and keeping it wonderfully steady at that for a considerable time. After heating and cooling there is a farther diminution in bulk; the cake formation is destroyed, and the heap becomes a mass of mere greasy muck.

Wet sludge has never been known to heat anywhere, and in most cases is about as combustible as Embankment mud on a wet day. At Ealing all this is different; the addition of a few cabbage leaves, meat-tins, and ashes confers remarkable burning qualities on the wet slop. It burns freely, and, after driving off its own moisture, has heat to spare, which is diligently utilised. No one has ever clearly explained the furious affinity for oxygen which characterises the Ealing sludge; some talk vaguely of dietic peculiarities of the contributory population, others of transmutation and the philosopher's stone. One had the theory that the solids consisted exclusively of potassium, but half an hour to leeward of the chimney stack dispelled that notion. The facts stand: ten parts of solids (and these mainly mineral and incombustible anywhere else) not only burn, not only evaporate nine times their weight of the water in which they were drowned; but they do these and yet have energy to spare for evaporating other waters, transformed later into mechanical and again into electrical energy, with effects visible to all men on the tops of arc lamp poles in Ealing Town. The old scientists used to dream about the circulation of matter, beginning, say, at the villager with a deal of guano in his destiny, who lay in the churchyard and made the grass grow. The churchyard fed the village sheep, the sheep the villager, and so the cycle went on. But what a poor figure these dreams make beside the realised results at Ealing. The natives live on the fat of the land; the dejecta, garbage, and refuse, elsewhere a costly nuisance, transformed into brilliant light; and all by mere cunning engineering and chemistry at the sewage works. Imagine this system applied to London—but we cannot.

J. Hetherington.

A Legal Point.

I should be pleased if you could kindly tell me whether the following action on the part of a corporation is legal or not, as it opens up a wide field:—

A corporation, with an electricity supply for the borough, has just secured an order for a large private installation outside their area of supply, and, in fact, in the area of an urban district council which has just got a provisional order. This corporation, I should mention, has its own wiring department, and the private installation is to consist of engine, dynamo, wiring, &c. My opinion is that this is illegal, as it is using ratepayers' money in a speculative business, quite outside the area of the borough.

Another point I should like to mention, and that is, the assistant engineer for this same corporation is at the present time acting as consulting engineer for two large private installations, thereby depriving consulting engineers, who are dependent upon it, of obtaining clients.

If the first instance is illegal, it will result, I understand, in the corporation being prosecuted, and a few words from you on the matter would, I feel sure, awaken interest in the subject, which, I think you will admit, is a serious one.

Legal.

[Although there may be some uncertainty as to the exact legal position of a corporation when undertaking wiring inside its own area of supply, there seems to be little doubt that a corporation is exceeding its functions when it undertakes wiring outside its own district. We do not think that much complaint can be urged against assistant engineers who do occasional consulting work, for it is doubtful whether their outside practice interferes very much with that of engineers who devote their whole time to consulting work.—Eds. Elec. Rev.]

Currents Necessary to Fuse Wires.

On looking over a table of above, taken from a paper by W. H. Preece, F.R.S. (*Proceedings Royal Society*, Vol. XLIV., March 15th, 1888), I noticed the following relations between the currents; and as they appear to have been overlooked hitherto, I thought they might interest your readers.

The following is part of the table in question:—

Wire-diameter in inches.	Cu. × 1	Fe. × 3	Sn. × 6	Pt. × 2	Pb. × 8	Al. × ¾
0·080	231·8	71·22	37·15	117·0	31·20	171·6
0·064	165·8	50·96	26·58	83·73	22·32	122·8
0·048	107·7	33·10	17·27	54·37	14·50	79·75
0·036	69·97	21·50	11·22	35·33	9·41	51·18
0·028	48·00	14·75	7·69	24·23	6·46	35·53
0·022	33·13	10·27	5·35	16·88	4·49	24·75
0·018	24·74	7·60	3·96	12·49	3·33	18·32
0·014	18·44	5·66	2·95	9·31	2·48	13·66
0·012	14·15	4·34	2·26	7·14	1·90	10·47
0·010	11·50	3·53	1·84	5·80	1·55	8·51

You will notice that, approximately, the current required to fuse Pt. is one-half of that necessary to fuse Cu.; also, that necessary to fuse Sn. is one-sixth of that required to fuse Cu.; and similarly for the other elements, using as divisor, in each case respectively, the figure given under symbol in table. So that, in order to get the approximate fusing current for any one of those elements, all one requires to know is the fusing current for one of the particular wires and the multipliers.

There is also the somewhat curious fact that if the currents necessary to fuse a given wire of Fe., Sn., and Pt., respectively, are added together, their sum is, approximately, the fusing current for Cu. wire.

This, of course, follows as a mathematical deduction from the above.

I may mention that the currents in above table are in amperes, and that the wires are of such lengths that end effects may be neglected.

W. H. F. Murdoch.

Glasgow, *February 28th*, 1898.

Information Wanted.

I would be very much obliged if any person could inform me, that when designing a ring slotted armature if the section is calculated as if the slots were solid, or how is it calculated, or what allowance is made for slots?

Also, supposing the slots were a quarter of an inch wide, would the air space between armature and fields be one-eighth of an inch on each side, or what proportion of width of slot would the air space on each side be?

Subscriber.

Cost of Long-Running Plant.

I should be much obliged if you or your readers would let me know of any electrical plant running more or less continuously at or near full load. I am anxious to find out the cost of generation under these conditions, and should be glad to be put into communication with the owners of any such plant, whether used for electro-chemical or any other purpose. The plant need not be of large capacity necessarily, but the main feature should be that it runs for long hours at or near full load. I imagine there must be cases where such plant is run more or less continuously all the year round, and if so, I should be glad to know of its existence. The main difficulty seems to be that the owners of such plant object, on business grounds, to making their experience public; but I hope it may be possible to find some cases where such considerations do not hold.

Atlas.

The Salaries of Assistant Electrical Engineers.

I do not think that I am the only one of your readers who will heartily endorse the opinions of the two correspondents in your last week's issue with respect to the magnificent salaries now being offered for responsible positions in station work. I could a little understand the policy of the borough electrical engineers, if they were ever in the habit of considering the ratepayers by keeping down their own salaries, as well as those of their assistants. But I notice that, whether the place be paying or not, the salaries of the chiefs are going ever upward, while those of their staffs are going down. I do not think that these men, in doing this, are rightly keeping up the dignity of their profession. For do not they themselves belong to the same rank of the profession as they, and do not they expect their assistants to have gone through the same electrical training as themselves? If their respective committees think at all about this strange state of affairs, it must strike them that there is some unfairness in paying an assistant who is expected to be able to take the place of the borough electrical engineer in his absence, such a ridiculous fraction of his salary. Of course, the poor fellows have it all so nicely explained to them by the continual humbug, "Look what you are learning." But an assistant cannot continue everlastingly extending his experience for nothing, any more than a borough electrical engineer. In any profession, and especially in that of electrical engineering, a man is learning all his life.

There is no reason for this starving policy even in the case of the few non-paying stations. But it certainly ought not to be seen in a place which pays like Tunbridge Wells. Borough councillors do not expect the officials in their other departments to do work for nothing, and it ought not to be allowed in their electric light station. What would these gentlemen think of engineering firms who pay their skilled mechanics 25s. or 19s. 2¼d. per week? In most tenders a Corporation now expressly stipulates that the men must be paid the standard wage.

If the ratepayers' pockets must be considered in such a remarkable way, and if it is absolutely necessary for the profession that this grinding should go on, might I suggest that permission be obtained from the mayor and councillors of the towns where it is practised for boxes to be placed outside their public buildings with a legend such as this:—

"Electricians' Poor Box.

"As we only pay our assistant electricians enough for board and lodging, we should be glad of your help, so that they may provide themselves, in the interests of decency, with a little clothing. Remember that they work 365 days in the year, and that it is mostly night-work."

Fiat Justitia.

While sympathy for the writers of "Protests" against small pay to *shift engineers* fills my breast, I fail to see that there is sound "horse-sense" in the proposal of W. Fennell. There are dozens ready to pay for a chance at practical electrical experience, and your refusing to accept such advertisements would probably let others try to enter this overcrowded market, who may see these advertisements and be deterred thereby, to our future advantage. I could tell of a small high tension station on this island whose chief engineer and manager accepted the post a few years ago on £2 a week, with the privilege of taking a pupil, and he got the pupil.

L. D. Collins.

Dublin Cables.

Referring to the note on "Dublin Cables" in your last issue, it is evident to me that you are not correctly informed as to the actual facts.

The statement that the arc light cables were too small is entirely without foundation, as 7/16 cable should be perfectly adequate for a current of 10 amperes, and the further statement that it was unsuitable for the mechanical strains it was called upon to bear from time to time is equally incorrect, as no interference was found necessary with these cables until the first breakdown occurred, some three years after the station commenced work.

With regard to your remaining remarks, I may say that the necessity of applying for a loan was due to the fact that the distributing system had repeatedly failed during the previous two years, owing to deterioration of the rubber insulation of the cables at many points, and when as many as 20 failures occurred during one week, it was impossible to preserve the proper continuity of supply to the consumers.

To remedy this state of affairs, it became necessary to lay down new cables; and as these could not be placed in the same pipes with the existing cables without disorganising the supply, it naturally resulted that the ground must be reopened over the whole system to accommodate the new cables, and it was considered advisable to take advantage of this opening to change the system of distribution to the consumers from high tension supply with house transformers, to low tension supply from transformer sub-stations.

When the new system of mains is in complete working order, the existing system of pipes, &c., would be available for use in extensions as required, and such of the cable as should be found suitable would be used for the same purpose.

It is obviously impossible for anyone to know the actual condition of this cable over its whole length until it has been withdrawn and carefully examined; but from the observations I had made I considered that cable to the value of £2,000 should be found capable of being used, out of the total amount of £3,300 which had been expended in purchasing same, and I estimated that the cost of making such cable serviceable should not exceed £500.

In face of the above summary of the recorded facts, I am quite unable to see any foundation for your suggestion of inconsistency, and must request you in future to verify your facts before basing upon them any reflections upon my personal conduct.

M. Ruddle,
Electrical Superintendent,
Dublin Electricity Works.

[We are unaware of having made any reflections upon Mr. Ruddle's personal conduct, and if he will take the trouble to read through the report of the official Government Board inquiry on the city electric light, as published in the *Irish Daily Independent* for December 9th, he will surely admit that his own evidence was sufficient foundation for our note of last week.—Eds. Elec. Rev.]

Estimating, &c.

Could any of your readers inform me of a book on estimating for "mechanical and electrical plant and installation work," or how I could gain some experience of the subject.

A Subscriber.

Royal Institution.—The course of lectures on "Recent Researches in Magnetism and Diamagnetism," which Prof. Fleming commenced at the Royal Institution on March 3rd, are the "Tyndall Lectures."

DUBLIN ELECTRIC LIGHTING.

The following is a copy of the letter from the Local Government Board to the town clerk, conveying the decision of that body on the recent application of the Corporation for a further loan of £20,000, in connection with the existing electric lighting system:—

"Local Government Board, Dublin,
"*January* 13*th*. 1898.

"Sir,—I am directed by the Local Government Board for Ireland to state, for the information of the Corporation of Dublin, that they have received the report of their chief engineering inspector, Mr. Cotton, on the local inquiry, held by him on the 8th ult., into the application of the Corporation for sanction to a loan of £20,000 for works in connection with electric lighting. With regard to this application, the board wish to observe that in November, 1891, a loan of £32,800 was sanctioned for machinery, cables, posts, lamps, &c., for electric lighting, and £4,200 for buildings at the generating station. In November, 1893, a further loan of £16,837 was sanctioned for additional and extra cost of machinery, and £7,563 for cables, pipes, and laying. Of this latter loan only £5,000 was advanced. Recently, it appears, there have been many failures in the cables, and it was resolved by the Corporation to apply for a loan, which, among other things, would provide for laying these cables *de novo*. The Board observe that on September 23rd, 1897, the Electric Lighting Committee recommended that a new generating station should be provided at the Pigeon House Fort, at a cost of £100,000, and also—(2) That a system of sub-transformer stations be adopted. (3) That the entire system of cables or mains, so far as it may be found necessary by the borough surveyor, be altered or renewed. (4) That for the purpose of such renewal the sum of £20,000 be provided. The Council at their meeting on October 8th, adopted a report of the committee of the whole house, slightly varying the recommendations of the Electric Lighting Committee, including the following:—

"'That a system of sub-transformer stations be adopted, as such will ultimately prove a saving to the Corporation: that the entire system of cables and mains, so far as it may be found necessary, be altered or renewed; that for the purposes of such renewal the sum of £20,000 be provided, but that no portion of this amount be expended or orders given, until the description of cable be reported on by the consulting engineer with the borough surveyor to a committee of the whole house, to be called for that purpose, and approved by them; that the Electric Lighting Committee be empowered to apply to the Local Government Board for their sanction to a loan of £20,000, the law agent and the town clerk to take whatever steps are essential for this purpose.'

"On November 10th, 1897, the town clerk wrote to say that the Municipal Council have, on a representation from the Electric Lighting Committee, decided that it is absolutely necessary to have the cables renewed with as little delay as possible, and have therefore directed me to make application for the sanction of your board to a loan of £20,000, to enable the Corporation to proceed with the proposed work. This letter, of course, indicated that £20,000 was required to be spent in re-placing 'cables' which had failed, and the town clerk was informed that a loan to replace failures would not be sanctioned while the loans under which the works were constructed are running. The town clerk wrote again on November 23rd, 1897, to the effect that only a small portion of the £20,000 was required to purchase 'cables' to replace those that failed. Under these circumstances the Board considered it desirable to order the local inquiry, which, as already mentioned, was held by Mr. Cotton on the 8th ult. The town clerk's letter of November 23rd, 1897, and the evidence given at the inquiry, show that the £20,000 is proposed to be applied to two purposes:—1. For forming sub-transformer stations and costs incident on the change of system, say £6,500; 2. For new cables and laying, £13,500—£20,000. From the wording of the report of the committee of the whole house it might naturally be inferred that the whole £20,000 was required simply for the renewal of the cables which had failed. As regards the portion of the loan destined for sub-transformer stations, and costs incident thereon, the Board find that this change of system was recommended by Mr. Ruddle, in his report of September 18th, 1897, and was adopted by the Electric Lighting Committee, and by the committee of the whole house, and approved by the Council of October 8th, 1897. It was also recommended by Prof. Kennedy, in his report of October 25th, 1897, which report the Board are informed, has been approved of by a committee of the whole house. The estimate for this work, contained in the town clerk's letter of November 23rd, 1897, appears to be approximate only. The Local Government Board will be prepared to consider a loan for this purpose when full particulars, specification, and detail estimate are submitted and approved. As regards the rest of the loan which is required for new cables and works in connection therewith, the estimate is also approximate only, and no particulars or specifications have been submitted. The present cables insulated with vulcanised rubber are laid in pipes, and cost, so far as the Board can ascertain—For cables, £3,300; for pipes and road work, £8,000; (about) £11,300. The evidence shows that it would not be possible to draw out the present damaged cables and replace them in the same pipes with new cables without dislocating or stopping entirely the lighting arrangements over the whole area at present supplied. This circumstance, in the opinion of the Board, points to the advisability, in future works, of providing for duplicate mains. There appears, therefore, to be no remedy for the present state of things but to provide new cables, as suggested by Prof. Kennedy in his report, which, as stated above, has been before the committee of the whole house, and approved by them, in accordance with the resolution of the Council of October 8th, 1897. It is stated that the rest of the work, the pipes and works incident thereon, will not be rendered useless, but are available, and will be used for extensions to the further parts of the city outside the present lighting area, and to provide duplicate means of supply as required in consequence of increased demands in future. The Local Government Board consider that a further loan for these cables may be entertained, but the amount should be limited by deducting from the amount required the sum properly outstanding in respect of the portions of the original loans appertaining to the cables which have to be replaced, the cost of which appears to be £3,300, of which about £2,600 is now properly outstanding. The balance (£2,563) of the second loan, not drawn, should be considered as cancelled. The Board do not consider that the suggestion that the present cables can be removed, and when repaired be again used, ought to be taken into consideration. When full particulars, specification, and detailed estimates are submitted and approved, the Board will be prepared to sanction a loan for new cables and works connected therewith.—I am, Sir, your obedient servant,

"(Signed) D. J. MacSheahan,
"*Assistant Secretary.*"

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending March 1st, 1897.

	£	s.
Amsterdam	265	0
Barcelona. Teleg. cable	120	0
Bilbao. Teleg. mat. ...	86	0
Bombay	65	0
Buenos Ayres	18	0
Bundaberg	119	0
Calcutta	276	0
Cape Town. Teleg. mat.	220	0
Christiana. Teleg. wire	86	0
Durban	597	0
East London	89	0
Flushing	13	0
Fremantle (400) ...	400	0
" Teleg. cable	730	0
" Teleg. mat.	3,982	0
" Teleph. mat.	1,553	0
Genoa. Teleg. wire ...	50	0
Gibraltar	110	0
Gothenburg. Teleg. wire	108	0
Malaga	85	0
Marseilles. Teleg. mat.	60	0
Melbourne	1,074	0
" Teleg. mat.	403	0
Ostend	104	0
Passages	80	0
Perth	111	0
Port Elizabeth	28	0
Rio Janeiro	70	0
Rotterdam	18	0
Santos	27	0
Shanghai	399	0
Singapore	80	0
Sydney	87	0
Wellington	1,130	0
" Teleg. mat.	434	0
Yokohama	283	0
Total ...	£14,379	0

Week Ending March 1st, 1898.

	£	s.
Adelaide	23	0
Alexandria. Teleph. mat.	77	0
Antwerp	29	0
Auckland	18	0
" Teleph. mat.	2,740	0
Bangkok	447	0
Bombay	433	0
Boulogne	86	0
Buenos Ayres	520	0
" Teleg. mat.	127	0
Calcutta...	84	0
Cape Town	1,250	0
Constantinople ...	230	0
Colombo	100	0
Delagoa Bay	1,076	0
Durban	205	0
Flushing	25	0
Gibraltar	277	0
Lyttleton	2,297	0
Madras	10	0
Malta	72	0
Mauritius. Teleg. mat.	42	0
Melbourne	143	0
Passages	29	0
Port Elizabeth... ...	135	0
Reval	62	0
Shanghai	7	0
Singapore. Teleph. mat.	44	0
Sydney	1,726	0
Tientsin	31	0
Wellington	112	0
Yokohama	488	0
Total ...	£12,915	0

Foreign Goods Transhipped.

	£	s.
Rio Janeiro. Teleg. mat.	1,024	0

Appointment.—We learn that Mr. William Isaac Taylor, M.I.M.E., of 50, Fenchurch Street, E.C., has been appointed as the successor to the late Mr. Archibald Thomson, to represent the Darlington Forge Company, Limited, for London and South of England, for all work of their manufacture, with the exception of railway work. Mr. Taylor has represented Messrs. Clarke, Chapman and Co., Limited, of Gateshead, for the last 15 years, and this position he still retains.

Art Metal Fittings.—Mr. Charles Escare, of 16, St. Anne's Court, Wardour Street, Soho, send us an illustrated list of various designs of brackets, electroliers, switch covers, &c. Nearly all the designs shown are Louis XV. and XVI., and are exact copies taken from State castles and museums, and adapted for the electric light. The chasing, mounting, gilding and repairing, are carried out at St. Anne's Court.

Bankruptcy Proceedings.—A receiving order was made last week at the London Bankruptcy Court against Trehearne, Son & Crump, electrical engineers, 155, Fenchurch Street, City. Messrs. Montagu & Co. attended on behalf of the General Electric Company, Limited, Queen Victoria Street, the petitioning creditors. The act of bankruptcy alleged in the petition was non-compliance with the requirements of the usual bankruptcy notice. No particulars transpired regarding assets or liabilities.

Brussels Exhibition.—We understand that in addition to obtaining the gold medal at the recent Brussels Exhibition, the jurors have awarded a special prize of 1,000 francs for Geipel's patent steam trap in recognition of its exceptional merits.

Business Announcement.—Messrs. Henderson, Bunn and Co., Limited, of Giltspur Street, announce that they are placing upon the market an insulated iron armoured conduit for electric wiring, the insulation being porcelain enamel. The same firm is also introducing the H.F. dry battery.

Personal.—Mr. Joseph Bastick informs us that he has relinquished his electrical engineering business at Levenshulme, and has joined the Birmingham Carbide Company, Limited, as works manager, on a seven years' engagement, to erect the plant and superintend the manufacture of carbide. Mr. Bastick has been with Messrs. Crompton & Co., Swinburne & Co., John Turner & Sons, and other firms.

Calcium Carbide Plant.—We learn that Messrs. Ashton, Frost & Co., Limited, have on hand a dynamo (60 volts 2,000 amperes) four polar, with slotted drum armature and duplex winding, for the manufacture of calcium carbide in conjunction with Pictet's patent furnace, for Messrs. Carter & Lupton, Ingleton, who hold a license for the Pictet furnaces.

Change of Addresses.—Mr. Geo. Stegmann informs us that, in consequence of increased business, he has removed to larger and more commodious premises at 45, St. John's Hill, Clapham Junction. He will shortly open electric light showrooms, where every requisite relating to electric lighting will be on view.

Mr. J. S. Cunnington, electrical engineer, has removed from 18, Cecil Court, to larger premises, 93, St. Martin's Lane, W.C., in consequence of increased business.

Electrical Plant for Collieries.—During the general meeting of the Federated Institution of Mining Engineers in Newcastle a large number of members and delegates visited the works of Messrs. Ernest Scott & Mountain, Limited, at Newcastle-on-Tyne. The following is a list of electrical colliery plant and other machinery in course of construction and on view in a state of completion, ready for shipment, that was open to the inspection of the visitors:—For the Clay Lane Iron Company.—One set of 14 inches by 18 inches three-throw mining pumps capable of delivering 1,000 gallons per minute against a head of 300 feet. For the Arniston Coal Company.—One set of 14 inches by 18 inches three-throw mining pumps (high lift) capable of delivering 500 gallons per minute against a head of 700 feet. For Messrs. Rowley, Thomas & Co.—One set of 7 inches by 12 inches three-throw mining pumps (low lift) capable of delivering 200 gallons per minute against a head of 250 feet. For the Mitchell Main Colliery.—One set of 10 inches by 12 inches pumps capable of delivering 500 gallons against a head of 150 feet. For the Arniston Coal Company.—Two 200-unit generators for driving pumping machinery, and three 80-H.P. motors for driving pumping machinery. For the Hickleton Main Colliery Company.—Two 90-unit generators for driving electric haulage plant. For Young's Paraffin Oil Co.—Endless rope electric haulage plant with 40-H.P. motor, driven through worm gear. For the Digby Colliery Company.—Electrical coal-cutting machinery, fitted with disc of suitable diameter to cut 4 feet 6 inches deep, and with motor of 30 H.P. For Sir Wm. Gray & Co.—Enclosed compound engine of improved self-lubricating type, coupled direct to "Tyne" dynamo with drum bar armature. Output, 44,000 watts. For Messrs. Walter Scott & Co., for London Central Railway.—Electric locomotive fitted with motor of 25-H.P. and suitable for 2 feet gauge; designed for mines, or for contractors' use underground. For Messrs. Humphreys, Tennant & Co.—Four sets of 20-inch centrifugal pumps and engines combined. For the St. Petersburg Cement Co.—Two 4-foot ventilating fans, with motors combined, capable of delivering 10,000 cubic feet of air per minute at 4 inches pressure.

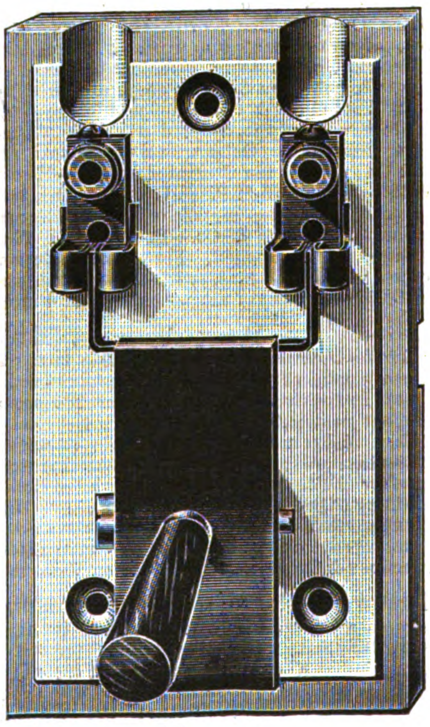
Electrically-Driven Wood Working Machinery.—The *Timber Trades Journal* for February 19th is the twenty-fifth special anniversary issue of that journal. The number is special for several reasons. It consists altogether of over 260 pages of reading and advertisement matter, and the number of special articles got together for the occasion must have entailed an immense amount of work. Our attention is especially drawn to the engineering section, where among other matter we observe a lengthy article on "Wood Working Machinery with direct Electric Driving," in which are shown planer, saw bench, band-saw, boring, and other wood-working tools with electric motors attached. The machines were made and fitted by Messrs. Kirchner & Co., Limited, 118, Queen Victoria Street, E.C.

E.P.S. Batteries.—Mr. J. W. Barnard informs us that his engagement as secretary of Electrical Power Storage Company, Limited, having terminated, the company have appointed him their sole agent in the United Kingdom for the sale of their Q and V types of storage cells. It will be remembered that these types of E.P.S. cells are intended specially for use in connection with carriage, cycle, miners', domestic hand-lamps, phonographs, electro-medical appliances, &c. Mr. Barnard has secured offices at 4, Great Winchester Street, E.C., where he will have every opportunity of meeting the numerous customers of the Electrical Power Storage Company who are interested in this particular branch of its manufactures.

Forthcoming Books.—Messrs. Whittaker will publish immediately "Alternate Currents in Practice," translated from the French of Loppe and Bouquet, by F. J. Moffett, A.I.E.E., electrical engineer to the colony of Lagos, W. Africa. "Electrolytic Methods of Analysis," translated and adapted from the German of Dr. B. Neuman, by J. B. C. Kershaw, F.I.C., and a volume on "Radiography," by S. Bottone, a well-known writer for amateurs upon kindred subjects. The same publishers will also issue, in conjunction with the General Electric Company, "A Popular Guide to Commercial Telephony," by M. Byng, M.I.E.E., and F. G. Bell.

Flannery v. The National Telephone Company, Limited.—In the Queen's Bench Division, before the Lord Chief Justice and a special jury, Mr. J. Fortescue Flannery, M.P. (of Flannery, Baggallay & Johnson), sued the National Telephone Company for damages for breach of contract in failing to supply his house at Norwood with a telephone connection within reasonable time according to the terms of an agreement entered into between the parties. It appeared that in 1893 Mr. Flannery was proposing to stand for Parliament, and in order to be able to attend to his business, which he carried on in the City, as well as to matters connected with his Parliamentary candidature, he thought it would be convenient to have a telephone at his house at Norwood. He therefore communicated with the company, and entered into a contract for connecting his house with an exchange on March 8th, 1893. As there was considerable delay about the matter he complained to the company, and they said that the reason of their delay was that they could not get wayleaves by the route they were proposing to adopt through Streatham. Eventually at the end of May, 1896, the plaintiff's house was connected with the Sydenham exchange. Mr. Flannery said he had been put to great inconvenience by this unreasonable delay, and he brought this action in the interests of the public. The defendants counterclaimed £25 as rental due since the house had been connected, and the plaintiff admitted his liability, and paid the amount into Court. His Lordship asked the jury to consider whether the defendants had taken reasonable and proper steps to carry out their contract, or whether they had been guilty of unreasonable delay. The jury found there had been unreasonable delay on the part of the defendants, and gave a verdict for the plaintiff for £5. Judgment was accordingly given for that amount for the plaintiff on the claim. Judgment was also entered for him on the counterclaim, the defendants to have costs up to the date of payment into Court, and all costs to be on the High Court scale as the case raised an important question.

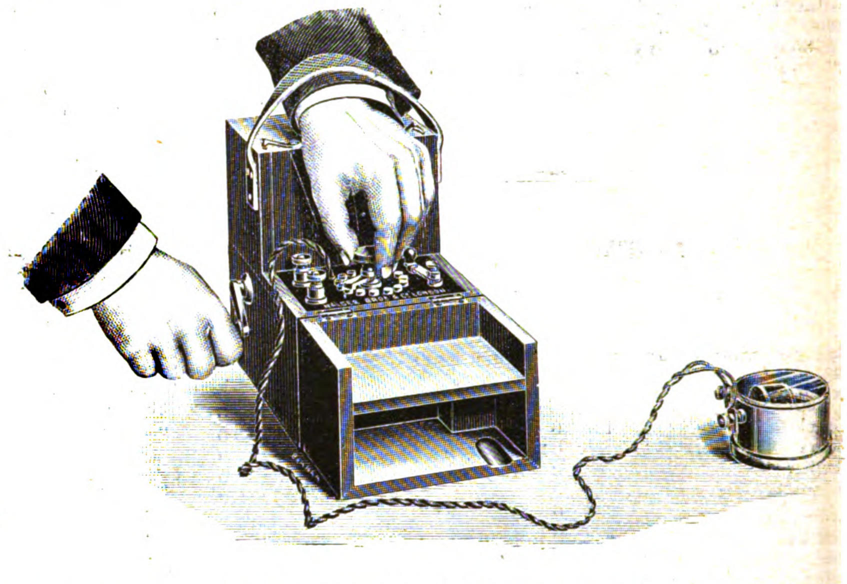
High Voltage Main Switch.—The switch we illustrate below has been designed by Messrs. W. T. Burbey & Co., of Hatton Garden, to meet the requirements of the various central stations and insurance offices for 200-volt supply. In the case of double and triple pole switches, each pole is protected by a



separate china cover, which is fixed by means of a strap and seal on the outside of the switch. The cable connectors are on the front of the switch, as preferred by station engineers, but if a back connection is required, the base is so made that they could be allowed for without extra charge. Front cable connectors are always supplied, however, unless otherwise ordered.

List.—Messrs. Measures Bros., Limited, send us a pocket list, with calendar, giving particulars of their stock sections of steel joists, rails, plates, &c. Numerous tabulated figures are given, showing the breaking loads of cast-iron columns, weights of various sizes of metals, weight per foot of different metals, and other useful notes of a similar kind.

N.C.S. Insulation Test Set and Generator.—We illustrate below the latest pattern of N.C.S. insulation test set. It consists of a 200-volt generator in one case, with Messrs. Nalder Bros. and Co.'s well-known insulation test set. It gives a plain bridge measurement of the insulation under test, thus obviating all errors due to change of magnetism of the needle, or to disturbances from any magnetic bodies in the neighbourhood. The readings depend solely



on carefully wound coils, just as in an ordinary bridge. It reads direct, without calculation, from ·1 megohm up to 50 megohms, with 20 intermediate values. A perfectly sharp difference is obtained between 50 megohms and infinity, and all the other readings are equally sharp. By pushing over a small switch, the readings are all divided by 10; that is, the bridge then reads from ·01 megohm (or 10,000 ohms) up to 5 megohms.

Leicester Corporation v. Warren Hill.—A case of considerable importance to electrical engineers, came on for hearing at the Leicester County Court, on the 24th ult., before his Honour, Judge Wightman Wood, in which the Mayor and Corporation of Leicester, sued H. Warren Hill, electrician, of King Street, Leicester, to recover the sum of £4 19s., in respect of goods sold and delivered. Mr. Simpson, on behalf of the Corporation, stated that so far as the actual purchase was concerned, there was no dispute. The defendant purchased a number of appliances on September 15th, 1895, from the electrical department of the Corporation, but declined to pay for them, on the ground that the Corporation were trading *ultra vires*. There were altogether eight items in the purchase, and in respect of the the first item, 10s. 6d. had been paid into court. The point at issue was whether the Corporation were entitled to sell and recover the price of articles and apparatus, used in connection with the supply of electricity. Mr. Simpson proceeded to quote clauses in the various Acts of Parliament, under which the Corporation supplied electricity, and maintained that they could also deal in apparatus and appliances. Mr. Newell for the defence, said it was a public corporation, and held delegated powers to supply electricity to the public, but it has deviated from those powers, and was selling lamps and appliances, which were not necessarily connected with the supply of electrical energy. They had become traders and shopkeepers, and thereby damaged the local tradesmen, with whom they were unfairly competing. The Corporation, in fact, competed with the local shop-keepers by means of the very rates which the tradesmen partially contributed. His Honour: I suppose this is a case brought on principle? Mr. Newell: Yes, the defendant does not by any means wish to shirk the liability. His Honour: Do you mean to say that under the Charter of Elizabeth, the Corporation has no power to trade. Mr. Newell: I should say that such is the case. Eventually his Honour said he should take time to consider his judgment, as there were important issues raised. Mr. Newell said if his Honour was against him, he should have to appeal, as the Corporation had taken away the bulk of the electrical trade in the town.

Liquidation Notices.—At a meeting of the Crompton-Howell Electrical Storage Company, Limited, held at Mansion House Buildings on January 24th, a resolution was passed winding up the company voluntarily, and appointing Mr. R. H. Marsh, of Ethelburga House, Bishopsgate Street, E.C., liquidator.

A New and Novel Telephone.—Messrs. Henderson, Bunn & Co., Limited, of 15 and 16, Giltspur Street, London, E.C., are introducing a telephone, which will be of interest to many of our readers. It is, perhaps, the smallest and most compact instrument yet produced; at any rate, the patentees claim it to be so. A microphone transmitter and a bell push are fitted into a case, which, when the instrument is not being used to receive or transmit a message, is connected with the receiver in such a way that the two together form a pear shape, quite dust and moisture tight. The receiver is so contrived, that when the transmitter is slipped upon it, a metal nib is pressed, which actuates a Morse key in such a way that the circuits are changed from the microphone and receiver to the bell. When the bell has been rung, the two parts are separated, which act puts the receiver and transmitter into circuit. A braided flexible cord, containing the wires, join up the instruments in such a way, that the receiver may be held to the ear, and the transmitter before the mouth. The internal mechanism is extremely simple, and cannot get out of order and prove ineffective unless the instrument be tampered with. The bell push is likewise upon the Morse principle. Every contact piece is made of platinum; the screws are of brass; the coils cased in, and especial care is given to secure perfect insulation. The ordinary type of instrument is suitable for distances up to 500 yards; beyond this distance an induction coil is used. The induction coil is buried in the rose which carries the bell. The size of the pear over all is 3 inches × 2 inches. Of course, any number of ways may be allowed for, and by means of a line selector, any one of a number of stations may be communicated with. The telephone has been designed with a view to satisfying those who require a portable telephone, small and compact. Each telephone is supplied with about 4 feet of flexible cord. The cases of the instrument are made of vulcanite, with silver plated mounts, the whole presenting a handsome and highly finished appearance.

New Company.—A company has just been registered in Brussels with the title La Compagnie d'Electricité Thomson-Houston de la Mediterranée.

Omnibuses.—In his remarks to the shareholders of the London General Omnibus Company last week, the chairman said that the directors were watching very closely the development of motor vehicles, but as the prime cost of a motor 'bus would not be less than £500 to £600, they did not see their way at present to adopt them. It is interesting to note that the company values its horses at £27 a-piece. Many of them cost between £30 and £50.

Outlet Boxes.—The Ward Leonard Electric Company, of Bronxville, New York, send us a copy of their new catalogue of outlet boxes. We understand that these porcelain-lined boxes have become standard for good wiring work in New York City, and is becoming so in other large cities. The list shows that 81,000 were installed in New York City alone in 1897. The company make outlet boxes of every variety, including a large number of "specials" not shown in the list. Prices and particulars are given.

Presentation.—On 28th ult., a handsome gold watch, with an illuminated address on vellum, was presented to Mr. T. W. Vaughan on his 50th birthday, managing director of Vaughan and Brown, Limited, of Kirby Street, Hatton Garden, and Great Saffron Hill. The presentation was made by members of the staff and old employés, some of whom have been with the firm from 20 to 35 years.

"Specification."—This is the title of a new publication, to appear, revised and enlarged, quarterly. The volume (over 300 pages) is intended for architects, surveyors, and engineers when specifying, and for all interested in building. It is divided into three sections, *i.e.*, construction, professional practice, and buildings in progress. There are some general notes on electric lighting, arc and incandescent, giving particulars of the points to be considered in laying out an installation, and a glossary of English, Irish, and Scotch electro-technical terms is included. There are similar details *re* electric bell work. The price of the publication is 2s. 6d., and it is issued from the office of the *Builder's Journal*, Effingham House, Arundel Street, W.

Westminster Engineering Company v. Kent.—This case came before his Honour Judge Lumley Smith, Q.C., in the Westminster County Court on Friday last. The point in dispute was whether the trade discount should be 10 per cent. or 15 per cent., and whether there should be a cash discount of 2½ per cent. Plaintiffs said their terms in all these cases was 10 per cent., and cash discount was only allowed in some instances, and then only if cash was paid within a month. There was no discount on the wiring, and no special terms were made, and 2½ per cent. was not allowed on estimated work. Mr. Geo. Kent said the question was entirely one of principle. He was a builder, and where he got instructions to fit with electric light, the work was handed over to the plaintiffs for the wiring and fitting, and they always received 15 per cent. on the work done. This had been the custom for many years, and only on three occasions was that departed from, and there were exceptional circumstances in each case. The 2½ per cent. for cash was the custom of the trade. His Honour said he thought the plaintiff was right with reference to the cash discount, and gave judgment for £6 5s. 10d. With regard to the other defendant was right.

Willing's Press Guide.—The 1898 issue (twenty-fifth annual) of this book is before us. It is published by Messrs. Willing, at 125, Strand, (1s.) and contains in easy reference form details of newspapers published at home and abroad, giving the first year of publication, &c. The London addresses of provincial, colonial, and foreign papers are also given.

W. T. Burbey & Co.—With reference to our notice of the dissolution of the partnership of Messrs. Burbey & Hutton, we are asked to state that the business will be carried on under the style of W. T. Burbey & Co. The firm has issued a new catalogue, a copy of which is before us. In it are described and illustrated distributing switch and fuse boards, accumulator plant board, accumulator switches, main switches of various types, cut-outs, tumbler switches, &c.

ELECTRIC LIGHTING NOTES.

Aberdeen.—There was a recommendation of the Lodging House Committee before the Town Council, last week, to accept the tender of Messrs. P. C. Middleton & Co. (£177 odd), for electric wiring of the Corporation lodging house, but the matter was referred back.

The question of reducing the charges for current has been before the Electric Lighting Committee lately, but as the new system of charging has only been in operation for six months, no change is to be made during this half-year.

Bangor.—A Local Government Board inquiry was held on 25th ult. regarding applications *re* various loans, including a sum of £450 for the purchase of an electric light station site.

Barnet.—An electrical firm has offered to take over the District Council's electric lighting order. A committee is considering the matter.

Bath.—The state of the new electricity station was under consideration at last week's meeting of the Electricity Committee. The causes of the various delays were stated, but it was impossible to say when the buildings and the whole of the plant could be ready. Mr. Robert Hammond gave details of the forward condition of some of the machinery and the completion of part.

Bedford.—The Town Council is to purchase two more mechanical stokers at an estimated cost of £385, also two water purifiers in connection with the steam boilers at the price of £120. The electrical engineer is to consider and report as to the practicability and cost of (*a*) installing an electric motor at the water pumping works in place of present boilers now consuming coal, value £500 per annum; (*b*) letting out on hire motors for power, heating and cooking apparatus, with current at 2½d. per unit for certain day hours; (*c*) introduction of prepayment slot meters and wiring houses upon agreement; (*d*) the desirability of applying for powers to construct and work a service of municipal electric self-contained accumulator passenger cars connecting various parts of the town at fares of 1d. At the last Council meeting it was reported that a motor was being installed. Clauses (*b*) and (*c*) were carried, as was (*d*) after discussion.

Consumers were to hold a meeting yesterday to consider the high charges for current.

Belfast.—A sub-committee has been appointed to report on the question of the supply of current for power purposes.

Bradford.—A sub-committee has been appointed to consider the desirability of reducing the price of electricity for lighting purposes. The present charge is 5d. per unit.

Brewery Lighting.—The brewery and business offices of Messrs. George Younger & Sons, Limited, at Candleriggs, are now lighted by electricity. It is stated that the Alloa local authorities have decided to light the principal streets in the same way next winter—cost, £3,000.

Bridlington.—The Council, in reply to a letter from a Sheffield firm, says that it intends applying for an electric lighting order on its own account.

Brisbane.—Mr. Hesketh, electrical engineer to the Queensland Government, in reporting on the proposed electric lighting of Brisbane, states that at first operations should be confined to the main streets of the city, using the direct-current system, with a three-wire distribution at 400 volts.

Buxton.—Prof. Kennedy's report on electric lighting was before the District Council last week. He estimates the cost at £18,000, and recommends a site near the gas works. The Council will hold a special meeting this month to discuss the matter.

Camberwell.—At the last Vestry meeting the General Purposes Committee recommended that notice be given to the County of London and Brush Provincial Electric Lighting Company requiring them to sell their undertaking to the Vestry. The terms were stated to be £133 for every sum of £100 properly expended by the company, and 5 per cent. per annum dividend. After some discussion the recommendation was referred back to the Committee.

Carlisle.—The Carlisle Citadel Station Joint Committee have decided to have the station lighted by electricity. The necessary dynamos and apparatus have been ordered, and the work will be begun at once by the London and North-Western Railway electrical department.

Chelsea.—The Vestry is considering the advisability of purchasing the undertaking of the Chelsea Electricity Supply Company, Limited, forthwith. A committee has power to consult experts.

Coventry.—The annual report of the Electric Light Department shows that the number of consumers increased during the year 1897 from 72 to 100, and the lamps connected from 5,662 (8 C.P.) to 8,149. Further connections are being made. The number of units sold had increased from 51,114 to 79,583, and the revenue from current and meter rental from £1,245 16s. 6d. to £1,958 19s. 8d. The profit on working was £106 2s. 8½d., as against a loss the previous year of £41 0s. 8d. The net charge on the rates was £1,558 7s. 11½d. as compared with £1,706 13s. 8d. the previous year.

Dublin.—The Electric Light Committee is reported to have decided to advertise for tenders in connection with the laying of the new cables for the electric lighting of the city.

Edinburgh.—The Council has accepted the offer of Messrs. Wm Clowes & Sons, Limited, to purchase two engines and dynamos now at the Torphichen Street station for £1,100. These are too small for the Corporation station, and Prof. Kennedy advised the acceptance of an offer. Electric light is to be introduced into the Police Chambers at an estimated cost of £640. A new feeder is to be laid from Dewar Place, along Grove Street, and out to Merchiston at a cost of £1,400.

Edmonton.—The Board of Guardians have referred the matter of electrically lighting the workhouse back to the architect, Mr. Knightley, to obtain plans, specifications, and estimates.

Exeter.—Twelve more electric meters are to be obtained. The clerk is informing the contractors for the electric street lamps that unless they are supplied forthwith in accordance with the contract proceedings will be taken In consideration of the extra work which has devolved upon the assistants and clerk, £30 additional remuneration has been voted for them. A complete return giving the results of 18 months' working, to the end of 1897, shows a gross profit of £1,843. Of this £1,018 goes for interest and sinking fund, £750 is put aside for reserve and £75 is carried forward.

Greenock.—Mr. Teague, in his report as to the electric lighting of Greenock, states that the most suitable site for the installation would be at the Water Trust works at Prospect Hill, and the cost (apart from site) of laying the necessary plant to light the streets from Rue-End Street and along west to Campbell Street, would be probably about £25,000. Mr. Teague will submit a complete report. He recommends a modified scheme, and advises the Board to take up the matter themselves.

Harrow.—Mr. Hawtayne, engineer to the Electric Light Company, recently submitted plans for the extension of the mains down Southill Avenue.

Hartlepool.—The Guardians have decided to obtain a report in reference to the suggestion to light the workhouse by electricity.

Hampstead.—The Vestry Clerk has been instructed to communicate with Messrs Ferranti, informing them that if the new plant ordered is not immediately made available for the purposes of the station, as provided for in their contract with the Vestry, the Vestry will put in force, without further notice, their powers under the contract.

Hoarcross.—An electric light installation has just been completed at Hoarcross Hall and Church for the Hon. Mrs. Meynell Ingram. Messrs. Walker Brothers, of Birmingham, carried out the work.

Hull.—At a meeting of the Electric Light Committee last week the electrical engineer (Mr. Barnard) reported, with respect to the price of current for motive power, that he had been approached by several gentlemen who were considering the question of using the Corporation supply, as to the price charged for current for electric motors. It appeared that the present price of 4d. per unit did not compare favourably with the price charged in Hull for gas for gas engines. He had gone into the question and was of opinion that the price at present charged, namely 4d. per unit, might be very substantially reduced. During 1897, the number of units sold for purposes other than lighting was only 2,550. It was resolved that from March 31st next, the price for current for purposes other than lighting be reduced to 2½d. per unit.

Ipswich.—The Electric Lighting Committee is inviting offers from firms willing to carry out its electric lighting order.

Lancaster.—The Council will borrow £10,000 to increase the plant in the electricity department, so as to double the output.

Leeds—The Parliamentary Committee has decided to recommend the City Council to formally make a definite offer to the Yorkshire House-to-House Electricity Company for their undertaking.

Lewisham.—The Board of Works has resolved not to give its sanction to the proposed scheme of the Great Western Electric Light and Power Company.

London.—The Local Government Board has sanctioned the proposal of the Metropolitan Asylums Board to enter into a contract with Messrs. Crompton & Co., for two dynamos for the *Exmouth*, at a cost of £105 without first advertising for tenders.

The Metropolitan Asylums Board has appointed Messrs. Burstall and Monkhouse, engineers for the electric light installation at the Northern Hospital at a 5 per cent. commission.

The wiring of the new offices of the Court of Common Council Public Health Department is in progress, and the court-room of the late Commission of Sewers and the offices of the engineer are also to be fitted at a cost of £120.

London County Council.—The contract for the electric lighting installation for the Metropolitan Fire Brigade headquarters has been given to the National Free Wiring Company, Limited. The work comprises steam dynamo, storage batteries, incandescent and arc lighting complete. The same firm have also secured the order for the installation of the electric light at the Bridge Hotel, Arundel. The National patent system of house wiring is to be used throughout in both these cases.

Loughboro'.—A committee has been appointed to report on the advisability of taking steps to acquire the gas undertaking, and also to obtain information and report on the question of electric lighting.

Manchester.—Arrangements have been made by the Manchester Corporation with the Moss Side and Levenshulme District Council, by which those districts shall be supplied with electric light at the rate charged to Manchester consumers.

Morecambe.—Mr. Parkinson was recently authorised to instal electric light in the central generating station and the substations.

Portsmouth.—In respect of the proposal to erect a refuse destructor at the electric lighting station, Alderman G. Ellis has reported that there is no land available for the purpose; the boilers at the station could not be used in connection with destructors, and the chimney is not the proper shape. In fact, at present it is altogether impossible to use a destructor at the station. When a new engine house and engines were provided the advisability of building a destructor might be considered.

Sheffield.—The City Council had a brief discussion last week regarding the purchase of the electric light company's undertaking, and in consequence the negotiations will now be completed. It will be remembered they were brought to a standstill by the company objecting to certain statements and insinuations recently made in the Council. In connection with the purchase arrangements Mr. Joshua Wortley, chartered accountant, has examined and reported upon the company's books, and he gives the following note of capital expenditure to December 31st, 1897:—

Capital Expenditure to December 31st, 1897.

			£ s. d.
Electricity Department—			
Land			12,258 9 3
Buildings			14,410 14 9
Machinery and Plant			85,981 7 2
Mains (New Account)		£36,123 12 0	
Mains (Old Account)		1,903 8 1	
Mains (Service)		2,829 15 8	
Mains (Instruments)		23 0 4	
			40 873 11 1
Transformers, Motors, &c.			6,462 12 6
Meters			4,001 16 0
Electrical Instruments			617 16 1
Cost of License			384 10 1
Office Furniture			278 6 6½
Tools			121 17 3
Formation Expenses			200 3 0
Depreciation written back—1892		£153 15 9	
Depreciation written back—1894		202 7 2½	
Depreciation written back—1895		220 16 11	
Depreciation written back—1896		445 9 0	
			1,022 8 10½
Library			44 11 11
New Office Account			110 1 2
Construction Stock			1,699 2 6
			£118,418 8 2
Wiring and Fittings Department—			
Tools	£68 16 6		
Depreciation written back	19 11 7		
		£88 8 1	
Showroom	212 4 7		
Depreciation written back	115 17 10		
		328 2 5	
			416 10 6
Factory—			
Plant and Tools		£1,516 10 1	
Buildings		2,655 12 10	
Office Furniture		56 3 3	
Patterns and Models		853 18 0	
Catalogues		626 1 6	
Formation Expenses		729 8 1	
			5,687 8 9
			£124,472 7 5

As recently stated, the company receives £213 8s. for every £100 share originally invested, and in addition £70,000 for stock and stores in hand and recent capital expenditure.

Southampton.—The Sub-electric Lighting Committee reported that the output for December and January showed an increase of 38 per cent. and 36 per cent. respectively over the corresponding periods of last year. At a recent County Council meeting Mr. Manville read a report on low tension mains to be laid in connection with the high tension system outside the centre of the town. In view of the probability of the house connections becoming numerous in many streets, and also of the advisability of making a supply in further streets or roads adjoining those already decided upon, he suggested that it would be advisable to lay low tension mains at once from which to supply consumers, and place large transformers in street boxes, feeding into these low tension mains in place of small isolated ones on the premises themselves. He had conferred with Mr. Lee, and they had picked out those streets which are likely to prove the more remunerative in the immediate future, and in these streets and roads he proposed that a low tension concentric main should be laid. In addition to these streets and roads he would propose that a low tension main be drawn into the ducts already laid to carry the high tension feeder and the tramway feeder, with one spare duct in the other stated streets. The total cost would be £3,500. The Electric Lighting Committee recommended the Corporation to lay additional mains in various streets, &c., at a cost of £4,000, and to apply to the Local Government Board for sanction to borrow the amount; also that application be made to borrow the amount required for various works already sanctioned by the Council, and in addition to the sum of £54,000 previously sanctioned by the Local Government Board. As to public lighting, Mr. Manville reported that the position for the arc lamps should be largely guided by the necessary position for the standards carrying the trolley wire for the tramways. He suggested that he should be given power to lay out the position of the new tramway lines, in order to be able to fix the position of the standards carrying the trolley wire, which could then be ordered, together with the requisite materials for the public lighting. Mr. Manville was instructed to submit report and plans upon the proposed position of the standards, to carry both the trolley wire for the tramways and the arc lamps for public lighting along the route of tramways. He reported that the first alternator will be delivered and set to work by May 30th, the second by June 16th, and the third by July 7th. The motor-alternator on June 6th, and the two new continuous current dynamos on July 5th and 26th respectively. As to the high tension switchboard, the Committee recommended the Council to procure a high tension switchboard from Messrs. Ferranti, at an additional cost of £314 (£714 in all), and apply to the Local Government Board for sanction to borrow this amount. They also recommended that the tender of Messrs. Pritchetts & Gold be accepted in substitution for the tender of the Chloride Electrical Storage Syndicate, Limited, for accumulators. For the supply of from 150 to 200 tons of large steam coal the tender has been accepted of Messrs. E. T Agins & Co, at 16s. 9d. per ton. The committee instructed Mr. Manville to submit a report and plans. The committee's report was adopted by the Council.

Southborough.—The District Council will oppose the application of Mr. D. E. McKrell, of Little Mowhurst, Edenbridge, for a provisional order.

Stirling.—Prof. Kennedy has submitted a further report to the Town Council *re* the water power at Touch in connection with proposed electric lighting. He finds the maximum theoretical hydraulic H P. coming into Stirling at 40. The actual amount of this H P. in the mains for supplying light would not be more than half this. The total H.P. provided for in Prof. Kennedy's steam-power estimate was 320, which would deliver at least 233 electrical H P at the lamps. The total cost of this plant would be between £8,000 and £8,500 If turbines and dynamos were put down at Touch, at least £1,600 would have to be spent, and probably considerably more, to deliver about 15 H.P. at the lamps. The capital expenditure on this power would, therefore, be about £107 per H.P. at the lamps, as against about £35 for the steam plant.

Sunderland.—The Lighting Committee has presented a report on electric lighting extensions. Mr. Snell, the electrical engineer, says that further extensions are necessitated by the increased demand. Looking ahead, he estimates that to meet the requirements up to 1901, £12,728 would be required for buildings, boilers, and dynamos, tools, &c., and a further £12,540 for mains and such like. Immediate requirements would be met by £7,800. Application to the Local Government Board for leave to borrow not less than £25,000 is suggested. With this sum it is thought that all the districts in the borough can be served. Mr. Snell estimates that in the first year the profits would be £105, in the second, £760, and in 1901, £1,370.

Swansea.—The Sub-Electric Lighting Committee had a conference with Mr. Manville on Saturday *re* electric lighting. Mr. Manville recommended low tension for the present scheme, and will at once prepare a report. There was practical unanimity as to proceeding with the scheme immediately. The question of a dust destructor was discussed.

Swinton.—Mr. Scott Anderson is to advise the Urban Council on the matter of electric lighting.

Trinidad.—A Liverpool paper says Mr. J. Stanley Richmond, who has had a good deal of experience with English and American houses, has secured the appointment of electrical engineer to the Government of Trinidad to examine and report upon the various systems—light, power and telephone—using electric currents in Port of Spain and its vicinity, with a view to determining the risk to life and property now involved.

Wakefield.—On Tuesday last week the New Municipal Buildings for the County Council of the West Riding of Yorkshire, were opened. These premises, which have cost about £130,000, have been fitted up for the electric light by Mr. T. Harding Churton, of Leeds; there are in all about 1,100 lights, all the wiring being carried out in insulated conduit, the distribution being effected by the switch and fuseboard plan. All the electroliers have been specially designed by the architects, and are of a most artistic character. The light was on for the opening and gave great satisfaction. The buildings are fitted throughout with a complete telephone installation. There are five exchanges in the building, all being connected by "up" and "down" trunk lines. All the wires, which have been run in iron conduit, are metallic circuit. This work has been carried out by the Private Wire and Telephone Installation Company. All the electrical work has been under the direction of Mr. Sidney à Court, A.M.I.C.E., of Victoria Street, S.W.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Ashton.—The Council will oppose the Bill of the Manchester Carriage Company on various grounds, one being that it is calculated to prejudice the Corporation's power to purchase the tramways three years hence. The Corporation already has electric lighting powers, and, therefore, objects to the company having similar powers.

Bordeaux.—The report of the Bordeaux Tramways and Omnibus Company for the year 1897, says that the question of electrical traction has received constant attention from the directors during the past year, and after lengthy negotiations they succeeded in coming to terms with a committee of the Bordeaux Municipal Council appointed for the purpose. Since the end of the year, however, the Council has rejected the committee's report by 18 votes to 15. The directors, whilst regretting this decision, feel that they have gone as far as they prudently can in their endeavour to meet the views of the municipality without prejudicing the position and interests of the shareholders.

Bournemouth.—The electric tramway schemes which were being promoted here will now fall through. The Light Railway Commissioners have held a lengthy inquiry at Bournemouth with respect to applications by two electric tramway companies to construct lines connecting Bournemouth with Poole and Christchurch. Strenuous opposition was offered by Bournemouth Town Council to any tramways being laid within the borough. The Commissioners, over whom the Earl of Jersey presided, decided that no public necessity had been proved to induce them to overrule the decision of the Council or to authorise any remaining portions of the two schemes which lay outside the borough.

Brighton.—The Bill for the construction of an underground electric railway from the Brighton terminus to the sea front passed the second reading in the House of Lords last week.

Bristol.—Controversy between the Bristol Tramway Company may still be regarded as acute, but citizens have an impression that possibilities of a settlement are nearer. In a speech to the company's shareholders the Chairman of the company criticised the assumption of the Sanitary Committee as to the extent of the saving which electricity made possible in working expenses, and declared as the result of their experience the working expenses of electric traction cannot be reduced below 60 per cent. of the receipts. These figures were important, bearing in mind the allegation of the Sanitary Committee that electric power would enable the company to reduce fares and to pay a royalty to the Corporation. The civic electrical engineer, Mr. Faraday Proctor, included this subject in the report in which he embodied information derived from his visit to Liverpool, Manchester, Bradford, Leeds, and Sheffield. He took, as the result of figures he has supplied to the committee in reports which have not been made public, 4½d. per car mile as the total cost of working trams in Bristol should electricity be applied. That this amount was ample was, he said, shown by figures of other towns. When the Bristol company had one line working by electricity they stated that the cost was found to be 5½d. per car mile, as compared with 9½d. for horse cars, and in this case plant was "admittedly badly arranged." Thus, according to the company's own showing, the cost was only 41·67 per cent. of the electric car receipts. In a supplemental note the engineer again referred to the plant, and termed it "an absurd arrangement of engines and dynamos coupled together by ropes for driving purposes." Better engines than those in question did not exist when they were properly used, but the Tramway Company threw out the whole plant, and put in fresh. A great expense had been incurred, and it ought to have been, and doubtless was, charged to revenue. This, he suggested, might have raised the cost of working, and he asked suggestively if the cost of the advertising, circularising and printing on behalf of the company during the controversy (the propaganda has been very extensive) has not also been charged to revenue, so as to raise the working cost. Basing a calculation on the 4½d. per car mile for electric traction, as compared with 9½d. for horse cars, Mr. Faraday Proctor pointed out that on the mileage for the year ended June 30th, 1897, the company would make an additional profit of £36,380 by the adoption of electricity. This would be altogether apart from the probable increase of traffic. The secretary to the company, Mr. Sam White, in reply denied that the company ever stated that they found the cost of electric traction 5½d. per car mile as against 9½d. for horse traction. "This assertion is absolutely untrue," said the company's representative, "no such statement has ever been made, and the two figures named are incorrect." He challenged the Electrical Engineer to name any place in the Kingdom which justifies the statement that 4½d. per car mile for electric traction can be taken as the total cost. The Engineer's estimate of the cost of the trolley system meant that working expenses would be only 35·29 per cent. of the receipts, a ratio unheard of amongst tramway men for the operation of any tramway in the world. Mr. White then alluded to the information given by Mr. Faraday Proctor with regard to the working in northern cities, and said its "fragmentary and unreliable character is perhaps excusable, seeing that he himself tells us that having received the Committee's instructions on Monday he was able to visit Liverpool, Manchester, Bradford, Leeds and Sheffield, and return to Bristol in time to prepare his report on the subsequent Friday." Mr. White concludes his letter by stating that he considered it undesirable to reply upon the general tone of this report, or the "offensive innuendos as to the company's management." The Tramway Company has also replied to the Corporation upon the terms submitted and reported in last week's ELECTRICAL REVIEW. The company do not consider the Corporation justified in seeking to impose conditions as to the terms of employment of the tramway men, and give figures to show the Bristol men are well treated already. The company see no objection to the tramways to be worked electrically being specified in the Bill; they agree to the Corporation control over streets and works being as under the Act of 1894; they agree that the company shall not supply electricity to others, or that the company shall not require the Corporation to supply them with electricity. They agree also that the company's posts shall be usable by the Corporation for electric lighting standards, although they regard this as equivalent to a gift to the city of £10,000. They contend that the purchase of lines by the Corporation must be coupled with purchase of the company's power station, as the two cannot be severed, and when the purchase takes place the company will arrange for working any tramways outside the city which may have been operated from that power station. The company do not seek to disturb the existing periods for the purchase of the west horse lines by the Corporation, but drafted the Bill on those lines, not contemplating the Corporation imposing additional and exceptional obligations on the company, and if such obligations are imposed they could only be undertaken if accompanied by an agreed extension of the purchase period. The company do not propose to proceed with their extensions Bill unless under the terms of 21 years' purchase contained in the Tramway Act. The company refuse to consent to the issue of new capital by auction, but are prepared to discuss the payment of an annual sum to the Corporation and the reduction of fares, if an arrangement is arrived at for fixing the period of purchase of all the company's tramways within the city of Bristol at one uniform date—25 years.

It is reported that in the last few days a body of motor-men of the Bristol Tramway Company (said to be 25 in number) have taken part in an agitation for improved conditions of employment, and have been dismissed from their situations.

Chiswick.—A poll of this district is to be taken to ascertain the feeling in regard to the electric tramway scheme of the London United Tramways Company.

Clontarf.—The work of laying the electric cable for the Clontarf tram line to Nelson's Pillar was commenced last week by Messrs. Porte, Sykes & Co., of Dublin.

Collision.—One of the Dublin electric cars collided with a cart one day last week and did considerable damage to both conveyances, at the same time seriously injuring the car driver.

Dalkey.—The Dalkey Town Commissioners will send witnesses to support the Bill now being promoted by the Dublin and Southern Districts Tramway Company to amend the provisions of their 1893 Act, relating to the speed of cars on the company's line. The witnesses will give evidence that the residents of the townships at large consider the present speed at which the cars are allowed to travel, far too slow.

Dover.—The contractor for the permanent way of the electric tramway was fined by the Corporation £2 per day from July 16th to December 10th (£254 total), for delay in completing the contract.

Dortmund.—The Allgemeine Lokal and Strassenbahn Gesellschaft have got out the plans for a normal-gauge light electric railway to run in connection with the Dortmund street railways. The light railway will be adapted for passenger traffic, and will run from Dorstfeld by Marten to Lütgendortmund.—*Elektr-Rund.*

Edinburgh.—The Lord Provost's Committee had before them last week the report by Prof. Kennedy on the proposed conversion of the Portobello tramways. It dealt with the arguments for and against electric traction and cable traction, and, it appears, gave great consideration to the objections of the lessees to electricity. The report was delayed.

Electric Carriages in Berlin.—The *Elektrotechnische Zeitschrift* of February 24th contains an illustrated description of two types of electric carriages which are being demonstrated in the streets of Berlin. These carriages, which have been built by one of the leading cycle companies, are fitted with bicycle wheels and pneumatic tyres, which can be inflated to a pressure of 120 lbs., whilst the bodies are supported on steel tubular frames. The wheels have ball bearings, and steering is effected by means of a lever connected with the front pair of wheels. Each carriage is equipped with a motor suspended from a steel frame lying parallel with the rear axle, the latter passing through the hollow armature shaft, and being driven by differential gearing from a toothed wheel arranged on that shaft. The battery consists of 44 cells contained in four boxes, the total weight being eight cwts. It can be charged at a pressure of either 65 or 110 volts, and the connections allow of four different speeds being attained, three by altering the disposition of the battery, and one by weakening the motor field. The carriage is provided with a watt-hour meter, which indicates the condition of the battery, and the total weight complete is 16 cwts. It is possible to attain a speed of 12 miles an hour, and one charge will allow of the carriage covering a distance of 27 miles before the cells require to be re-charged. The carriages possess a pleasant appearance, having been built specially for the work.

Electric Water Vans.—The Clerkenwell Vestry recently referred to the Works Committee to report on electric watering vans, but the committee say that they are unable to report, as they cannot ascertain that there is such a van in existence.

Great Orme's Head.—The Llandudno District Council held a special meeting last week to consider steps to be taken in regard to the proposed application to Parliament by a company for an Act to construct an electric tramway from Llandudno to or near the summit of Great Orme's Head. The terms regarding purchase by the municipality were amended.

Gateshead.—The directors of the Tramway Company in their report say that, as the shareholders are aware, an agreement has been entered into between the company and the British Electric Traction Company, Limited, which was unanimously accepted at the extraordinary meeting held on December 9th last. The scheme is now under consideration by the Gateshead Corporation and the Felling Urban District Council, whose consents are necessary before the arrangement come to can be carried into effect. Under the terms of the agreement made with the British Electric Traction Company, Limited, a director of that company is to be elected an additional director of this company, and the directors propose that Mr. Emile Garcke, managing director of the British Electric Traction Company Limited, be so elected.

Light Railway.—The Beaumaris Town Council is doing everything possible to help forward the construction of the proposed light railway from Llanfair P.G. to Beaumaris.

Hagen.—The Hagener Strassenbahn Aktien Gesellschaft is about to build, in connection with the Hagen street railway terminating at Haspe, a narrow-gauge electric light railway for passenger traffic, from Haspe to Gevelsberg.

Motor Cars in the Army.—It is stated that the Royal Engineer Committee of the War Office has appointed a sub-committee of its members to consider the adaptibility of motor cars for purposes of army transport.

Manchester.—The City Council met on Wednesday to consider the recommendation of the Special Committee *re* the working of the tramways, and to consider the necessary measures to be taken for promoting a Bill to enable the Corporation and any neighbouring local authorities to make arrangements for working their tramways in conjunction with those of Manchester, the powers to include the supply of electricity by the Corporation, or by any local authority, for working tramways in the district of such local authority.

Norwich.—The Council has, on the recommendation of the Tramway Committee, laid before the Norwich Electric Tramways Company a note of its requirements respecting the roads to be traversed by the electric tramways. Some of the roads will be paved with wood and others with granite setts.

Rome.—The question of the conversion of the present tramways into electric tramways has now for some months occupied the attention of the municipal authorities, especially since the new electric lines from Piazza San Silvestro to the station and Sant Agnese, as well as that from Piazza Venezia to San Giovanni and San Paolo, have not only been extensively used, but have also paid a good return on capital. In the Municipal Council a strong opposition to the overhead conductor has gradually arisen, and there the matter rests. Accumulator traction would be the best solution of the difficulties, but all systems hitherto have failed on account of the weight of the accumulators (3,000 to 4,000 kg.), which makes it impossible to run on steep inclines or sharp curves. The Societá Italiana di Elettricita of Turin put itself, therefore, in communication with the Roman tramway company, with the view of testing the invention of a colonel of engineers, named Pescetto, which professes to reduce the weight of the accumulators to one-half. Recently the official test was made. A car with the new accumulators ran from the Quartier Ludovisi to the church of Sant Agnese, in front of the Porta Pia, and back, and took all the curves and gradients with ease. The officials of the tramway company celebrated in a suitable manner this remarkable success of an Italian invention, on Italian soil, and supported by Italian capital.—*Elektr-Rund.*

The Life of a Tramway Wheel.—At a Board of Trade inquiry, held on 24th ult., into the recent tram accident on the Sparkbrook route, Birmingham, when a car overturned, it transpired that the cause of the accident was a broken wheel of the back bogey, which brought about derailment. The particular wheel which was broken, was, according to the company's engineer, attached to the car last September. It was then 20 11/16 inches in diameter. When taken from the car after the accident it measured only 19 inches in one direction, and 18 11/16 inches in another. The flattening was attributed to skidding when the brake was put on. The inspector (Col. Yorke) made close inquiries as to the quality of the wheel. He was informed that it was one of the best-known makes—Miller's, of Edinburgh—and that it was of average hardness, although it had worn very badly. The life of a tramcar wheel, said one of the witnesses, was about ten months. They were calculated on the average to run 20,000 miles. This particular wheel had probably covered 10,640 miles, at the rate of 72 miles per day. The loss of a couple of inches in its diameter in so short a time was attributed to the great friction which the sludge had set up on the rails—friction which, according to one witness, was nearly as great as that of a grinding stone.

The Power Distribution Schemes.—In connection with one of the large power schemes to which we have several times referred, we understand that a Bill has been introduced into Parliament, under which it is proposed to incorporate a company by the name of the "General Power Distributing Company." Upon this company Parliament will be asked to confer power to erect a central generating station at Stockholme, Nottinghamshire, from which electricity will be conveyed throughout the proposed area of supply. This area is defined in the Bill to be "so much of the counties of Derby, Nottingham, Lincoln, and Yorkshire as is contained within a radius of 25 miles from the north-west corner of the Parish Church of Warsop, in Nottinghamshire," including all cities, county and other boroughs, towns, villages, urban and rural districts within that area. The share and loan capital of the company is proposed to be £1,000,000, of which £750,000 will be in £10 shares, and £250,000 will be raised on debentures. The promoters of the Bill are Sir Thomas Thompson, Bart., Mr. William McArthur, Mr. Ernest Lazarus, and Mr. Albert B. Monks, who, with six other duly qualified persons to be nominated by them, are to be the first directors of the new company.

Lincoln City Council is among the latest bodies to decide to oppose the General Power Distributing Company's scheme.

At a meeting of the Wolverhampton Town Council, on Monday, a letter was read from Mr. Addenbrooke, engineer to the Midland

Corporation for Electrical Power Distribution, Limited, asking the Town Council to reverse their decision to oppose the scheme. Ultimately a resolution was proposed to the effect that the letter be referred to the General Purposes and Lighting Committee for consideration. On being submitted to the Council, however, the resolution was rejected by 24 votes to 16.

Rotherham will oppose the General Power Distribution Company's scheme, as it is hoped to go in for municipal electric lighting shortly. Rowley Regis will support the Midland Company's scheme conditionally.

TELEGRAPH AND TELEPHONE NOTES.

Australian Telegraphs.—In the House of Commons on Tuesday Mr. Hogan asked the Secretary to the Treasury whether he was aware that telegraphic communication with Melbourne and Sydney had repeatedly been interrupted during the past five months; who was responsible for the satisfactory maintenance of the Australian trans-Continental telegraph line on which the interruptions occurred; and whether any steps could be taken by Her Majesty's Government to prevent these repeated failures of communication. Mr. Hanbury, in reply, said the interruptions mentioned in the question have occurred on both the trans-Continental lines. These are maintained by the South Australian and Western Australian colonies respectively. Her Majesty's Government is not in a position to take any steps to prevent the failures of communication, which are, it is understood, caused by storms. The cable companies have, however, put forward a scheme, in connection with the question of an alternative cable service, for taking a cable direct to a point near Adelaide, and this will no doubt be duly considered by the colonies concerned.

Bedford Telephones.—The Postmaster-General has replied to the Corporation that as the Select Committee of the House of Commons appointed to consider the matter has not yet reported, he cannot entertain the application for a municipal license.

Cable Repair.—The Great Northern Telegraph Company's steamer, *H. O. Orsted*, succeeded on Wednesday last week (says the *Buchan Observer*) in repairing the damaged Norwegian cable between Peterhead and Bergen. The damaged part was found about 35 miles from the Aberdeenshire coast. For some years past the cable has been frequently destroyed and broken, entailing a great deal of expense to the company. The belief is entertained that the damage is attributable to trawlers, who either cut or otherwise injure the cable in the course of their trawling operations.

French Telephones.—Telephonic communication is now established between Paris and several towns in the south-west, including Dax, Pau, Bayonne, Biarritz, and St. Jean de Lux.

Some Causes of Delay in Australian Telegrams.—The following is an extract from an Australian paper dated January 13th.—"*Interruption of Cables.*—The Postal and Electric Telegraph Department has been advised by the Postmaster-General of South Australia that the Eastern Telegraph Company notify an interruption to one of their Mediterranean cables, and the Persian Gulf station reports the cutting of Mekran landlines. Some delay to European traffic is, therefore, likely to accrue therefrom." We also read the following in the *Sportsman* of March 2nd:—"Australian wires have been simply blocked by the cabled reports of the test games, causing delay, except to those forwarded at urgent private rates, *i.e.*, 14s. per word, instead of the ordinary press rate, 2s." *Observer* adds:—"The fight between the representatives of the big cable syndicates to get first on the wire at the fall of a wicket is like the rush of war correspondents when a big battle is being fought, and one company will spend, probably, £3,000 in cables over the five test matches. Who says cricket is simply a sport?"

Telegraphic Interruptions and Repairs:—

CABLES.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1898 ...	...
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Paramaribo-Cayenne ...	Jan. 27th, 1898 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Saigon-Hong Kong	Jan. 8th, 1898 ...	Feb. 28th, 1898.
Cyprus-Latakia	Feb. 10th, 1898 ...	...
Bolama-Bissao	Feb. 19th, 1898 ...	Feb. 28th, 1898.
Aden-Zanzibar	Feb. 28th, 1898 ...	...
LANDLINES.		
Trans-Continental line beyond Mascol	March 12th, 1898 ...	...
Cartagena-Barranquilla ...	July 4th, 1896 ...	...
Majunga-Tananarive ...	Feb. 28th, 1898	

The Telephone Service.—The Court of Common Council is sending a copy of the arguments and judgment in the recent action between the G.P.O. and the Commission of Sewers, to every municipality in the United Kingdom, as well as to the metropolitan vestries and boards.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belfast.—March 8th. The Corporation wants tenders for the wiring of the new police cells, Chichester Street. Electrical engineer, Mr. V. A. H. McCowen. See our "Official Notices" February 18th.

Belgium.—April 1st. The Municipal Authorities of Seraing are inviting tenders for the concession for the supply of electrical energy in the town for public and private lighting purposes during a period of 30 years. Particulars may be had from, and tenders to be sent to, the College des Bourgmestre et Echevins, Seraing, Belgium.

Berlin.—March 15th. The Municipal Traffic Deputation of the Town Council has opened a competition for the construction of several new electric tramways in that city. Exhaustive details concerning this project are contained in the *Elektrotechnische Zeitschrift* of the 13th inst., which mentions that proposals will be received by the Stadtische Verkehrsdeputation Rathhaus III, Berlin, by March 15th.

Blackpool.—March 22nd. The Corporation wants tenders for a tubular boiler, superheaters, condensers, rectifiers, boosters, transformers, lead-covered cables, arc lamps and pillars. Borough electrical engineer, Mr. R. C. Quin. See our "Official Notices" February 25th.

Bolton.—The Bolton School Board is inviting tenders for the supply of six electrical clocks. Specifications can be obtained from the Clerk to the Board (Mr. G. R. Rothwell).

Coventry.—March 8th. The Electric Light Committee wants tenders for the supply and erection of engine house, separate exciting and surface condensing plant, also pipework, switchboards and instruments for extensions of the municipal electricity works. Consulting engineer, Mr. Robert Hammond. See our "Official Notices" February 18th.

Denmark.—March 12th. Tenders are being invited for the supply of the engines, dynamos, accumulators, &c., required in connection with the new central station at Frederiksberg, near Copenhagen. Tenders to be sent to the Frederiksberg Sporveis-og Electricitets Aktieselskab, Gammel Kongevie, 140, Copenhagen V., from whom particulars may be obtained.

Derby.—March 24th. The Corporation wants tenders for the electric wiring of the Lunatic Asylum and premises at Rowditch. See our "Official Notices" this week.

Devizes.—March 21st. Tenders are wanted for the supply and delivery of two 40 kw. continuous current belt-driven dynamos for the Wilts County Asylum, Devizes. Engineers, Messrs. Massey & Allpress, 25, Queen Anne's Gate, Westminster. See our "Official Notices" this week.

Edinburgh.—The City Council is inviting tenders for a host of stores and sundry articles. Among the items are "electric lighting materials for the Powderhall destructor," and "upholding of electric light installations." Particulars, &c., from the electrical engineer, Dewar Place.

France.—March 31st. Tenders are being invited by the Municipal Authorities of Saint Chamond (Loire) for the concession for the lighting of the public streets of the town, either by gas or electricity. Particulars from, and tenders to be sent to, La Mairie de Saint Chamond (Loire).

Liverpool.—March 8th. The West Derby Board of Guardians wants tenders for supply and erection of boilers, engines, dynamos, batteries, wiring, &c., for the lighting of the Mill Road Infirmary. Consulting engineer, Mr. T. L. Miller. See our "Official Notices" February 25th for particulars.

Manchester.—March 15th. The Great Central Railway Company (M. S. & L.) want tenders for the supply of various materials and stores during 12 months ending April 30th, 1899. Among the items are asbestos packing, brass sheet and tubing, electrical materials, India-rubber, tin and zinc sheets, wire, &c. Particulars from Mr. A. W. Longden, storekeeper, at Junction Street Mills, London Road, Manchester.

Northwich.—March 5th. The Weaver Navigation Trustees are inviting tenders for the construction and erection of the necessary electric power plant for lighting and working the new swing bridges at Northwich. Current will be supplied by the Northwich Electric Supply Company. Engineer, Mr. J. A. Saner, M.I.E.E. See our "Official Notices" February 11th.

Pembroke (Ireland).—March 5th. The Lighting Committee wants tenders for the supply and erection of various plant, machinery, &c., for electric lighting. See our "Official Notices" February 18th for full particulars. Consulting engineer, Mr. Robert Hammond.

Plymouth.—March 23rd. The Corporation wants tenders for the supply of alternating current meters for the year ending March 31st, 1899. Particulars from Mr. J. H. Rider, Borough electrical engineer, East Street, Plymouth.

Roumania.—March 15th. Tenders are being invited by the General Direction of the Roumanian Post and Telegraphs in Bucharest for the supply of 56,000 metres of galvanised iron and steel wire.

Shoreditch.—March 8th. The Vestry wants tenders for the supply of electric cables and sundries, also engineers' tools, ironmongery, &c. See our "Official Notices" February 18th.

Southampton.—March 7th. The Corporation invites tenders for the supply of stores and fittings required in the electric light department during a period of 12 months. Tenders to the Town Clerk.

Southgate.—March 14th. The District Council want tenders for an installation of electrical communication for fire brigade purposes. Surveyor, Mr. C. G. Lawson. See our "Official Notices" this week.

Switzerland.—April 30th. The Government Authorities of Fribourg (Switzerland) are inviting plans and estimate for a projected electricity generating station of about 6,000 H.P. capacity to be established at Hauterive, where water power is available. A premium of 3,000 francs (£120) will be awarded to the three best schemes sent in. Particulars of the competition may be had from the Départment des Travaux Publics, Fribourg, Switzerland, to whom all plans, &c., are to be sent not later than April 30th next.

The War Office.—April 27th. The Secretary of State for War is prepared to receive offers, competitive designs and specifications for the supply of portable electric search light apparatus. Particulars from the Director of Army Contracts, War Office, Pall Mall, S.W. See our "Official Notices" February 4th.

Victoria.—March 21st. The Telegraph Department of the Victorian Government Railways is inviting tenders for the supply of alternating current transformers and one main switchboard. Tenders to the Telegraph Superintendent's Office, Spencer Street, Melbourne.

Wallasey.—March 17th. The District Council wants tenders for the supply of engine, alternator, exciter, two Lancashire and one water-tube boilers, and condensing apparatus. Engineer, Mr. J. H. Crowther. See "Official Notices" February 11th.

Watford.—March 16th. The District Council wants tenders for the supply and erection of various plant for the electric lighting of the district. For details of the seven sections see our "Official Notices" February 11th. Mr. W. C. C. Hawtayne, consulting engineer.

West Ham.—March 8th. The Council invites tenders for wiring and fitting up various buildings, including the Town Hall, police court, Corporation stables, fire stables, &c. Mr. J. Steinitz borough electrical engineer. See our "Official Notices" February 18th.

CLOSED.

Gloucester.—The following is a list of tenders for the supply of plant and machinery for the municipal electricity works of the city of Gloucester. Consulting engineer, Mr. Robert Hammond. The Council accepted the tenders at its meeting on Tuesday.

SECTION A.

Boiler House Plant.—Lancashire boilers and accessories, mechanical stokers, feed pump, injector, economiser, electric motor.

Name of Firm.	Make of Boiler.		Amount of Tender.
Yates & Thom	Yates & Thom	(accepted)	£2,409
Tinkers, Limited	Own make		2,478
E. Danks & Co. (Oldbury), Limited	E. Danks & Co. (Oldbury), Limited		2,478
India-Rubber, Gutta-Percha and Telegraph Works Company, Limited	J. Adamson & Co.		2,558
H. T. Danks, Limited	Own make		2,590
Holdsworth & Sons	"		2,665
Henry F. Joel & Co., and Thos. Potter & Sons, United, Limited	Yates & Thom		2,821
John Fraser & Son	Own make		2,910

SECTION B.

Engine House Plant.—Steam Dynamos and Accessories.

Name of Firm.	Make of Engine.		Amount of Tender.
C. A. Parsons & Co.	Parsons turbine		£4,570
India-Rubber, Gutta-Percha and Telegraph Works Company, Limited	Belliss	(accepted)	5,917
Siemens Bros. & Co., Limited	Sisson & Co.		6,495
Easton, Anderson & Goolden, Limited	Willans		6,585
Crompton & Co., Limited	Sisson & Co.		6,614
Siemens Bros. & Co., Limited	Belliss		6,720
Electric Construction Company, Limited	"		6,753
Crompton & Co., Limited	Sisson & Co.		6,820
Henry Joel & Co., and Thos. Potter & Sons, United, Limited	Willans		6,882
Thos. Parker, Limited	Belliss		6,980
Laurence, Scott & Co., Limited	Willans		6,994
Electric Construction Company, Limited	"		7,035
P. R. Jackson & Co., Limited	Belliss		7,052
Siemens Bros. & Co., Limited	Willans		7,060
Crompton & Co., Limited	Belliss		7,402
W. Sisson & Co.	Sisson & Co.		7,415
Crompton & Co.	Willans		7,640
Brush Electrical Engineering Company, Limited	"		7,749
J. C. Howell, Limited	"		7,752

SECTION C.—*Overhead Travelling Crane.*

Bedford Engineering Co.,		£240
India-Rubber, Gutta-Percha and Telegraph Works Company, Ltd.		262
James Spencer & Co.	(accepted)	265
Marshall, Fleming & Jack		267
Humpidge, Holborow & Co., Limited		285
Carrick & Ritchie		306
Henry F. Joel & Co., and Thos. Potter & Sons, United, Limited		310
Summers & Scott		315

SECTION D.—*Switchboard and Instruments.*

James White		£1 074
Nalder Bros. & Thompson	(alternative)	1,083
Edison & Swan United Electric Light Company, Limited		1,093
Crompton & Co., Limited	(accepted)	1,111
Nalder Bros. & Thompson		1,190
Williamson & Joseph, Limited		1,211
P. R. Jackson & Co., Limited		1,265
Veritys, Limited		1,275
General Electric Company, Limited		1,300
Ernest F. Moy, Limited		1,318
Electric Construction Company, Limited		1,357
Henry F. Joel & Co., and Thos. Potter & Son, United, Limited		1,393
Siemens Bros. & Co., Limited		1,530
India-Rubber, Gutta-Percha, and Telegraph Works Company, Limited		1,555
Burbey & Hutton		1,559

SECTION E.—*Accumulators.*

Electrical Power Storage Company, Limited	(accepted)	1,350
Lithanode Electric Storage Syndicate, Limited		1,384
India-Rubber Gutta-Percha and Telegraph Works Company, Limited		1,587
Pritchetts & Gold		1,576
Chloride Electrical Storage Syndicate, Limited		1,700
Epstein Electric Accumulator Company, Limited		1,808
Peto Radford, Limited		1,862
Henry F. Joel & Co., and Thos. Potter & Sons, United, Limited		1,868
Allan & Adamson, Limited		1,943
Hill, Gilkins & Co.		2,036
Tudor Accumulator Company, Limited		2,043
D.P. Battery Company, Limited		2,119
J. C. Howell, Limited		2,247
Elieson Lamina Accumulator Company, Limited		2,508

SECTION F.—*Mains.*

Callender's Cable and Construction Company, Limited, approx.	(accepted)	£18,500
British Insulated Wire Company, Limited		

Schedule prices were quoted by the following:—Western Electric Company (Fowler-Waring Cables Company, Limited), W. T. Glover & Co., W. T. Henley's Telegraph Works Company, Limited, India-Rubber, Gutta-Percha and Telegraph Works Company, Limited, Siemens Bros. & Co., Limited.

SECTION G.—*Public Lamps.*

The decision upon the tenders for this section has been deferred.

Name of Firm.	Amount of Tender.
Stewart Electrical Syndicate (Part I. only)	£ 828
Brockie-Pell Arc Lamp, Limited (Part I. only)	1,058
Phæton Electrical Company, Limited	1,558
Taylor & Fairbrother	2,138
General Electric Company, Limited	2,206
Crompton & Co., Limited	[illegible]
Hill, Gilkins & Co.	2,387
W. Lucy & Co., Limited	2,488
British Insulated Wire Company, Limited	2,550
Brush Electrical Engineering Company, Limited	2,679
Siemens Bros. & Co., Limited	2,702
India-Rubber, Gutta-Percha, and Telegraph Works Company, Limited	2,717
British Blahnik Arc Light Company, Limited	2,859
Johnson & Phillips	3,144
Electric Construction Company, Limited	3,330
Drake & Gorham	3,681

SECTION H.—*Meters.*

Name of Firm.	Type of Meter.		Amount of Tender.
Chamberlain & Hookham	Hookham	(accepted)	£1,121
S. Z. de Ferranti, Limited	Ferranti		1,207
India-Rubber, Gutta-Percha, and Telegraph Works Company, Limited	Hookham		1,207
General Electric Company, Limited	British Aron		1,210
James White	Kelvin		1,210
Downie & Adams	Brillie		1,439

L.C.C.—The L.C.C. has, on the recommendation of the Fire Brigade Committee, accepted the tender of the National Electric Free Wiring Company (£992) to instal the electric light at the central station, Southwark Bridge Road.

Portsmouth.—For the extension of the station in Gunwharf Road (new boiler house, chimney stack, &c.), the Electric Light Committee has accepted the tender of Mr. T. W. Quick at £4,198. The following were the only tenders received for the boilers, steam pipes, condensers, economisers, &c.:—

	£	s.	d.
Messrs. Yates & Thom	7,900	0	0
Tinkers, Limited	9,215	0	0

The lowest tender was accepted. The engineer's estimate was £8,500.

FORTHCOMING EVENTS.

1898.

Friday, March 4th, 8 p.m.—At the Westminster Palace Hotel. The Institution of Junior Engineers. Paper on "An Outline of Patent Law and Practice," by Mr. Arthur H. Stanley, Fel.C.I.P.A., Member.

At 9 p.m.—Royal Institution, Albemarle Street, W. Prof. T. E. Thorpe on "Some Recent Results of Physico-Chemical Enquiry."

Saturday, March 5th.—Latest date for Northwich and Pembroke tenders.

Tuesday, March 8th.—Latest date for Belfast, Coventry, Liverpool, Shoreditch, and West Ham tenders.

Wednesday, March 9th, at 8 p.m.—Society of Arts. Prof. J. A. Ewing on "Linde's Method of Producing Extreme Cold and Liquefying Air." Prof. Dewar will preside.

At 8 p.m.—Mr. Mervyn O'Gorman will lecture on "Trades Unions and Factory Management" to the Brixton Literary Society, in the Lecture Hall of the Independent Church, Brixton.

At 7.30 p.m.—The Institution of Junior Engineers. Joint meeting with Architectural Association at 9, Conduit Street, W. Paper on "Desirability of a Closer Relationship between Architect and the Engineer," by Sydney B. Beale, A.R.I.B.A., and Percy J. Waldroun, P.A.S.I.

Thursday, March 10th, at 8 p.m.—The Institution of Electrical Engineers. Continuation of discussion on Mr. G. Binswanger-Byng's paper on:—"On the Manufacture of Lamps and other Apparatus for 200 Volt Circuits."

Friday, March 11th, at 5 p.m.—Physical Society at the rooms of the Chemical Society, Burlington House. Agenda:—(1) "On Dynamical Illustrations of certain Optical Phenomena," by Prof. J. D. Everett, F.R.S.; (2) "On Properties of Liquid Mixtures," by R. A. Lehfeldt.

Saturday, March 12th, at 7.30 p.m.—At the Westminster Palace Hotel. *Conversazione* of the Institution of Junior Engineers.

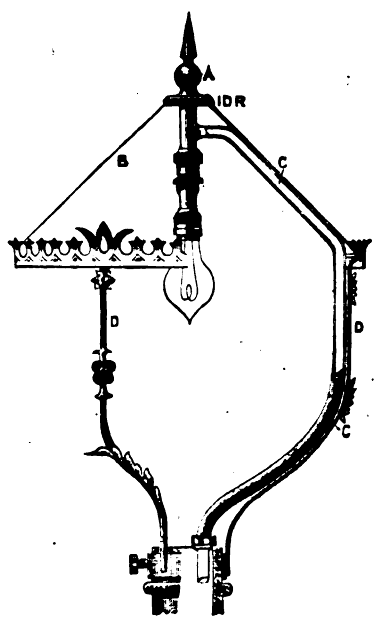
At 10.30 a.m.—Institution of Electrical Engineers. Students' visit to the stations of the Metropolitan Electric Supply Company. Applications to join the party should be made at once to the Students' Hon. Sec. (Mr. S. Grant, 28, St. Mary Abbot's Terrace, W.).

NOTES.

Electrical Engineers' Salaries—England v. America.—Some of our American contemporaries have been drawing attention to the low salaries paid to electrical engineers, scientific demonstrators, and other professional men in this country. The *Electrical World* in some editorial notes on the subject remarks that there is considerable difference of opinion as to the market value of intelligent effort, and in some quarters a disposition to believe it very small. A recent vacancy advertised by a London local authority is taken as a text. £130 per annum was offered for a chief electrical assistant, who had had a thorough electrical and mechanical training, and who was familiar with high tension alternating work. The gentleman appointed was to devote his whole time to the duties of his office. The *Electrical World* passes some severe strictures upon us, strictures which, in the light of recent events, appear to be, in a degree, justified. Our contemporary has, doubtless, overlooked the various appointments which have been made by some English municipalities recently at salaries much smaller than £130 per annum. The recent advertisement published for a "shift engineer" for high tension works at £50 a year (less than £1 a week), to which several correspondents have referred in our columns, we cannot seriously consider to be a true index of the general tendency among electricity committees. If it were so we should not like to prophesy regarding the operation of the plants. We do not know what our trans-Atlantic friends will think of the £50 instance. This is what they say of the £130 appointment:—

If this case is a fair index of the value of engineering service in England, it is no great matter for wonder that that country is so far behind in electrical progress. Nor is it remarkable that contracts come from there to this country, where there is a more proper recognition of the value of engineering service. A state of things that offers little better than labourer's wages to trained and skilled engineers cannot be productive of a high degree of ability among members of the profession, nor does it offer much incentive to young men to undertake the laborious course of preparation necessary to fit themselves for its exercise. Even in this country, where electrical engineering is notoriously overcrowded, such a rate of wage for such service would be regarded as ridiculous. It seems that, in England, the rates of payment for engineers are not much more than those for high-class mechanics. There a competent mechanic earns $10 a week; here he earns $21. Yet, notwithstanding this great difference, and a further difference against us in the cost of most of the raw materials of manufacture, we can under-sell English makers of electrical machinery in their own market. Perhaps the disregard of the money value of brains shown by the Council of the County Borough of West Ham, or the fact that engineers are so cheap thereabouts, may account for this otherwise anomalous fact.

Street Lighting by Glow Lamps.—The desirability of street lighting with incandescent electric lamps has been a matter of great consideration with the Derby Electric Lighting Committee. To meet this, the borough electrical engineer, Mr. J. E. Stewart, has designed a lantern, shown in the drawing annexed, which so adapts itself to the requirements that it has been decided to replace, in some of the main roads, the existing gas lamps with Mr. Stewart's lantern. As will be seen by the illustration, the lantern can be fitted on already existing gas lamp posts by means of an iron band and set



bolts. The lantern is fitted with a large opal shade, B, which is held in position by means of an ornamental cap, A, which is also provided with an India-rubber ring for weathering purposes. The copper pipe, C, carries the wires, and also forms the main support for the lamp connections, which are so constructed as to enable one or more lamps being fitted. The uprights, D, are of steel, and are riveted to a circumferential T-ring, to which is attached the ornamental copper spinning. The Corporation have approved the design, and will shortly erect some of the lanterns in the main thoroughfares of Derby.

India-Rubber Cables.—With regard to the alarmist reports from Dublin and Burton-upon-Trent, we regret that we have only received one reply from users of cables insulated with this material, although as we stated we should have been glad to have treated any answers we might receive as confidential. Nor have we yet heard from Prof. Kennedy or Mr. F. Bailey as to whether or not it is correct that in each case the cables were condemned without full test or complete examination. Prof. Kennedy based his report presumably to a large extent on the information supplied by the superintendent. Mr. F. Bailey is reported to have condemned the cables at Burton apparently without seeing them, but can this be so? Surely it is of interest to all central station engineers to get reliable information on the subject of cables at the earliest moment. Is not some forthcoming?

Personal.—Mr. Walter P. Adams, A.I.E.E., late of Messrs. Crompton & Co., has taken offices at 35, Queen Victoria Street, where he intends to practice as a consulting engineer, design and superintend electric lighting, power and heating installations, and periodically inspect and report upon any work which may be entrusted to his care. Mr. Adams has had a long and varied experience in electrical work of nearly every kind, five years of his career being passed in assisting Mr. Chamen, the newly appointed Glasgow engineer, and he is an expert in electric heating matters, having managed this department for Messrs. Crompton and Co. He has our best wishes for his success in his new venture.

Mr. F. Kenyon has been appointed resident engineer to the Northwich Electric Supply Company, in place of Mr. T. H. M. Swinburne, resigned.

Another New Storage Battery.—We have received a copy of a statement made by the inventor of a new storage battery, Mr. W. A. Crowdus, giving results of tests showing that at a discharge rate of about 1 ampere per pound of battery, it has a capacity of 18 watt-hours per pound of battery on a run of 9·5 hours' duration. If this result can be verified by an independent expert, it shows a considerable improvement. But the tests shown by the figures given are not what we should accept as quite correct. The rate of output in watts is allowed to fall during the test, as commencing with a rate of 16·8 watts, it gradually falls to 12·6 watts. Now, in practice we require quite as many watts from a battery on a car or a vehicle at the finish of a journey as at the beginning; hence, the tests, to be of practical value, should be made with a variable resistance in circuit, whereby the watts can be kept constant from the start to the finish. If this were done with the cell in question, the watt-hours per pound of battery would be much less than 18. We cannot keep the volts constant, but the amperes ought to be varied to keep the watts constant, if we are to obtain the true working capacity of a traction battery. To allow both amperes and volts to drop during a test gives a spurious result greatly in favour of any cell. A letter from an expert, Mr. Pumpelly, accompanying the inventor's statements says that a 14-lb. cell gives 15 amperes for six hours; this, calculated out, gives, approximately, 12 watt-hours per pound of cell. But, beyond all this, a letter from Mr. John T. Bowden, who holds the patent rights for Great Britain, demands more drastic treatment. He says:—A $3\frac{1}{2}$ horse-power motor is worked from 44 cells of 100 amperes (hours) capacity each. Now, in a report made by Mr. Pumpelly, the 14-lb. cell would just weigh $5\frac{1}{2}$ cwt. if made up on a battery of 44 cells. Pumpelly says this cell gives 100 ampere-hours or 15 amperes for six hours; further, 44 cells will not give more than 85 volts, and 85 volts multiplied by 15 amperes, equals 1,275 watts, or a little more than 1·5 horse-power. How is a $3\frac{1}{2}$ horse-power motor to be driven with a $1\frac{1}{2}$ horse-power battery? The letter informs us that the cell has been tested very carefully; this may be so, but it evidently has not been carefully *reported* upon! If Mr. John T. Bowden believes in reports which appear to be based upon so evidently erroneous figures, he is, we fear, doomed to considerable disappointment if he ever submits his cells to the tests of a competent expert. To get an available $3\frac{1}{2}$ horse-power out of 44 cells, we must obtain a 35-amperes discharge, and at this rate the cells would be exhausted in about two hours, so that it must do the alleged 50 miles at 25 miles an hour. Although things go pretty "slick" in Chicago, their wagons do not seem to fly at this rate. In fact, the figures appear both contradictory and improbable.

Appointment.—Mr. T. U. N. Aldridge has been appointed by the Crown Agents for the Colonies as electrical engineer to the Public Works Department, Lagos, West Africa, for a period of six months.

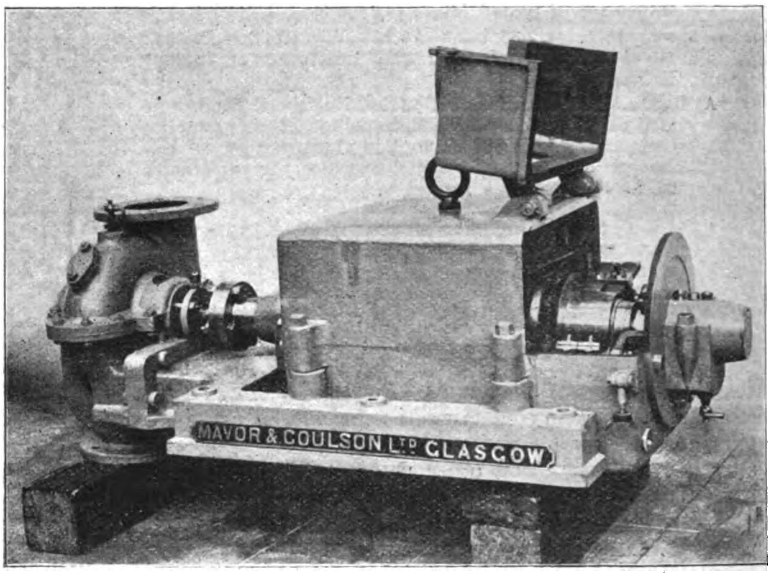
The City Company's Charges.—It is stated that the City of London Electric Lighting Company is reducing its scale of charges, and from the commencement of 1898 the charge for lighting will be 7d. per unit for the first six consumed per 8-C.P. lamp, 6d. for the next four units, 5d. for the next two, and 4d. per unit after. For motive power purposes, the charge will be 3d. per unit for a minimum of 45 hours per week, and 4d. otherwise.

Obituary.—By the last advices from Cape Town we have information of the death, at the early age of 37, of Mr. J. K. Waterman, manager of the Cape Electric Tramways.

We regret to learn of the death of Mr. Thomas Holliday, of the firm of Read Holliday & Sons, Limited, manufacturing chemists and electricians, which occurred on the 1st inst. Mr. Holliday was 57 years of age.

Lord Kelvin's Patents.—Before the Philosophical Society at Glasgow on 23rd ult., Dr. Magnus Maclean, read a paper on "Lord Kelvin's Patents." There were, he said, altogether 47 patents from February 20th, 1858, to September 28th, 1896—a period of 38 years. All of them could be conveniently classified under four heads:—A. Patents relating to improvements in electric telegraphic apparatus. B. Patents relating to improvements in navigational apparatus. C. Patents relating to improvements in generating, regulating, measuring, recording, and integrating electric currents. D. Improvements in valves for fluids. Under the first head (A) there are 11 patents. Under the second head (B) there are 10 patents. Under the third head (C) there are 24 patents. Under the fourth head (D) there are two patents. There are up to September 28th, 1896, 47 patents.

Motor-driven Pump.—We illustrate below a motor-driven centrifugal pump for condensing plant. The pump, which was made by Messrs. Mavor & Coulson, is designed



to raise 640 gallons of water per minute against a head of 28 feet. The motor develops 10 brake H.P. at a speed of about 900 revolutions per minute.

Electrical Engineers Royal Engineers Volunteers.—The head-quarters of the corps at 13, Victoria Street, Westminster, are now open during the week, Saturdays excepted, from 11 to 4, between which hours general information in reference to the corps can be given to inquirers. On Monday and Thursday evenings, at 8 p.m., some of the officers are in attendance for the purpose of considering applications and enrolling recruits.

The Diesel Rational Heat Motor.—The Diesel heat motor, of which we have already given a description, appears to be securing a considerable amount of attention, not only here, but in America. The new motor is essentially novel in its principles and decidedly worth study, for it is very different from other motors. Its initial pressure is secured by mechanical compression of air up to the point of ignition of the fuel, and the fall of temperature due to expansion is made up by the continued combustion of added fuel up to the "cut-off" point, after which expansion proceeds in the usual way. So far, petroleum has been the fuel managed successfully, but powdered coal is hoped to be used. Initial pressures of 500 to 600 lbs. have to be dealt with, but the Diesel motor is not large for its power, and is expected to cope with these pressures; but undoubtedly high pressures will for some time yet prove a little difficult to manage. As the tests of Schröter and Gutermuth and others have shown an efficiency of 34 to 35 per cent. for full load, and even 38 to 40 per cent. for half loads, there is very good reason to endeavour to deal with the high pressures. The best gas engine efficiency recorded is, we believe, only 27 per cent. by Dugald Clerk. The increased efficiency at less than full load is a remarkable feature. Altogether, the new motor is likely to receive considerable application in the near future.

Lecture.—On Tuesday last week Mr. H. Kilgour, borough electrical engineer, Cheltenham, lectured at the Gloucester Guildhall, his subject being "Notes on Electric Lighting and Electric Works."

NEW COMPANY REGISTERED.

Electric Installation Company, Limited (56,171).—Registered February 19th with capital £100,000 in £1 shares, to carry on the business of an electric light, telephone and telegraph company in all its branches, and to construct, lay down, establish, fix and carry out all necessary cables, lines, accumulators, lamps and works. The subscribers (with one share each) are:—W. Coffey, 50, High Street, Manchester, manufacturer; J. Boydell, Cowley Hill, St. Helens, merchant; T. Currie, 28, Swan Street, Manchester, factor; H. T. Johnson, Dakeim Lymm, Chester, engineer; R. A. Beaver, 3, Old Hall Street, Liverpool, merchant; R. V. Critchley, 6, St. James's Square, Manchester, chartered accountant; F. F. Bennett, 13, Victoria Buildings, Manchester, engineer. The number of directors is not to be less than five nor more than seven; the first are the first five subscribers; qualification, £250; remuneration as fixed by the company. Registered office, 6, St. James's Square, Manchester.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Thomas G. Poole, Limited (53,736).—This company's statutory return was filed on February 12th. 507 shares have been taken out of a capital of £3,000 in £1 shares, and all are considered as fully paid.

Amazon Telegraph Company, Limited (44,532).—This company's return was filed on January 20th. The capital of £250,000 in £10 shares has been fully subscribed, and paid for in full.

London Electrical Omnibus Company, Limited (47,990).—This company's return was filed on January 21st. The capital of £250,000 in £1 shares, (80,000 deferred). All the deferred and 17,818 ordinary have been taken up, and the deferred are considered as paid. 19s. 6d. per share has been called on the ordinary, and £33,274 2s. 6d. has been paid (including £17 15s. paid in advance). £15,500 9s. is in arrears, and £16,520 8s. 6d. has been received on 32,189 forfeited shares.

CITY NOTES.

The Dover Electricity Supply Company, Limited.

The report to be presented at the fourth annual general meeting of shareholders of the Dover Electricity Supply Company, Limited, to be held at the offices, Park Street, Dover, on Wednesday, March 9th, 1898, at 3.30 o'clock, states that the capital expended during the year amounted to £11,932 7s. 9d., making the total to December 31st last £62,836 7s. 9d. Of the amount thus expended £7,915 0s. 3d. was for additional generating plant necessary for the supply of current to the cars of the Dover Corporation Tramways, the running of which commenced in September last, has given great satisfaction to all concerned, and it is not unlikely that the present service may be increased, additional cars having been lately ordered. In the early part of the year it was decided to issue £25,000 4½ per cent. debenture stock, and the whole was subscribed for at a considerable premium, of which the balance, amounting to £761 2s. 6d., after payment of all legal and other charges in connection with the issue, has been applied to reduction of the previous debits to revenue account.

The directors consider the result of the year's working very satisfactory, since, instead of a loss of £455 19s. 11d., as in the previous year, there has been a gross profit of £1,127 17s. 5d. on revenue account. The company may now be considered as fairly established on a profit-earning basis, and the directors believe that in future years the annual increments in gross profits will at least equal, if not exceed, those for the year just ended, as during the construction and after the completion of the national harbour at Dover the trade of the town will largely increase, to the benefit of all its present established undertakings.

During the year applications have been received for the equivalent of 2,748 8-C.P. lamps, including nine additional arc lamps for street lighting (of which there are now 40 in all), making the total applied for on December 31st last 10,376, and of these 10,137 were then connected to the company's mains.

With the view of inducing an increased average daily use of electricity by householders, your directors decided to adopt, as from July 1st last, the demand indicator system of charging, and to reduce the cost of current after the first two hours' daily consumption from 5d. to 3½d. per unit. This system has been introduced in Brighton and many other towns, where it has given general satisfaction; and your directors believe that as its advantages become more generally known, both consumers and the company will correspondingly benefit.

The retiring directors are Mr. C. W. Bagshawe and Mr. R. Percy Sellon, who, being eligible, offer themselves for re-election. The auditor, Mr. R. H. Marsh, chartered accountant, also retires, and is eligible for re-election.

The Richmond (Surrey) Electric Light and Power Company, Limited.

The report presented to the shareholders at the fourth ordinary general meeting of the company, held at the registered offices of the company, Moorgate Court, yesterday, states that the directors beg to submit their report and statement of accounts for the year ended December 31st, 1897. The capital expended during the year amounted to £3,828 17s. 1d., making the total expenditure at December 31st last £44,793 11s. 9d.

Of the amount expended during the period under review, the principal items are in respect of mains and accumulators, the latter of which have been increased to more than double their previous capacity. The balance to credit of revenue account, including the amount brought forward, and after payment of interest, depreciation and reduction of suspense account, is £1,072 18s., as against £33 14s. 9d. in 1896. Out of this sum the directors recommend the payment of a dividend on the ordinary shares of the company at the rate of 3 per cent. for the year ended December 31st, 1897, which will leave a balance of £133 to be carried forward to next account.

The total number of lamps connected on December 31st last was equivalent to 9,512 8-C.P., being an increase for the year of 2,387. In order to meet the growing demand for current, additional plant will be installed in time for next winter's lighting, and further extensions of mains have already been decided upon.

The retiring director is Mr. F. W. Reynolds, who, being eligible, offers himself for re-election. Mr. R. H. Marsh, the auditor, also retires, and is eligible for re-election.

Mr. Frederick W. Reynolds (chairman), presided at the meeting of the company, and in moving the adoption of the report, said he congratulated them at last on reaching a small dividend. The improvement shown in 1896, had been maintained during the year, which was very satisfactory considering the condition of affairs which prevailed in Richmond. The receipts from the sale of current, showed the satisfactory increase of £1,116 15s. 3d., and the total income for the year was £4,468 16s. 6d., as compared with £3,194 8s. 8d. in 1896. The working cost £2,235 11s. 2d., as compared with £2,031 10s. 10d., being only £204 0s. 6d. increase, while the current sold increased to 41,872 units. After payment of interest, and provision for depreciation, &c., they had £1,072 18s. left, out of which a dividend was recommended of 3 per cent. That was the first dividend, and he thought it augured well for the future of the company. The lamps connected on December 31st were equivalent to 39,512 8-candle-power lamps, an increase of 2,387 over last year. There were applications for a further 425 8-candle-power lamps, so that with those connected and those applied for, they had now 10,000 lamps. The total units sold was 138,916, against 97,044 in 1896. In view of the encouraging prospects, it was the intention of the board to lay down more plant for the winter lighting, and they also intended to extend the company's mains, which would go into some of the principal residential streets of Richmond.

The Chevalier Soares seconded the motion, and it was agreed to.

The Hove Electric Lighting Company, Limited.

The report of the directors to be presented at the annual general meeting of the shareholders at the City Terminus Hotel, Cannon Street, in the City of London, on Monday, March 7th, 1898, at 12 o'clock noon precisely, states that the progress and improvement in the position of the company continue satisfactory.

As stated in their report last year, the directors made a very considerable reduction, from January 1st, 1897, in the price of current, charging the consumers for the first hour 6d. per unit and for all current subsequently consumed 4d. per unit only. This reduction, which practically amounts to 20 per cent. in the charge for current, has had the effect anticipated of increasing the number of consumers and the consumption of electricity to such an extent that the large reduction is more than compensated for by the increased consumption.

The revenue from the sale of current has increased to £6,838 17s. 10d., and after debiting profit and loss account with the cost of generation and distribution of electricity, and management expenses, there remains a net profit for the year of £3,602 9s. 8d. compared with £3,114 5s. 6d. in 1896. To this amount must be added £183 7s. 10d. brought forward from last year, increasing the amount to be dealt with to £3,785 17s. 6d., and after deducting debenture interest paid and accrued and the interim dividend paid in October last, there remains a net balance of £2,092 7s. 11d. at the credit of the revenue account.

The directors propose to write the sum of £150 off preliminary expenses account, to place £600 to the reserve fund, to declare a dividend (payable on April 15th next) at the rate of 6 per cent. per annum for the half-year on the share capital (making, with the interim dividend, 5 per cent. for the year), and to carry the balance, £218 7s. 2d., forward. The number of lamps attached to the company's system has increased to the equivalent, at December 31st last, of 27,777 8-C.P. lamps, and the number or consumers to 397, compared to 21,756 lamps and 314 consumers at December 31st, 1896.

Out of the sum of £600 which has to be set aside for repairs and maintenance, in accordance with the contract with the Hove Commissioners, the unexpended sum of £390 13s. 11d. has been placed to the depreciation and maintenance reserve fund, bringing the total of this account to £914 10s., while the general reserve fund, by the addition now proposed to be made, will stand at £2,259 17s.

Since the date of the last report the directors have issued £2,400 of 4 per cent. debenture stock, bringing the total amount issued at the present date to £17,000.

The increase of the company's business, and the continued applications for supply of current from residents in new streets entail upon the company further outlay on mains and machinery, for which additional capital is required. The directors, therefore, propose to increase the capital of the company to £50,000 by the creation of 2,000 new shares of £5 each, ranking *pari passu* with the existing shares, and the necessary resolution for giving effect to this proposal is contained in the accompanying notice of meeting. The directors propose to make an early issue of 1,000 of these shares which will be offered to the whole of the members of the company, *pro rata*, at a premium.

A resolution will also be submitted for consideration, increasing the limit of the directors' borrowing powers from £25,000 to £50,000.

The County of London and Brush Provincial Electric Lighting Company, Limited.

The report to be presented to the shareholders at the fourth ordinary general meeting of the company to be held at Winchester House, Old Broad Street, London, E.C., at 12 o'clock noon, on Monday, March 14th, 1898, states that the capital expenditure during the year in respect of the company's London districts amounted to £141,066 3s. 9d. Of this sum £138,078 5s. 10d. has been expended at St. Luke's and Clerkenwell and at Wandsworth, making the total expenditure on the two London stations up to December 31st last, £410,801 12s. 1d.

This expenditure was met by the balance of instalments falling due on the second issue of 10,000 6 per cent. preference shares, and by the sale at a premium of the balance of the second issue of ordinary shares. In order to provide funds for additional requirements during the current year, a further 10,000 ordinary shares at par were allotted *pro rata* to the ordinary shareholders on December 6th last.

The premium received on the balance of the second issue of ordinary shares has been applied as follows:—

	£	s.	d.
To reduction of general preliminary expenses	3,253	19	6
To writing off costs in connection with applications for provisional orders	889	15	6
Amount carried to reserve (raising this item to £5,000)	1,500	0	0

The interests of the company in the Bournemouth and District Electric Supply Company, Limited, have been disposed of to the Bournemouth and Poole Electricity Supply Company, Limited, at a substantial profit. Your directors deeming it to your advantage to retain an interest in the latter company, applied for and received an allotment of ordinary shares at par.

The net revenue for the year, including the balance from last account, and after payment of proportion of rents, rates, taxes, interest, and general establishment charges, is £21,400 14s. 2d. Out of this sum an interim dividend on the preference shares for the half-year ended June 30th last, at the rate of 6 per cent. per annum has been paid; and the directors now recommend that a further dividend on the preference capital for the half-year just ended be declared at the same rate. This will leave a balance of £10,090 14s. 2d., which it is proposed to carry forward.

The company's two London generating stations are now fully equipped and in good running order, having a joint plant capacity sufficient for the supply of 120,000 8-C.P. lamps connected. It is intended to supply the company's districts north of the Thames from the St. Luke's station in City Road, and those on the south side of the river from the station on the Wandle.

For the information of shareholders a map is attached to the report, showing:—(*a*) Districts where current is now being supplied. (*b*) Districts wherein works are in progress. (*c*) Districts for which provisional orders have been obtained (works not yet commenced). (*d*) Districts where the consents of the local authorities have been obtained to the company's application for provisional orders.

The retiring directors are Mr. B. H. Van Tromp and Mr. R. Percy Sellon, who are eligible for re-election.

LONDON STATIONS.

St. Luke's and Clerkenwell.—The station buildings and the equipment thereof are practically completed. The plant installed is capable of supplying 80,000 8-C.P. lamps connected. The equivalent of 23,757 8-C.P. lamps were connected to the mains at December 31st last, showing an increase of 9,578 for the year; and applications representing a further 1,073 were then awaiting connection. A considerable demand having arisen for motive power, separate mains have been laid down, and a supply of current for power purposes is now available in most of the important thoroughfares in the district.

Holborn (Eastern Portion).—A provisional order for the eastern portion of this district was granted to the company by the Board of Trade, and confirmed in the last session of Parliament. The work of laying mains in the compulsory area was at once taken in hand, and current is now being supplied to consumers within this district from the generating station in City Road. The company's application to the Board of Trade for a provisional order for the western portion of Holborn, and for the adjoining district of St. Giles-in-the-Fields, has received the consent of the local authorities.

Wandsworth.—The station buildings on the Wandle were completed during the year, and the capacity of the plant there installed is equal to 40,000 8-C.P. lamps connected. The company's mains have been carried into new neighbourhoods, and further extensions are in progress. The supply of current was commenced in the early part of 1897, and since September last has been available throughout the 24 hours. The equivalent of 13,907 8-C.P. lamps were connected to the mains at December 31st last, showing an increase of 13,690 for the year, and applications representing a further 2,927 were then awaiting connection.

Camberwell.—The work of laying mains in the compulsory streets within this district has been commenced, and it is expected that by next autumn a supply of current will be available.

Mile End Old Town, St. George's-in-the-East, and the district of the Limehouse District Board of Works.—Provisional orders for these districts were granted by the Board of Trade in 1896, and confirmed by Parliament in 1897.

PROVINCIAL STATIONS.

The Dover Electricity Supply Company, Limited.—In the past year an important addition was made to the Dover Station by the laying down of generating plant for the supply of current to the Corporation tramways. The running of the trams by electricity was commenced in September last. In the second completed year of the working of this station the gross profits amounted to £1,127 17s. 5d., as against a loss in 1896, and the company may now be considered as fairly established on a profit-earning basis. The equivalent of 10,137 8-C.P. lamps were connected to the mains at December 31st last, showing an increase of 2,619 for the year (including nine arc lamps for street lighting); and applications representing a further 239 were then awaiting connection. In the early part of 1897 the Dover Company made an issue of £25,000 4½ per cent. debenture stock, the interest upon which is guaranteed by the company.

The Richmond (Surrey) Electric Light and Power Company, Limited.—A considerable improvement is shown in this company's accounts for the year under review. The gross profits amounted to £2,233 5s. 4d., which allows of a dividend of 3 per cent. on the share capital, after providing for interest charges and reserve for depreciation of plant, &c. The equivalent of 9,512 8-C.P. lamps were connected to the mains at December 31st last, showing an increase of 2,387 during the year; and applications representing a further 220 were then awaiting connection. In order to meet the increasing demand for current at this station, it is intended to lay down additional plant during the present year, and further extensions of mains have been decided upon.

Isle of Man Tramways Company.

The report of the directors for the year ended December 31st last, to be submitted at the general meeting to be held on the 10th prox., states that the balance of profit and loss account, after providing £6,500 for debenture interest, is £11,154. The directors propose dividends at the rate of 6 per cent. on the preference, and 7 per cent. on the ordinary shares, absorbing £10,850, of which £5,669 has been paid in interim dividends, and that the balance of £304 be carried forward. The loss on the first half-year's working of the cable section has been exceptionally heavy, owing to many unforeseen circumstances and through frequent stoppages. With the experience gained, the management confidently hope next year to have a satisfactory return on the cable lines. It is expected that the new electric tramway from Laxey to Ramsey, now in course of construction, and which will be worked as a separate undertaking, will be opened for next summer's traffic, and will bring considerable increase of revenue on the company's present lines.

Telegraph Construction and Maintenance Company, Limited.

Sir Anthony H. Hoskins, who presided at the ordinary meeting of this company, held on Tuesday, regretted the absence of the chairman, Sir Robert Herbert, through illness. They had had no important contract to carry out during the period under review, but their factories at Wharf Road and East Greenwich had been actively employed, and they were able to maintain the dividend at the same rate, 15 per cent., as last year. They carried forward a somewhat smaller amount, but they consider it better to do that, rather than to lower the dividend. They would be interested to learn that this was the 50th year of the most important branch of the manufacture—the insulation of telegraph wires. Their gutta-percha works were started in 1845, although it was not till 1848 that the insulating properties of gutta-percha were generally recognised. The total amount of raw gutta imported into this country had been officially stated to be 84,000 tons, of which he believed 40,000 had been used by their company. The gutta-percha manufactured by them had been mostly for submarine cables, of which they had made 145,000 knots of various sized cores. Gutta remained to-day unrivalled as an insulator for submarine cable cores. It was interesting to note that they were manufacturing for the British Postal Telegraphs a telegraph cable, 60 knots in length, to be laid between this country and Ireland, having a core of novel design. It possessed considerable electrical advantages, and they hoped the form would solve the question of telephonic communication. The cable had been invented by their engineer, Mr. Willoughby Smith, and his assistant, Mr. Granville, and a small section had been laid in Southampton Water, and had been successful. They had entered into a contract for building a new cable steamer, which would be the largest telegraph ship in the world. In planning and designing her they had had the accumulated experience extending over a good many years, and they could reasonably expect the vessel to be thoroughly up to date. It was absolutely necessary that a vessel of her capacity and dimensions should be brought into use with a view to securing contracts that may be forthcoming in the future. She would be capable of lifting a dead weight of 8,000 tons, and that would enable her to carry the largest ocean cable in one length. It would be fitted with twin screws, the engines and boilers would be of a modern type, and would give a speed of 12 knots per hour on a moderate consumption of coal.

After one or two remarks from shareholders, one of whom elicited from the chairman the fact that the new cable ship would be finished in early autumn, the report was adopted.

The statutory provision for depreciation and reserve funds in accordance with the City of London Electric Lighting Act, 1893, has been made, of which £20,528 have been set aside out of revenue. The generation and distribution expenses for the year, including repairs and renewals, were 31·3 per cent. of the earnings, as compared with 34 per cent. in 1896, 36 87 for 1895, 46 for 1894, and 54 2 for 1893.

The progress made by the company will be seen by the following comparative statements, which show the position as it was in 1892 and at subsequent periods:—

NUMBER OF CUSTOMERS AND LAMPS CONNECTED.

	Dec. 31st, 1892.	Dec. 31st, 1893.	Dec. 31st, 1894.	Dec. 31st, 1895.	Dec. 31st, 1896.	Dec. 31st, 1897.
Number of customers being supplied	242	1,080	2,740	4,280	5,808	6 322
Number (equivalent) of 8-C.P. lamps connected	20,241	65,341	135,460	195,817	247,785	296,012

On February 9th, 1898, there were 316,705 8-C.P. lamps (equivalent) applied for, out of which 302,871 were connected.

STATEMENT OF INCOME AS SHOWN IN THE AUDITED STATEMENTS OF ACCOUNTS ISSUED BY THE COMPANY.

	For the period to Dec. 31st, 1892.	For the year ended Dec. 31st, 1893.	For the year ended Dec. 31st, 1894.	For the year ended Dec. 31st, 1895.	For the year ended Dec. 31st, 1896.	For the year ended Dec. 31st, 1897.
	£ s. d	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Gross revenue (after deducting allowances to consumers)	12,450 5 4	39,662 17 9	68,863 19 3	106,999 17 2	146,946 14 7	175,792 13 2
Net revenue available for depreciation, reserve fund, interest on debenture stock and dividends	500 (est.)	16,940 14 10	34,865 2 6	59,100 5 11	85,701 8 3	107,550 2 4

The City of London Electric Lighting Company, Limited.

THE report presented to the shareholders at the ordinary general meeting held on Wednesday stated that the expenditure on capital account during the year ended December 31st, 1897, amounted to £82,085 17s. Details of this outlay are given in the capital account No. III.

REVENUE.

				£	s.	d.
The total revenue for the year was				190,573	12	11
From which must be deducted the following items:—						
Expenses of generation and distribution	£42,923	10	8			
Rents, rates, taxes, general charges	23,980	19	6			
Allowances to consumers	14,780	19	9			
Transfer to depreciation fund No. 1	17,000	0	0			
Transfer to reserve fund	3,528	0	0			
Amount written off suspense account	1,338	0	8			
				103,551	10	7
Leaving				87,022	2	4
To which must be added the balance brought forward from 1896				1,415	3	1
Making a total available revenue of ...				88,437	5	5
Of this sum the following amounts have been distributed:—						
(a) Interest on debenture stock for year ended December 31st, 1897	£20,000	0	0			
(b) Interim dividend on £400,000 6 per cent. preference shares, half-year to June 30th last ...	12,000	0	0			
				32,000	0	0
Leaving for further distribution				£56,437	5	5

The directors now recommend the payment of the following dividends, subject to the deduction of income-tax, to members registered in the books of the company on February 16th, 1898.

Preference Shares.—6s. per share for the six months ended December 31st, 1897, making, with the interim dividend already paid, a total distribution of 12s. per share, or at the full rate of 6 per cent. per annum.

Ordinary Shares, Nos. 40,001 to 80,000.—£1 per share for the 12 months ended December 31st, 1897, being at the rate of 10 per cent. per annum.

Ordinary Shares, Nos. 80,001 to 90,000 (February, 1897, issue).—10s. 7d. per share, being at the rate of 10 per cent. per annum, calculated from the due dates of the respective instalments to December 31st, 1897.

This will absorb £55,381 18s. 10d., and leave a balance of £1,055 6s. 7d. to be carried forward. It is proposed that the respective dividends shall be paid on March 3rd, 1898.

The ordinary general meeting of the shareholders of the above company was held on Wednesday at Winchester House, Old Broad Street, Sir David L. Salomons presiding.

The CHAIRMAN, in proposing the adoption of the report, said it was satisfactory that the directors were able to recommend a dividend at the rate of 10 per cent. per annum. To effect that, it had been necessary to take £5,000 from the premium fund towards depreciation, and approximately a similar sum was taken last year for the same purpose. In 1896 the revenue was aided, from the fact that there was a sum somewhat exceeding £5,000 from the profits on investments; also the sum that was put to the depreciation fund, making in all £10,000 added to the revenue. In other words, last year they paid 7 per cent. dividend with the aid of that additional £10,000; but this year they would be able to pay 10 per cent.—with the approval of the shareholders—without having had the advantage of that additional £10,000. Those facts showed that the business was progressive. It also proved that which he had often referred to, that when the business had reached a certain point, they would be able to make much larger profits at a very small additional cost. As they could well understand, the standing charges remained virtually the same, it was simply a question of burning a little more coal, and keeping the machinery running for a longer period to produce a larger output of current. In 1896 about £10,000 was taken from the premium fund to assist the depreciation fund number two, and this year it was proposed to take £20,000 to add to that fund, as they considered that that fund being a voluntary one on the part of the board, should be kept up to a fair amount to meet any contingencies that might arise in the future. The expenditure on capital account during the year had amounted to £82,085. It might be curious to notice that their freehold investments appeared to be less than they were the year before, but that was really to be accounted for by the fact that some of the investments had been shifted from a general heading, and put definitely to represent the depreciation and reserve fund. The capital expenditure had increased, and also the expenditure for running the company during the year, which was due to their having supplied a greater amount of current. It was very satisfactory to know that the demand for the supply of electric energy continued to increase. The number of customers on February 23rd was 6,517, the number of lamps applied for was 318,741, and the number of lamps connected to the circuits 305,163. That afforded abundant proof that not only was the electric light appreciated in the City, but also that they had given satisfaction to their customers. The great fire in Cripplegate at one time gave the directors very great anxiety, but he was very glad to be able to say that the damage caused to the company was only nominal—between £200 and £300 would cover their entire loss. It was said it was an ill wind that blew nobody any good, and it was possible that, as a result of that fire, their company might benefit, for they were sending round a circular to the builders of the new premises that were to be erected, pointing out the advantages that would accrue by wiring the premises for the electric light. He had had a letter from a shareholder who had asked whether the board could not see their way to paying an interim dividend in the future. To that he would say that, if the business continued to prosper in the coming years as it had done in the past, the directors saw no objection to that course, seeing that it would meet the wishes of many shareholders. He would like to point out, however, that any interim dividend would necessarily be small, as the first half of the year was always a small one. Referring to the relations of the company with the City authorities, the chairman said that the directors were anxious to meet the Corporation in all matters in a fair and even conciliatory spirit. They were a business company carrying on operations for the purpose of obtaining a profit on their investment, and therefore had no desire to enter into litigation, and they would only have recourse to the law courts to enforce their just rights. If such a position were forced upon them the board would protect the rights of the shareholders; but, as he had said, they desired to act in harmony with the authorities. It had been decided to reduce the maximum price from 8d. to 7d. per unit, and the board hoped to reduce the price still further as the exigencies of the business admitted of it. In order to give the public the fullest possible benefit, they had decided to make that reduction date back from January 1st last.

The report was adopted.

The retiring directors—Mr. Edward Lucas and Mr. F. W. Reynolds—having been re-elected, a similar proposition was agreed to with reference to the auditors, Messrs. W. H. Pannell & Co.

A vote of thanks to the Chairman for presiding closed the proceedings.

Notting Hill Electric Lighting Company.

The annual general meeting of this company was held at Winchester House, on Wednesday, Sir William Crookes presiding.

Referring to share capital account, the Chairman said the whole £100,000 of share capital had been issued and paid up. In the loan capital there was still £40,000 of 4 per cent. debentures available for issue against further capital expenditure. By making use of these the shareholders reap the benefit, as the debentures carried interest at 4 per cent. only, whereas a further issue of shares would rank for dividend with the old ones, and would therefore have to receive the full 6 per cent. By issuing debentures, however, the odd 2 per cent. goes to increase the share dividends. During the year the directors allotted £10,000 of the 4 per cent. first mortgage debentures at £106 per cent., being part of an issue of £50,000 secured on the company's undertaking by a trust deed. They anticipated requiring about £11,000 this year, and the issue price of the debentures will be increased to £107 10s. per cent. The amount of capital expended on lands, buildings, mains, and machinery, was £3,184 in excess of the amount received from shares and debentures. Very little capital was expended during the year except on new mains, which represent £11,769 of the total expenditure of £14,079. The reason for this large expenditure is that they had now seriously commenced to lay mains in the principal streets of the new area, most of the compulsory ones being already supplied with current. They had every reason to be satisfied with the number of customers on the new extensions, which appeared an almost certain source of additional revenue; but there was still a large field for further development. Other small extensions of the mains had to be made in the old area, and they were always prepared to extend into any street where the demand appeared sufficient to guard against a loss being incurred on the capital employed. The revenue account was in a very satisfactory state, the number of units sold having increased during the past 12 months from 230,787 to 354,969, or 50 per cent., and the total revenue from £8,550 to £11,620. The increase in the revenue, compared with the previous year, is over £3,000, but the expenses show an increase of only about £900. The principal increases were for coal, repairs, and rates. The whole of the machinery and mains are kept in an efficient state of repair, the entire cost being taken out of revenue. He took the opportunity of expressing their entire satisfaction at the excellent manner in which their engineering staff, under Mr. Schultz, had carried out the duties devolving on them, more especially in view of the very anxious times at the end of the year. Owing to the labour troubles at that time in the engineering trade, the contractors were unable to deliver the large engine and dynamo which should have been completed last summer ready for the winter load. Had one of the machines failed at the critical moment, they would have been in a most awkward predicament, having no spare plant whatever to fall back upon. Happily, no accident occurred, and the new machinery was delivered last week.

A table was then given showing the progress of the company. Their revenue per 8-C.P. lamp still continued low, being about 6s. only, showing that their district was not so good as most of the others in London, where the average consumption per lamp was above 10s. They hoped to derive considerable benefit from their contract with the National Electric Free Wiring Company, who undertake to wire houses and provide suitable fittings free of initial cost to the consumer, who merely had to pay an additional 1d. per unit, which 1d. is handed over to the Free Wiring Company. Already 20 houses had been connected on those terms. They had every reason to be satisfied with the result of the reduction in the price per unit to 6d. at 200 volts; and although their principal thought must be to benefit shareholders, they must not overlook the claims of those who supply the dividends, viz., the consumers. As many of their shareholders were also using their light, he could assure them that their interests would be very carefully considered, and immediately it was possible to make a further reduction they could rely that this would be done. The dividend of 6 per cent. on the ordinary shares, which they now recommended, marked a period in their history. After this was paid, preference and ordinary shares ranked equally for dividend, and the founders' shares came in for their proportion. To simplify matters, they proposed to regard the ordinary dividend as a 6 per cent. one, payable half yearly, and at the end of the second half year proposed to pay in addition such bonus as the profits may allow. The total amount of profits available for dividend, after payment of the 6 per cent., would be divided into two moieties, and one moiety would go to the 9,450 preference and ordinary shares *pro rata*, and the other moiety to the 550 founders' shares *pro rata*.

After some little discussion the report was adopted.

Henley's Telegraph Company, Limited.

Mr. Sydney Gedge, M.P., presided at a general meeting of this company, which was held last Friday at the offices of the company, Martin's Lane, E.C., and referred to the fact that the company for some years had been going on well, and improving in every way its position and its prospects. He congratulated the shareholders upon the success which had attended the efforts of those who had the management in their hands. Dwelling for a moment upon the progress that had been made during the five years, the chairman said in 1893 they issued £30,000 preference shares partly to pay off debts, and partly to provide fresh capital. The benefit of that was felt during the following year, for they made a very substantial profit of £10,771, and were able to pay a dividend of 5 per cent. They also raised fresh debentures at a lower rate of interest, to replace older ones, and they practically increased their capital by £12,000 at an increase of interest of only £253. They commenced to pay better dividends, and in 1895, when they wanted more capital, they increased from the nominal £70,000 to £100,000, the whole of which issue was taken up at par by their own shareholders and friends. It was found necessary in 1896 and last year to further increase the capital, and they issued £25,000 of further capital at a very considerable premium, making, in fact, £15,000, which had been added to the reserve fund. Their business was increasing so rapidly, and as they found it necessary to have the best of machinery, it was not at all unlikely, before the year ended, that they would have to issue another £25,000, although shareholders must not expect to get them at the same price as the last. The profits for the last five years had been as follows:—

	Profits.	Paid in dividends.
1893	£10,780	£6,000
1894	16,450	6,800
1895	21,820	9,500
	(£1,600 from previous year)	
1896	26,080	12,400
	(less £500 to directors)	
1897	29,585	15,800

Their net profits had continuously progressed, and the sums paid in dividends had also increased year by year, and at the same time they had been able to pay dividends out of profits actually earned. The actual earnings had paid interest on debentures, and during the five years they had written off £10,000 for depreciation, added £20,000 to the reserve fund, besides the £15,000 profit on issuing shares, they had paid in dividends £50,500, carrying forward £12,700 to 1898. Referring to the present accounts, they would see that the value of stock had increased, but it was not unsaleable stock, but represented goods which they might have to supply at 24 hours' notice. Referring to the effects of the strike, the chairman said that in their case men of inferior position had been put to do the work of the skilled workmen, and the result had been that they had done more and better work.

After some remarks from shareholders the accounts were adopted.

Stock Exchange Notices.—The Stock Exchange Committee has appointed Thursday, March 10th, a special settling day as under:—Chelsea Electricity Supply Company, Limited—Further issue of 8,000 ordinary shares of £5 each, fully paid, Nos 32,501 to 40,500; and National Electric Free Wiring Company, Limited—100,000 shares of £1 each, 5s. paid, Nos. 1 to 100,000. The Committee has also ordered the under-mentioned securities to be quoted in the official list:—Edmundson's Electricity Corporation, Limited—17,400 ordinary shares, Nos. 1 to 17,400. Halifax and Bermudas Cable Company, Limited—£97,800 4½ per cent. first mortgage debentures, within Nos. 1 to 1,200.

Brazilian Submarine Telegraph Company, Limited.—The directors of this company have to-day declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income-tax, for the quarter ended December 31st last, and payable on March 25th. The transfer books of this company will be closed from the 18th to the 24th inst., both days inclusive.

The House-to-House Electric Light Supply Company, Limited.—The transfer registers of this company will be closed from the 2nd inst. to the 12th inst., both days inclusive for the preparation of dividend warrants.

TRAFFIC RECEIPTS.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending July 25th, 1898, were £2,290 8s. 11d.; corresponding period, 1897, £2,218 7s. 2d.; increase, £72 1s. 9d.

The City and South London Railway Company.—The receipts for the week ending February 27th, 1898, were £1,065; week ending February 28th, 1897, £996; increase, £69; total receipts for half-year, 1898, £9,630; corresponding period, 1897, £9,718; decrease, £88.

The Dublin Southern District (Electric) Tramways Company.—The receipts for week ending Friday, February 25th, 1898, were £352 0s. 1d.; corresponding week last year, £508 11s. 3d.; decrease, £156 11s. 2d.; passengers carried, 61,674; corresponding week last year, 77,074; aggregate to date, £3,215 12s. 9d.; aggregate to date last year, £3,456 1s. 11d.; decrease to date, £240 9s. 2d.; mileage open, 8 miles, as against 8 miles for the corresponding period of last year. Cars, 1898, 207; 1897, 292. Miles, 1898, 18,795; 1897, 26,060.

The Liverpool Overhead Railway Company.—The receipts for the week ending February 27th, 1898, amounted to £1,300; corresponding week last year, £1,275; increase, £25.

The Western and Brazilian Telegraph Company, Limited.—The receipts for the week ending February 25th, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brasilian Telegraph Company, Limited, were £2,396.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, Feb. 23rd.	Closing Quotation. March 2nd.	Business done during week ended March 2nd, 1898. Highest.	Lowest.
137,400*l*	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	...	...	100 —104	100 - 104	...	...
25,600	Amazon Telegraph, Limited, shares...	10	...	...	...	6 — 7	6½ — 7½	...	...
125,000	Do. do. 5% Debs. Red.	100	...	...	...	93 — 96	93 — 96	...	...
923,960*l*	Anglo-American Teleg., Ltd.	Stock	£2 9s.	£2 13s.	3 %	59 — 61	59 — 61	60½	59
3,038,020*l*	Do. do. 6 % Pref.	Stock	£4 18s.	£5 6s.	6 %	107½ 108½	107½ 108½	108½	107½
3,038,020*l*	Do. do. Defd.	Stock	...	...	...	11¾ — 12¼	11¾ — 12¼	12 1/16	11⅞
130,000	Brasilian Submarine Teleg., Ltd.	10	7 %	...	...	16¾ — 17¼	16¾ — 17¼	17 1/16	16⅞
75,000*l*	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	...	...	112 —116	112 —116	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	4 %	4 %	...	3 — 3½	3 — 3½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	...	187 —192	187 —192	...	...
653,586*l*	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	106 —108	106 —108	106¾	106½
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	2 %	...	1/16 — 3/16	1/16 — 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	...	7½ — 8½	7 — 8 xd	7⅝	7½
6,000	Do. 10 % Pref.	10	10 %	10 %	...	15½ — 16½	14½ — 15½xd	15⅛	14½
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	...	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	...	10 — 11	10 — 11	...	...
30,000*l*	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	...	103 —106%	103 —106%	...	...
60,710	Direct United States Cable, Ltd.	20	2¼%	2½%	...	10¾ — 11¼	10¾ — 11¼	11⅛	...
120,000	Direct West India Cable 4½% Reg. Deb.	100	...	...	...	98 —101	98 —101	99¾	99
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	...	18 — 18½	18 — 18½	18⅜	18
70,000	Do. 6 % Cum. Pref.	10	6	6%	...	19 — 20	19 — 20	19⅜	...
89,900*l*	Do. 5 % Debs., repay. August, 1899	100	5 %	5%	...	100 —103	100 —103	...	...
1,302,615*l*	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4%	...	131 —134	131 —134	131	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7%	...	18¾ — 19¼	18¾ — 19¼	19	18⅞
25,200*l*	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5%	...	99 — 103	99 —103	...	...
100,500*l*	Do do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5%	...	100 —103	100 —103	101½	...
320,000*l*	Do. 4 % Deb. Stock	Stock	4 %	4%	...	130 —133	130 —133	...	...
51,100*l*	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5%	...	99 —103	99 —103	...	...
69,200*l*	Do do. do. to bearer, 2,344 to 5,500	100	5 %	5%	...	100 —103	100 —103	100½	...
300,000*l*	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4%	...	102 —105	102 —105	101	...
200,000*l*	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4%	...	108 —111%	108 —111 %	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅛%	4½%	...	12 — 12½	12 — 12½	12⅜	12
180,042	Do. do. 6 % Pref.	10	6 %	6%	...	17¾ — 18¼	17¾ — 18¼	18⅛	17¾
150,000	Great Northern Teleg. Company of Copenhagen ...	10	10 %	10%	...	27½ — 28½	28½ — 29½	28¾	...
160,000*l*	Do. do. do. 5 % Debs.	100	5 %	5%	...	101 —104	100 —103 xd	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10%	...	52 — 55	52 — 55	...	...
100,000*l*	London Platino-Brasilian Teleg., Ltd. 6 % Debs.	100	6 %	6%	...	108 - 111	106 —109 xd	106½	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	...	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5½%	5½%	6 %	6⅞ — 7⅛	6⅝ — 6⅞xd	6 15/16	6 11/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 18	16 — 18 xd	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	16½	15¾
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6 — 6½	5¾ — 6¼xd	5 15/16	...
130,766	Do. do. Nos. 119,235 to 250,000, £5 paid	5	...	...	5 %	6 — 6½	5¾ — 6¼xd	...	...
329,471*l*	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	104 —109	104 —109	105½	105
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	⅝ — ¾	⅝ — ¾	...	...
100,000*l*	Pacific and European Tel., Ltd., 4 % Guar Debs, 1 to 1,000	100	4 %	4 %	...	105 —108	105 —108	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	8 — 9	8 — 9	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	139 — 144	139 —144	...	...
58,000	United River Plate Teleph., Ltd.	5	4 %	...	...	4 — 4½	4 — 4½	...	...
146,733*l*	Do. do. 5 % Debs.	Stock	5 %	...	...	101 —106	103 —107	...	...
15,609	West African Teleg., Ltd., 7,501 to 22,129	10	4 %	nil	...	4¼ - 4¾	4¼— 4¾	...	...
213,400*l*	Do do. do. 5 % Debs.	100	5 %	5 %	...	103 —106	101 —104 xd	...	...
64,268	Western and Brazilian Teleg., Ltd.	15	3 %	2 %	...	10¼ — 10¾	11½ — 12	11½	10½
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	...	7½ — 8	7½— 8	7⅝	...
33,129	Do. do. do. Def. Ord	7½	1 %	...	...	3¼— 3¾	4 — 4½	4⅜	3 9/16
382,230	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	105 —107	106 —108	106¾	...
88,321	West India and Panama Teleg., Ltd.	10	⅞%	1 %	...	½— ¾	½— ¾	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	8 — 8½	8 — 8½	8⅜	8
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	5 — 7	5 — 7	...	...
80,000*l*	Do. do 5 % Debs. No. 1 to 1,600 ...	100	5 %	5 %	...	105 -108	105 —108	...	...
163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7%	...	105 —110	105 —110	...	...
160,100*l*	Do. do. 6 % Ster. Bonds.	100	6 %	6%	...	100 —105	100 —105 xd	...	...

ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share.	1895.	1896.	1897.	Closing Quotation, Feb. 23rd.	Closing Quotation. March 2nd.	Highest.	Lowest.
30,000	Charing Cross and Strand Electy. Supply	5	5 %	6 %	7 %	14 — 15	14 — 15	14 5/16	14 1/16
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	6 7/16	...
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 16,277 ...	5	5 %	5 %	...	11½— 12	11½— 12	11 13/16	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	4½%	4½%	...	115 —117	115 —117	...	...
40,000	City of London Elec.Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	7 %	10 %	28½ — 29½	28½ - 29½	29½	28¾
10,000	Do. do. Prov. Certs.	5	...	...	10 %	28 — 29	28 — 29	...	...
10,000	Do. do. Nos. 90,001 to 100,000 £2 pd.	10	...	...	...	13 — 14	14 — 15	14¾	13⅞
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17½ - 18½	17½— 18½	18¼	18
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	129 —134	129 —134	...	...
30,000	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—30,000	10	nil	nil	nil	15½— 16	15½— 16	15⅝	15½
30,000	Do. do. do. 6% Pref., 40,001—60,000 ...	10	6 %	6 %	6 %	15¾— 16¼	15¾— 16¼	16⅛	16
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5	...		...	10½— 11½	11 — 12	11⅝	11½
10,000	Do. do. 7 % Cum. Pref. ...	5	...		...	11½— 12	11½— 12	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	4 %	5 %	...	20 — 21	20 — 21	20 15/16	20½
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem. ...	10	...	...	...	19½ — 20½	19½— 20½	20⅜	...
230,000*l*	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	117 — 121	117 —121	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	2½%	4 %	6 %	19 — 20	19 — 20	19⅞	...
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	7½%	10½%	14½ %	18½ - 19½	18½ — 19½	19¼	19
20,000	Do. do. 7 % Pref., 20,001 to 40,000	5	7 %	7 %	7 %	10 — 11	10 — 11	...	...
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	4 %	107 —110	107 —110	...	...
43,341	South London Electricity Supply, Ord., £9 paid	5	...	...	...	2⅞— 3⅛	2⅞— 3⅛	2 15/16	...
79,900	Westminster Electric Supply Corp., Ord., 101 to 80,000	5	7 %	9 %	12 %	18 - 19	17½ — 18½xd	18¼	17⅝

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capit
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation. Feb. 23rd.	Closing Quotation March 2nd.	Business done during week ended Mar. 2nd, 1898. Highest	Lowest
30,000	British Electric Traction	10	...	...	...	17½ — 17¾	16½ — 17	17½	15 13/16
90,000	Brush Elect. Enging. Co., Ord., 1 to 90,000...	3	...	...	...	2 — 2¼	2 — 2¼	2 1/16	2
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	...	...	2¼ — 2½	2¼ — 2½	2⅜	2¼
125,000*l*	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	109 — 113	110 — 114 xd	...	...
50,000	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	102 — 105	102 — 105	...	...
19,126	Central London Railway, Ord. Shares	10	...	...	...	10½ — 11	10½ — 11	10 15/16	10⅝
143,106	Do. do. do. £6 paid	10	...	...	...	6½ — 7	6½ — 7	6⅞	6⅝
58,830	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1½ — 2	1½ — 2	1 13/16	...
61,777	Do. do. Def. do. £5 pd. ...	...	...	...	...	4⅞ — 5	4⅞ — 5⅛	...	...
630,000*l*	City and South London Railway	Stock	1 3/16 %	1 9/16 %	1⅞ %	66 — 68	67 — 69	68⅜	65⅝
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	nil	...	...	2½ — 2¾	2½ — 2¾	...	...
99,261	{ Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 99,261 }	5	5 %	5½%	...	2½ — 3	2½ — 3	...	...
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5½%	...	4 — 5	4 — 5	4⅜	...
194,023	Do. do. do. 4% Deb. stock Red. ...	100	...	...	...	......	103 — 105	104½	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	5 %	6 %	...	2⅝ — 2⅞	2⅝ — 2⅞	2 13/16	2 11/16
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 ...	2	7 %	7 %	...	3⅛ — 3⅜	3⅛ — 3⅜	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	...	...	...	½ — ¾	½ — ¾	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	...	...	...	⅜ — ⅝	⅜ — ⅝	...	...
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	10½%	...	...	9 — 11	9 — 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	8 %	10 %	12 %	22½ — 23½	23 — 24	23⅝	23 5/16
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	19 — 20	19 — 20	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½%	112 — 117	110 — 115 xd	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	22 — 23	21½ — 22½xd	22½	21⅞
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	103 — 107	104 — 108	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	2⅞%	2⅞%	3¼ %	10 3/16 — 10 5/16	10⅜ — 10⅞	...	...
18,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15¾ — 16¼	15¾ — 16¼	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	15 %	15 %	39 — 42	39 — 41	39½	38⅝
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 — 105	102 — 105	...	...
54,000*l*	Waterloo and City Railway, Nos. 1 to 54,000	10	...	...	...	13¾ — 14¼	13¾ — 14¼	14⅛	13⅞

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0 %; 1891—7 %; 1890—8 %.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

* Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 11.

Electric Construction Corporation, 6 % Debentures, 106—108.

House-to-House Company, 4½% Debentures of £100, 106—109.

Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 16½—17½xd; 1st Preference Cumulative 6 %, £5 (fully paid), 8½—9. Dividend, 1896, on Ordinary Shares 7 %.

London Electric Supply Corporation, £5 Ordinary, 4½—4¾.

* T. Parker, Ltd., £10 (fully paid), 13¾—14¼.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8—8½xd. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount 3 per cent. (October 14th, 1897).

THE KELVIN QUADRANT ELECTROMETER AS A WATTMETER AND VOLTMETER.

By ERNEST WILSON.

Communicated by Dr. J. Hopkinson, F.R.S., to the Royal Society. Received January 11th—Read January 27th, 1898.

During the past seven years the author has had continued experience with the Kelvin quadrant electrometer, both in connection with scientific research and the training of electrical engineering students in the Siemens Laboratory, King's College, London. This paper embodies a good deal of the experience which he has gained with the instrument, and he has been fortunate in that two of these instruments were available. The numbers of the instruments are 71 and 184. The writer was therefore able to test the one as a wattmeter, using the other for the purpose of investigating the instantaneous rate at which work was being done by alternate currents. The instrument used as a wattmeter (No. 184) is of comparatively recent construction, and differs from the other principally in the omission of the guard tube in the immediate vicinity of the needle surrounding a portion of the needle axis, and the wire connecting the needle to the acid inside the jar. The induction plate employed in the old form is done away with, and the terminals are permanently fixed to the quadrants in this new instrument, otherwise, so far as the author can see, they are identical. These instruments belong to Dr. J. Hopkinson, F.R.S., the old form being the same that he has used for many years, and in connection with which he read a paper before the Physical Society on March 14th, 1885.*

Verification of Clerk Maxwell's Formula.

In the paper just alluded to, it is shown that the sensibility of the instrument (No. 71) increased with the charge on the needle up to a certain point, and that for further increase of the charge on the needle the sensibility diminished. The complete explanation of this is not given, and the author believes Professors Ayrton and Perry were the first to point out that this effect is due to the portion of the guard tube in the immediate neighbourhood of the needle.

* See *Philosophical Magazine*, April, 1885.

To test this point in the new instrument a Kelvin vertical electrostatic voltmeter was placed across the needle and case, and a constant electromotive force applied to the quadrants, one pair being put to the case. The jar was then charged by sparks from an electrophorous, and readings taken on the voltmeter and electrometer scale. The charge was continually increased until disruption occurred between the needle and the lantern which supports the idiostatic gauge. Up to about 2,450 volts on the needle the sensibility increased, and so far as the author could see the needle was further deflected as the charge was increased up to the point of disruption, the spot of light being then off the scale. No great care was taken with this experiment, since it was only carried out for the purpose of ascertaining if diminished sensibility could be obtained with further increased charge. The results are given in fig. 1. In Clerk Maxwell's "Electricity and Magnetism," Vol. 1, p. 273, edition 1873, it is shown that the deflection of the needle of a quadrant electrometer should vary as $(A - B)\left(C - \frac{A + B}{2}\right)$, where C is the potential of the needle, and A and B the potentials of the two pairs of quadrants. In fig. 1 the E.M.F. between the quadrants was less

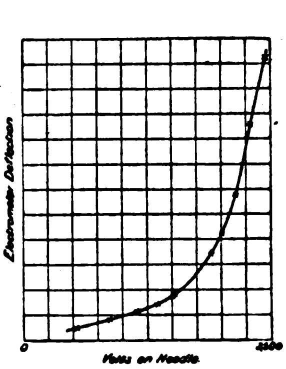


Fig. 1.

than 1 volt, and was constant. By the formula the quotient C/θ should in this case be constant, where θ is the observed deflection.

It varies in arbitrary units from 0·55 to 0·11 as the value of C varies from about 550 to 2,450 volts. This is working the instrument far beyond the range for which it is intended, since when the gauge is in proper adjustment the value of C is only about 550 volts.

In the following experiment the highest E.M.F. employed is 115 volts, and since a square root of mean square value equal to 100 volts was the maximum potential difference about to be used by the author in a certain series of experiments upon alternate current watt-hour meters, it was necessary to see that within this range of potential the formula above given is verified. The instrument was connected as before with one pair of quadrants to the case, the other pair being insulated and the electromotive forces applied to the quadrants, as also to the needle were supplied by storage cells, and accurately measured by Poggendorff's method, the standard of comparison being Clark's cell. The results are given in Table I.

TABLE I.

Observed deflection θ	A + B volts.	C volts.	$\dfrac{\left(C - \frac{A+B}{2}\right)(A+B).}{\theta}$
+ 106	57·5	20 7	436
− 140	58 6	3[illegible]·5	427
− 331	5[illegible]3	5[illegible]·4	431
− 552	52 7	71 6	432
− 773	51 5	91·0	434
− 551	32 5	89 7	433
− 268	14·2	89 7	438
− 352	14·1	115·0	432
− 729	32·3	114 0	434
− 726	48·5	88 9	432
− 427	60 6	60 7	431
− 338	8[illegible]9	60 7	427
− 110	113 0	60·7	432
+ 6[illegible]6	113 0	32 2	439
+ 9[illegible]7	113 0	18·1	439
			433 mean

The instrument in the above experiment was mounted on a slate base in the upstairs room of the Siemens Laboratory. The spot of light when working on this base with this instrument is never perfectly steady, and this may account for the errors observed in Table I.

Method of Test.

Fig. 2 gives a diagram of connections showing how the electrometer was used as a wattmeter for alternate currents, and how it was tested when being so used. In the formula

$$\theta = \lambda(A - B)\left(C - \frac{A+B}{2}\right),$$

where λ is a constant, it follows that if A and B are in phase with one another and with the alternate current, and have the same wave form as the alternate current; and if C is in phase with the potential

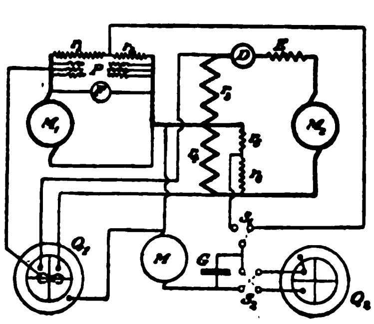


FIG. 2.

difference between two points of the circuit where the power is to be measured, and has the same wave form, A must be equal and opposite in sign to B, since the instantaneous rate at which work is done on or by the circuit must be proportional to A C or B C.

In the Siemens Laboratory there are two alternate current machines* coupled together in such manner that any desired phase difference between their armatures can be obtained. In fig. 2, M_1 and M_2 represent the armatures of these machines. On the shaft of one of these alternators is fixed a revolving contact maker, M, which makes contact between two brushes once in a period, that is, six times in a revolution of the alternator since there are 12 poles. It consists of a gunmetal disc keyed to the shaft of the alternator, and carrying two rings, one of ebonite and the other of gunmetal insulated from the disc by means of the ebonite ring. Into the ebonite ring are inserted six contact making strips of gunmetal $\frac{1}{16}$th of an inch thick, equally spaced out on the circumference and soldered into the gunmetal ring. An insulated copper brush bears on the gunmetal ring, and an insulated steel brush bears on the surface of the ebonite ring, touching each of the contact making strips as the contact maker revolves. The epoch at which such contact is made by the small steel brush can be varied and observed by means of a pointer moving over a fixed circle divided into 360 equal parts. The diameter of this revolving contact maker is 13 inches.

Q_1 is the No. 184 electrometer used as a wattmeter.

Q_2 is the No. 71 electrometer used in connection with the revolving contact maker, M, for the purpose of determining the instantaneous values of the current and potential difference.

D is a Kelvin balance or Siemens electro-dynamometer for the measurement of current; E is the thick wire circuit or circuits of the watt-hour meters being tested; F is a Kelvin multi-cellular voltmeter; r_1, r_2 are non-inductive resistances of comparatively large value for the purpose of reducing the potential difference applied to the electrometer, Q_2, when measuring potential difference, C; the pressure circuits, P, of the watt-hour meters, are placed across $r_1 + r_2$; r_3, r_4 are made up of a manganin strip 50 8 mm. wide and 0·4 mm. thick; $r_3 = r_4 = 0·2275$ ohms at about 10° C.; r_5, r_6 are non-inductive resistances of considerable magnitude for reducing the potential difference applied to Q_2 when necessary. The junction between r_3 and r_4 is connected to the case of Q_1; the quadrants of this instrument are connected respectively to the extreme ends of r_3, r_4; whilst the needle of the electrometer is connected to the other pole of M_1. In connection with Q_2, s_1 is a two-way switch for observing potentials across r_2 or r_4; s_2 is the ordinary switch supplied with the electrometer which short circuits the quadrants when moved to its central position, and in its two other positions reverses the charge on the quadrants; G is a condenser, which can be varied from 0·001 to 1 microfarad, its capacity being one microfarad during the experiments, the results of which are given in Table II.

Before giving the results of the experiments, it is well to explain the method adopted of treating the curves for the purpose of arriving at the average watts due to the alternate current, the relation between which and the deflection of the electrometer used as a wattmeter it is desired to find. It is also necessary to examine the limits of accuracy obtainable by this method. In any one experiment the frequency employed is kept constant as nearly as possible; the phase difference between current and potential is adjusted to any desired value, and the amplitude of these quantities is kept constant by observing their square root of mean square values on the instruments, D and F. The revolving contact maker, M, is then set to different positions of the phase, the number employed being at least ten equal divisions to the half period, and for each position, readings taken on the electrometer, Q_2, when the switch, s_1, is in each of its two positions. If the deflections so obtained be plotted in terms of the position of the revolving contact maker, M, the forms of the two curves are those due to the instantaneous values of the potential difference applied to the needle of the electrometer, Q_1, and the current which gives the form of potential difference applied to the quadrants of Q_1. By multiplying each of these deflections together, and by a suitable constant involving the square of the sensibility of Q_2, and the resistances, r_1, r_2; r_3 or r_4; r_5, r_6, the instantaneous rate at which work is being done by the alternate current can be inferred in watts. The average of these over a half period gives the average rate, and this can be obtained by plotting the instantaneous product and taking the area with a planimeter, or the average of the algebraic sum during a half period can be taken. The author found the latter method agreed so well with the former when the number of intervals at which observations are taken is ten, that he has adopted it in this paper, that is to say, the two electrometer deflections for a given position of M are multiplied together, the average of these taken over half a period, and such average multiplied by a constant to reduce to watts.

The best way, perhaps, to test the limits of accuracy is to adjust current and potential until they are exactly in phase. The voltmeter, F, and amperemeter, D, give the square root of mean square values, and the product of these should agree with the average results obtained from the curves. The time required to take one set of observations is generally about 20 minutes, during this time an average for volts, amperes, and frequency is taken. The author finds from experience that if care be taken an agreement between the results got from the curves, and from the product of volts and amperes, can be obtained to within 1 or 2 per cent. It must be remembered that for each position of the contact maker, *four* observations on the electrometer (Q_2) scale have to be obtained; that is, two for potential and two for current corresponding to the two positions of s_2 for each position of s_1, the difference in each case giving the net double deflection. This method is best, as it eliminates any zero error there may be. In working the electrometer, Q_2, a wooden tapper or mallet is employed, since in every electrometer there must be viscosity due to the fluid, and by gently tapping the slate base for each deflection very consistent results can be obtained. This viscosity is greater in winter, and it is advisable to keep the instrument in a warm room, although with this method of tapping the author does not find this necessary. The greatest trouble in the use of the electrometer undoubtedly arises from dust settling on the surface of the acid in the jar, thereby making the angular movement of the wire hanging from the needle smaller than it would be if such brake action did not exist. This takes place when the acid in the jar is old, and if the surface be agitated by blowing through a glass tube near where the wire dips into the acid it can be to a great extent remedied. Whatever the state of the acid the author finds he gets the most consistent results by gentle tapping. The electrometer, Q_1, is not so sensitive as the old form Q_2, and the effect due to the acid in it has not given so much trouble. The sensibility of Q_2 when the idiostatic gauge is adjusted is such that one Clark cell gives a deflection from zero of $10\frac{1}{2}$ inches on a scale 12 feet from the mirror. The potential of the needle is in this case about 350 volts.

(*To be continued.*)

* A full description of these machines is given in the *Phil. Trans. Roy. Soc.*, Vol. 187 (1896), A. p. 231.

INSTITUTION OF ELECTRICAL ENGINEERS.

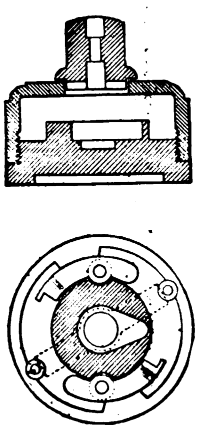
On the Manufacture of Lamps and other Apparatus for 200-Volt Circuits. By G. Binswanger Byng, Member. (Paper read February 24th, 1897.)

(*Continued from page* 272.)

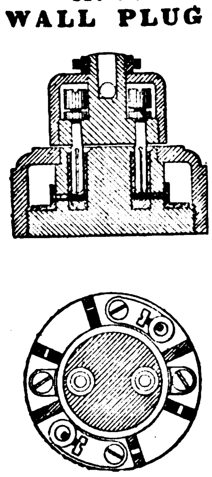
Without enlarging upon the subject of switches to an undue extent, I will show some specimens of different types I find to be satisfactory in practice.

Here (1) is a switch to take the place of the ordinary link or tumbler switch, and (2) here is an ordinary double-break china switch. You will notice the formation of the china base, and the

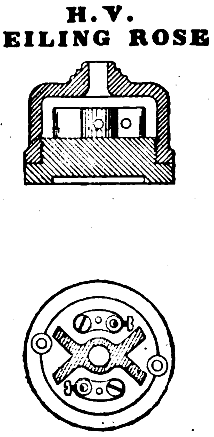
H.V. DOUBLE BREAK SWITCH



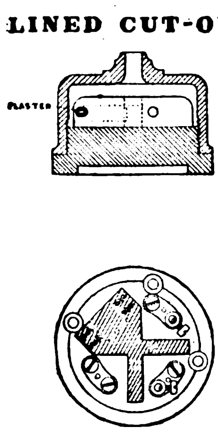
H.V. WALL PLUG



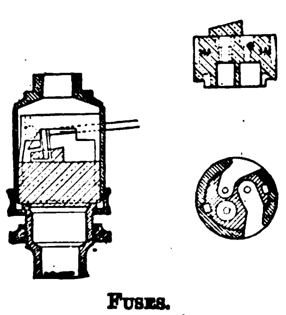
H.V. CEILING ROSE



H.V. CEILING ROSE LINED CUT-OUT



H.V. KEY SOCKET



Fuses.

separation and action of the metallic parts, which are arranged to produce a long break and perfect insulation, so that an arc cannot be maintained if established, nor can a shock be communicated to the operator. I have also placed there enlarged drawings of wall sockets and ceiling roses, to illustrate my further remarks under this heading.

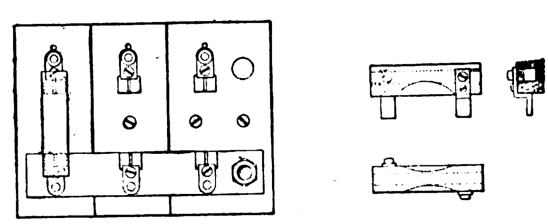
It is not necessary to go deeply into the subject of fixtures such as electroliers, pendants, &c., but in connection therewith I wish to refer to the question whether it is advisable to recommend the use of two or more low-voltage lamps in series on a 200-volt circuit. Within my own experience, I know of several installations fitted originally with 200-volt lamps that have, by reason of greater expense for current, and an inferior light, been re-wired for two 100 lamps in series, with satisfactory results. It is within the province of manufacturers to materially assist wiremen by designing fittings specially adapted to series wiring, such as series holders, ball fittings, brackets, or electroliers with arms in multiples of two, and such a practice might be extended with advantage to many other details.

The question of fuses for higher voltage requires more careful investigation, and would repay thorough discussion. Central station engineers agree to differ upon the various points of efficiency, as evidenced by the different rules issued for our guidance. Some lay stress upon increasing the length of fuse wires, others insist upon ventilation holes, and in some cases the height of covers are to be increased. But there is no unanimity between them, and none of these rules, in my opinion, indicate the right direction.

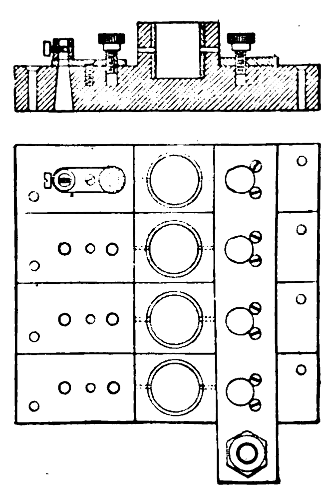
I have made some extensive experiments, and believe that the results are of interest to the profession generally.

When a circuit is opened by the disruption of a fuse, the combined metallic vapours and hot air produced by the high temperature of the resulting arc may extend and maintain it so as to bridge over the terminals which, melting and becoming volatilised, feed the arc, and rapidly increase the temperature. I find, in practice, that under these conditions the china base supporting the fuse and terminals is easily volatilised also, and not only contributes towards the maintenance of the arc, but is ruptured as if by explosion, tending to set fire to any inflammable surroundings. This rupture has hitherto, I believe, erroneously been attributed to the expansion of air confined by the cover, hence the ventilation holes, which, according to my opinion, are useless. The same experiments tend to prove the fallacy of using a long fuse wire, with the concomitant disadvantages of finding space for it, and also difficulty in renewal; and I feel sure that full efficiency may be attained with a short fuse.

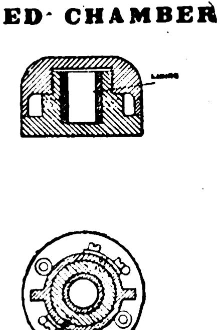
H.V. CUT OUT BOARD
SPRING CLIPS FOR HOLLOW CHINA FUSE HOLDERS



H.V. CUT-OUT BOARD WITH LINED CHAMBERS



H.V. CHINA CUT-OUT LINED CHAMBER



My deductions from the aforesaid experiments are that:—

1. It is essential to arrange a fuse wire so that it will break at a definite part of its length, *i.e.*, approximately, the centre.

2. The arc formed on breaking the fuse must be so confined that it cannot be maintained so as to damage the terminals, base, or cover.

I will now describe how I have carried out these essential points in china cut-out boxes, which are the general type of fusible cut-outs used in house installations in this country.

These fuses are arranged on china bases or in groups upon cut-out boards, and their carrying capacity varies from 1 to 100 amperes. In all these I provide what I call a "fuse chamber"—*i.e.*, a round china wall forming a central hole, from ½ to 1 inch in diameter—and this is pierced with two holes near to the terminals, which are fixed upon the base outside the wall. The wire is threaded through the holes from one terminal to the other, passing through the fuse chamber. Both ends of the fuse wire are supported by a material which is a better heat conductor than air, whilst it is free in the central fuse chamber. Thus the same current raises the temperature of the fuse wire within the fuse chamber more rapidly than at the supported ends, therefore the disruption takes place there, and the resulting arc is enclosed. I find, however, that china as an isolator is not sufficient, because of its tendency to volatilise under the high temperatures—a fact I have already mentioned. Therefore I line the interior of the chamber with another material which is a better heat conductor and less liable to fracture, and I find that ordinary plaster of Paris is most convenient for this purpose, although several other substances may be equally efficient.

Fuses constructed on this principle require but a short length of wire, and are perfectly safe on high voltages, and the general appearance and size does not differ to any great extent from those now in common use. The principle once established of surrounding part of the length of fuse wire with a substance that is a better conductor of heat than air, we can easily construct any other type of fuse upon the same principle.

Fuse wires enclosed in glass tubes filled with plaster or cement, but with a free central space for fusion, for instance, fulfil the same conditions.

I find that such fuses have been patented by Mr. Mordey in 1890. The mere fact of enclosing a fusible wire in a non-conducting refractory filling would not fulfil the essential functions of a perfect fuse as I have described, without a clear space at or about the centre for disruption. Mr. Mordey describes such a space in his specification, but it is for the purpose of observation only, and it is not clear, from the tenor of the specification, that the inventor had this purpose of the localisation of fusion in mind. Mr. Miller, of Kensington, has also altered the ordinary Edison fuse by substituting thin copper wire, and partly filling the centre with asbestos fibre. So far as localising the point of disruption and confining the arc, this fuse acts very well, although copper or alloyed fuses are not perfect under any circumstances, by reason of the maintenance of a dull red heat under normal load.

Arc Lamps.

Coming, now, to the subject of arc lamps in relation to the higher pressure, I do not see that, with alternating currents, the increased potential materially affects the consumer. The practice may bring a single-parallel system into vogue, with economy coils—an alteration which will, in my belief, increase the commercial efficiency of alternating arcs. But the disadvantages are apparent in the case of a continuous current circuit. For instance, in small installations of one or two lamps on the 100-volt circuit, these must be doubled on the 200-volt circuit, or useless resistances interposed. To equalise the conditions it has been proposed to substitute low current lamps, say, four 5-ampere instead of two 10-ampere lamps.

As this substitute has been advocated by one of the foremost central station engineers, and many others will possibly follow him, it may be useful and not out of place to prove that both in theory and practice low current arc lamps are deficient in points of economy and efficiency.

It is generally accepted that the current density of an arc is independent of its size; assuming this as correct, the area of an arc must be proportional to the current, and the cooling surface proportional to its diameter. This is the case with the cooling surface of the carbons, if these are used of areas proportional to the current taken by the lamp. Thus the cooling effect of the atmosphere will have a direct relation to the diameter of the arc and to the square root of the current. Therefore, for illumination, large arcs are more efficient than small ones, and the practical arc is attained when the benefit of increasing the number of light centres balances the inefficiency of small arcs. This gives, in practice, an arc of about 10 amperes.

Small arcs worked under same conditions are more unsteady than large ones, which is due to the fact that with an arc of a given length the E.M.F. decreases as the current increases. An experiment in which a fixed length of arc at 5 amperes and 44 volts was suddenly increased from 5 amperes showed—

Normal	5 amperes	44 volts.
Sudden increase from	5 to 6 amperes ...	40·5 „
„ „	5 „ 7 „ ...	38·5 „
„ „	5 „ 8 „ ...	37·2 „
„ „	5 „ 9 „ ...	36 „
„ „	5 „ 10 „ ...	35·2 „

So an arc, or series of arcs, with a total voltage approximating to the E.M.F. of the circuit is unstable and fluctuating—probably due to the disproportionate variations of the cooling surface, coupled with the decreased resistance of carbon at higher temperatures. If the arc flares, the current will increase, unless there is sufficient resistance in series to reduce the voltage across the arc at a greater rate than the above figures show. Certainly the mechanism tends to lengthen the arc, but to no advantage because the movement continues until the current decreases to the normal value, and the acceleration would extinguish the arc unless an interposed resistance allowed of a rapid increase of the voltage across the arc. Such a resistance is necessary to compensate the "negative resistance" of the arc, which may be more appropriately termed "decreased cooling surface per ampere." An additional resistance in series is necessary to ensure steadiness. It follows, therefore, that 5-ampere lamps must be worked on a higher E.M.F. or "pumping" will ensue.

(*To be continued.*)

TEST OF THE CHICAGO STORAGE BATTERY ROAD.*

The carefully conducted test of the plant of the Chicago Electric Traction Company furnishes the most valuable data at present obtainable regarding the application of the storage battery to street railway service. The vital question of the cost of battery maintenance is still an open one, yet the batteries tested have shown a better record than any of their predecessors. The results of the tests make a good average, showing just about what might be expected from a trolley road operating under the same conditions.

It may be well to preface the test with a sketch of the history of the company and a description of the equipment. The conception of the road was for the purpose of booming real estate in the south-western portion of the city. The company was chartered early in 1894 with a capital stock of $2,500,000, and almost from the beginning it has laboured under financial difficulties. In 1895 a majority of the bonds were placed with parties interested in the manufacture of storage batteries with the understanding that battery cars should be run. The company owned six franchises, covering 36 miles of streets, but nearly all the tributary territory is very sparsely settled. In a short time the company became insolvent, and in January, 1896, G. Herbert Condict was appointed receiver. Under foreclosure proceedings the road was sold at public auction October 12th, 1897, to J. S. Bache for $260,000. E. R. Gilbert was appointed general manager of the company. Some idea of the traffic of the road is given by a statement of the receipts and expenditures in the receiver's report:—

	Passengers and miscellaneous.	Operating expenses.
January to June	$4,972	$9,188
June	2,482	3,224
July	6,045	4,609
August	7,045	6,048
September...	6,347	6,584
October 1 to 12	2,254	2,880

The main line extends from the northern terminus at South Park Avenue and 63rd Street, the intersection with the Alley L, south to Englewood, Washington Heights and Blue Island, and a branch runs from Morgan Avenue West through Morgan Park. The line passes several summer resorts and three cemeteries; a large summer traffic results from the former, and for the latter a car, specially designed for funerals, is in operation. On the Morgan Park line a grade of 9·3 per cent. is encountered for a distance of 371 feet on Prospect Avenue. This gradient was insurmountable for a car equipped with one 50-H.P. motor geared to one axle only. A counter weight system was installed which is almost a duplicate of the one in Providence, R. I., designed by M. H. Bronsdon and J. P. F. Kuhlman, and described in the *Review*, April, 1896. There are 23 miles of track now laid, of which 19 miles are double.

After the decision to use storage batteries was reached, B. J. Arnold and J. H. Vail were employed as engineers to plan the entire system. All the designs follow the most approved line of engineering practice, and no pains were spared to make it a model of its kind. From the boilers to the batteries everything was designed with a view to economy and convenience. Perhaps this is the first time that the storage battery has been given an honest and prolonged trial in this country, and if it is capable of successful operation in street railway service it should be demonstrated in this system.

The track, which was constructed by C. E. Loss & Co., is the very best, for this was essential to long life for the battery plates. Johnson 7-inch girder rails, weighing 80 lbs., and resting on tie plates, are joined by 6 bolt fish plates with tie rods at every joint. Oak ties, 8 feet long, are placed 2 feet between centres, and rest on 6 inches of gravel ballast. The construction, with the absence of trolley wires and rail bonds, appears as though it were intended for steam traffic.

The power station is worthy of note, for it is certainly different in many respects from any other railway station. It is not necessary to locate the power house at the "centre of gravity" of the system to get the most economical current distribution, so a site was selected at 88th Street and Vincennes Avenue, convenient to the Rock Island railroad, and where land is cheap and transportation for fuel good. Car tracks run through the loggia, and above this are the offices, locker room, shower baths, toilet rooms, and waiting rooms for the employés.

Unlike street railway stations in general, the dynamos are not all of the same voltage, for it is necessary to have three circuits of different potential to charge the batteries properly. Four six-pole, 190 kw., shunt wound Walker generators, with a variable voltage between 160 and 190, were installed. This is the ultimate dynamo capacity of the station, the fourth machine being held in reserve. The dynamos are direct connected to two 250-H.P. Willans engines, the kind so generally used in the electric power stations of Great Britain. These two engines are at either end of the room, and a third one, of 500 H.P., will be put in the centre. To give the most flexible arrangement, the Arnold system of power station construction was adopted. A solid shaft with couplings extends from one engine to the other. The armatures of the generators are fixed to quills, which are free to rotate about the solid shaft. This makes a very complete and compact engine generator installation, a 1,000 H.P. plant occupying a floor space only 12 feet × 56 feet. Each engine has two sets of cylinders, the cranks being opposite to one another. The steam, entering the high pressure cylinder, from the steam chest, expands through the hollow piston rod into the receiver space below, ready to act on the following piston. An air cushion takes up the momentum of the moving parts and permits a speed of 380 r.p.m., without excessive noise or vibration. The speed is regulated by a throttle valve in the steam pipe controlled by a centrifugal shaft governor.

Just to the rear of the power units is the white marble switchboard, consisting of five panels, one for each generator and the fifth for the motor switches. There are four bus bars, the three lower ones being for the high, medium, and low voltages, and the top one

* *Street Railway Review.*

the common negative bar. Each panel has two switches, one for the negative lead of the generator after it has passed through a recording ammeter and circuit breaker, and the other switch can be turned through a semi-circle making connection with any of the three positive bus bars. Weston illuminated dial ammeter and voltmeter and a resistance box for controlling the voltage are attached to each generator panel. From the motor panel the circuits are controlled which run to the two battery transfer cars, the car transfer tables in the basement, to the cooling tower motor and the other motors in the building. By means of the circular switch in the centre of the motor panel, the motor bus bars can be connected to any of the three positive bus bars, or the motors can be operated from the car batteries when the generators are not running. The engine room presents a very attractive appearance, being finished with white marble floors and wainscoting, and visitors' gallery.

The passageway to the boiler room is behind the engines and by the condensers in the basement. There are three 200-H.P. Heine water-tube boilers, with room for three more. Coal is delivered on a side track back of the boiler room, where it is intended to have the fuel transferred direct from the cars to the iron platform in front of the boilers, about 7 feet above the floor. From here it is shovelled into the hoppers of the Roney stokers.

The smoke stack, which is located about 30 feet outside the building, is constructed of steel, is self-supporting, 7 feet in diameter and 150 feet high. It rests on a brick foundation, raising it to 22 feet above the ground. Connection to the boilers is made through an iron flue back and above them and through a brick flue entering the brick base of the stack. A Green fuel economiser, having 192 tubes, is in the brick flue; a by-pass is also provided for service when the economiser is not in use. Adjoining the stack is a Worthington cooling tower, 12 feet in diameter and 30 feet high. The condenser pump delivers the condensed steam and heated injection water to the top of the tower, and here, by means of revolving pipes turned by the pressure of the escaping water, it is sent in sprays over the tops of sewer tile set on end in tiers. During warm weather a large fan, driven by a Siemens-Halske motor, cools the water by evaporation, so that when it collects in the condenser well its temperature is about 80° F. The feed-water pipe taps into the condenser discharge before the pipe reaches the tower.

The supply of feed-water comes from an artesian well and from the city mains, but by the arrangement of the jet condensers and the cooling tower, the amount taken is only sufficient to make up for the waste due to evaporation. The water can be taken through a heater, which receives the exhaust from the auxiliary pumps, and through the economiser into the boiler, or either of the heaters can be cut out if necessary. The economiser not only heats up the water to the boiling point, but also acts as a reservoir with a supply of hot water which increases the duty of the boilers. The steam is supplied to each engine through a 6-inch pipe, having a copper expansion bend, and the engine exhaust is conducted to jet condensers.

The most unique and interesting features of the plant are to be found in the battery room, which is in the basement under the car barn. The car battery consists of 72 cells arranged in 12 rows of six each. These cells each have nine plates, 7¾ inches wide and 14⅛ inches long, five of which are negative of the "Chloride" type and four positive of the "Tudor" or "Manchester" type. The positive plates are $\frac{5}{16}$th inch and the negative ½ inch thick. Each cell, including plates, electrolyte and hard rubber jar, weighs 100 lbs., making the total weight for a tray 7,800 lbs. The plates are connected by electrically welded lead strips in four groups of 18 cells, each group being joined by flexible cables to two large brass plates on the sides of the trays. A loose fitting rubber crate over the top of the batteries prevents the electrolyte from splashing out of the jars.

By means of the three separate generator circuits the batteries can be charged at three different potentials as the counter electromotive force in the battery rises. The discharged battery is first connected to the 160-volt main with a current of 150 amperes flowing. The current decreases as the counter electromotive force increases, and when the current diminishes to 30 amperes, the battery is switched into the 172-volt circuit. The current jumps to 150 amperes, and diminishes again, and then the terminals are transferred to the 176-volt circuit. This operation can be accomplished in about 40 minutes, although a slightly better battery efficiency is shown when the time is longer.

After the batteries are charged the next important step is to get them in the cars expeditiously, and this is accomplished by a travelling carriage which runs along the track in the alley alongside the battery tables. On either end of the carriage is an elevator with rolls on top which are operated by bevel gears. Similar rolls are on the charging tables, which can be coupled to the elevator rolls and the trays automatically shifted. In the middle of the carriage is the operator's platform, with a controller for each of the motors, two of which are for the rolls, one for each elevator and one to run the carriage along the track.

When a discharged battery on a car is to be replaced a charged one is rolled upon one of the elevators and the carriage is run to a position where the vacant elevator is directly beneath the track in the loggia. The car, at the end of each round trip, runs into the correct position, which is determined by the vertical position of a lever the conductor lifts so that the front bumper of the car just touches it. The vacant elevator of the carriage is raised and the discharged battery released from the car by pulling a lever. When it is lowered the carriage is advanced so that the charged battery is beneath the car truck. The battery is elevated, the hooks automatically engaging the cross bars and the brass plates on the sides of the trays making a sliding electrical connection with the spring clips on the car trucks which are the terminals of the controller cables. The entire operation can be performed in 50 seconds, although the customary time is a little over a minute. The carriage then carries the discharged battery to an empty charging table, where it is rolled from the elevator and makes electrical connection with the charging circuit. The battery room, although well ventilated, is filled with the fumes of sulphuric acid. This disagreeable condition could probably be obviated by having hoods over the charging batteries and the fumes conveyed to the stack.

There is provision in the car barn at present for 28 cars, but it will be extended eventually to accommodate 50 cars. The transfer table, operated by an electric motor, runs on a track down the centre of the barn. No special tools or preparations have been made for repairs. Besides the regular equipment of cars, a 3,500-gal. sprinkler is provided for summer and a snow plough for winter.

The motor cars are mounted on Dupont trucks, made by the Johnson Company. Each truck has two bars running across the frame and engaging hooks, formed by bending over four 5-inch channel irons, which pass under the tray. A 50 H.P. Walker motor is suspended on the outside of the car axle. The controllers, made by the Walker Company, had to be of special design for the service, as the low voltage necessitated large currents. There are five points: the first combines four sets of batteries in parallel, giving 36 volts; the second gives 72 volts with the cells in series-parallel; the third puts the batteries in series with resistance; the fourth cuts out the resistance but leaves the batteries in series, and the fifth shunts the motor field with the batteries in series.

During the summer of 1897 over 20 motor cars were operated, often with trailers, and when the winter schedule of nine cars was instituted, Mr. Condict, then general manager of the road, decided to make a complete test of the road and power house to determine the most economical methods of operation. Under the direction of George A. Damon, who was assisted by Prof. Gaylord and a corps of students from the Armour Institute, three complete tests were conducted under actual operating conditions. The following is an abstract of the report of the tests for which we are under obligations to Mr. Condict. We are also indebted to Mr. Damon for courtesies extended.

Test of Power Plant.

The equipment of the power house has already been described. In preparing for the tests all proper precautions were taken to secure accurate data. The apparatus used was carefully calibrated. The water was measured by means of three tanks just before it entered the feed pumps. The steam used by the stoker engine, by the economiser engine, by the calorimeters, by the feed pump, and by the air pump was condensed and carefully measured. The blow-off from the boilers and other unused piping was opened up to guard against the water escaping through unknown leaks. All water not accounted for by the auxiliaries was charged against the engines, with the exception of a liberal allowance for leakage in the live-steam line.

The first test was with the plant running with two boilers, two engines and three generators. The second test was with practically the same load carried by one boiler, one engine and two generators, while the last test was made under practically the same conditions as the second test, with the exception that the three-voltage method of charging the batteries was abandoned. In this test but one generator was used, and the batteries were charged in successive sets, all at a common potential, the voltage being raised as the batteries became charged in such a way that the load upon the generator was kept nearly constant.

The coal used was from Fairmount, W. Va., and cost, delivered at the power house, $1.90 per ton. An average of five determinations of its calorific value by the Berthier method gave 10,145 British thermal units per pound. The average of six analyses gives the following result:—

Moisture	6·326 per cent.
Volatiles and combustibles	32·903 „
Fixed carbon	48·126 „
Sulphur	2·700 „
Ash	10·030 „

Card No. 7.—Taken 3.15 p.m. on November 26th, 1897.

——		M.E.P.	Horse-power.	
High-pressure cylinder,	North Line ...	59 85	31·14	...
do.	South Line ...	71·7	...	37·16
Intermediate receiver,	North Line ...	15 6	6 96	...
do.	South Line ...	15 8	..	7·04
Intermediate cylinder,	North Line ...	24·8	28·19	...
do.	South Line .	26 7	...	30·55
Low-pressure receiver,	North Line ...	5·85	6 38	...
do.	South Line ...	5·73	...	6·25
Low-pressure cylinder,	North Line ...	8·18	24 90	...
do.	South Line ...	8 81	...	26·81
Transfer chamber,	North Line ...	4·92	14·88	...
do.	South Line ...	4·12	...	12·46
Horse-power,	North Line ...	...	112 45	...
do.	South Line ...	...	...	120·27
Total horse-power	...	...	232 72	...

Revolutions per minute	373 3
Gauge pressure	182 0
Vacuum	25 5
Kilowatt output	139 4
Electrical horse-power	186·9
Efficiency	80 %

Eight indicators were necessary to obtain the horse-power developed by each engine. A typical record of one set of cards is shown in the table.

Cards were taken every half hour during each test. The results of the cards taken during the test of November 26th are shown in the following table:—

Time.	Card.	I.H.P.	E.H.P.	Efficiency per cent.
After test.	1	25 08	...	Friction.
After test.	2	32·36	...	Friction.
After test.	3	32·36	...	Friction.
3.15 p.m.	7	232·72	186 9	79 96
3.45 "	8	226·58	177·4	78 29
4.45 "	9	214·25	168 4	78·6
5.15 "	10	217 5	171·4	78 85
5 45 "	11	218 6	172·2	78 77
6.15 "	12	222 12	176·9	79·64
6.45 "	13	203 83	154·4	78·35
7.15 "	14	215 56	176 4	81·83
7.45 "	15	224 66	182·1	81·05
8 15 "	16	227·49	180·3	79 25
8.45 "	17	208 64	162·5	77 88
9 15 "	18	202 15	156 8	77 56
11 15 "	21	246 24	196·5	79·8
11 45 "	22	237 ·8	19[illegible]·3	80·

Average indicated horse-power, 217.
Average electrical horse-power, 172.
Average all-day efficiency, 79 3 per cent.

(*To be continued.*)

THE MAGNETIC PROPERTIES OF ALMOST PURE IRON.

By ERNEST WILSON.

Communicated by Dr. J. Hopkinson, F.R.S., to the Royal Society.
Received January 11th. Read January 27th, 1898.

One of the two rings of almost pure iron supplied by Colonel Dyer, of the Elswick Works, to Sir Frederick Abel, K.C.B., F.R.S., by whom they were sent to Dr. John Hopkinson, F.R.S., has already formed the subject of a communication,* and is herein referred to as Pure Iron I. As this pure iron has not been directly tested for dissipation of energy due to magnetic hysteresis, and the second ring was available, the author thought it would be interesting to examine its magnetic properties: it is referred to as Pure Iron II. The substances other than iron in this specimen are stated to be—

Carbon.	Silicon.	Phosphorus.	Sulphur.	Manganese.
Trace.	Trace.	None.	0·013.	0·1.

This ring has an internal diameter of 3·2 cm., an external diameter of 4·5 cm., a depth of 2·6 cm., and is wound with 61 turns for the secondary coil next the iron, and 49 turns for the primary or magnetising coils. The method of test † employs a ballistic galvanometer, and is that in use in the Siemens Laboratory, King's College, London, where the present experiments were carried out. The currents in the primary circuit were supplied by storage cells, and measured by balancing the potential difference due to such currents in a standard resistance against a Clark's cell. The current meter in the circuit was only used for convenience of adjustment.

Quoting from the communication above referred to, Pure Iron I. gives the following induction curve at atmospheric temperature:—

B....	84	118	467	2,700	7,060	10,980	14,160	15,590	16,570	17,120	17,440
H....	0·15	0·38	0·60	1·06	2·11	3·77	7·48	13·36	23·25	33·65	44·66

Pure Iron II. has been tested under two conditions: (*a*) as received, and (*b*) after careful annealing. The results are given in Table I, which also contains the results obtained by Prof. Ewing from a sample of transformer plate rolled from Swedish iron.‡ The figures of Prof. Ewing relating to magnetic hysteresis are exceptionally low, and although annealing has considerably improved the Pure Iron II., it is still slightly inferior to the transformer plate. On the other hand, the permeability μ of this pure iron after annealing is exceptionally high, having a value 5,490 for B = 9,000. The coercive force for maximum B = 15,270 is 1·13 C.G.S. units.

* *Roy. Soc. Proc.*, Vol. 52, p. 228.
† *Ibid*, Vol. 53, p. 352.
‡ *Proceedings Institution of Civil Engineers*, Vol. 126, p. 185.

Table I.

Limits of B in C.G.S. units per square centimetre.	Dissipation of energy by magnetic hysteresis in ergs per cycle per cubic centimetre.					
	Transformer plate rolled from Swedish iron (Ewing).		Pure Iron II. tested as received.		Pure Iron II. tested after annealing.	
		μ.		μ.		μ.
2,000	220	2,560	350	2,000	262	2,500
3,000	410	3,340	500	2,730	460	3,190
4,000	640	3,880	800	3,330	720	3,810
5,000	910	4,230	1,100	3,700	1,010	4,350
6,000	1,200	4,410	1,450	4,138	1,350	4,800
7,000	1,520	4,450	1,760	4,375	1,670	5,380
8,000	1,900	4,330	2,160	4,445	2,020	5,440
9,000	2,310	4,090	2,600	4,615	2,450	5,490
10,000		3,790	3,100	4,545	2,860	5,460
12,000			4,400	4,000		4,900
14,000			5,900	2,641		3,260
15,000				1,415		2,050

The figures in Table I. relating to Pure Iron II. after annealing have been obtained by interpolation from the actual observed data given in Table II. An induction density of 15,270 for H = 9·24 is higher than the author remembers having seen. In fact, for values of H below about 10 or 12 this specimen is exceptionally good, as is shown by the very high permeability.

Table II.

Limits of H.	Limits of B.	$\frac{1}{4\pi}\int H\,dB$.	μ	Coercive force in C.G.S. units.
0·783	1,965	262	2,510	0·50
1·14	4,840	...	4,245	...
1·17	5,150	1,080	4,400	0·73
1·42	7,500	...	5,280	...
1·66	9,100	2,490	5,480	0·90
2·23	11,460	...	5,140	...
2 68	12,500	...	4,660	...
4·74	14,270	...	3,010	...
9·24	15,270	...	1,650	1·13

Apparent Magnetic Instability.

Whilst making the foregoing experiments, the author noticed how great was the apparent magnetic instability in this specimen, and thought it worth to investigate this more closely.

It has already been noticed, and is well known, that if the magnetising force be varied from one maximum value through zero to a value equal, say, to the then coercive force of the material, that tapping the specimen will produce a considerable change of induction; or if the observed kick on a ballistic galvanometer (in circuit with a secondary coil wound on the specimen) due to such change be added to the observed kick when the magnetising force is raised to the opposite maximum, the sum does not equal the whole kick which would be observed if the force were at once varied from the one maximum to the other. During the interval the magnetism appears to continue to settle down, so that the change which lastly takes place is not so great as it would be if such apparent settling down did not occur.

Experiments were made to investigate the effect when the limits of B were (*a*) large and (*b*) small. It is assumed that the instrument gives the true time integral of current.

(*a*) Maximum B = 15,270, coercive force 1·13 C.G.S. units. The maximum force, H, of 9·24 C.G.S. units, was suddenly varied through zero to 1·13, and the secondary circuit kept closed until deflections to the left and right were observed, the periodic time of the galvanometer needle being 10·6 seconds. The scale is graduated from 0 on the left to 1,000 on the right, and the readings taken were 351, 623, giving a difference of 272, corresponding to a change of induction per square centimetre of 12,630 C.G.S. units. When the magnetism had settled down, as was shown by closing the secondary key with no extra resistance in its circuit, and observing no deflection on the ballistic galvanometer, a suitable extra resistance was inserted, and the force suddenly raised to its maximum value, the observed deflections are 362, 627, the difference 265 corresponding to B = 12,350. These results were many times repeated.

The total change of induction produced a deflection 662, 330, the difference 332 corresponding to B = 15,270. We have, therefore, to account for a difference of 5,560, or 18 per cent. of the total change from one maximum to the other. The zero, when the spot of light is perfectly steady, is 495, and we can see that when making the first change from one maximum through zero to force, 1·13 the deflection to the left is 143 as against 128 to the right; whereas, when making the second change, the deflections are 133 to the left and 132 to right. There is evidence here of a change of continuing in the same direction, since the first elongation is greater than the second, and the decrement would only account for about 1 per cent.

This effect was next observed in a slightly different manner. The change of force from one maximum through zero to the then coercive force was effected, and the secondary circuit closed at known intervals of time after such change. The results are given in Table III.

TABLE III.

Time in seconds ..	0	1	2	3	4	5	6	10
Change of B, 10 cells exciting through extra resistance	13,600	4,030	1,990	927	576	285	175	42
Change of B, 56 cells exciting through extra resistance	13,800	3,690	1,680	944	529	256	...	40

It will be seen from the figures that about 30 per cent. comes out after the first second has elapsed, and that the result is practically the same, whether the charging potential difference be that due to 10 or 56 cells. With a total reversal from one maximum to the other no such effect was observed, the change taking place immediately. Having taken the force from one maximum through zero to a value equal to the then coercive force, the specimen was tapped four times with a piece of wood, and at each stroke it delivered 105, 40, 56, 30 C.G.S. units per square centimetre in the direction of acquirement of magnetism.

(*b*) Maximum B = 3,770, maximum H = 1·003. The force was varied from one maximum through zero to 0·620 and a deflection corresponding to B = 3,620 observed. The figures in Table IV. give the results obtained by closing the secondary circuit at known intervals of time after reversal.

TABLE IV.

Time in seconds	0	1	2	3	5
Change of B, five cells exciting through extra resistance ...	3,620	536	95	25	10

One would expect the maximum induction to be affected in this case, since it is on the steep part of the curve: the figures obtained are given in Table V.

TABLE V.

Time in seconds	0	1	2	3	5
Change of B, five cells exciting through extra resistance ...	3,770	796	23	14	6·5

The curve in fig. 1 shows this effect clearly; the points 1, 2, 3, for any force show the observed change of induction density B when the secondary key is raised ½ second, 1 second after reversal, and kept down permanently as in the ordinary way. When observing the deflections for the curve in fig. 1, the five cells used for exciting had placed across their terminals a condenser of 4 microfarads capacity.

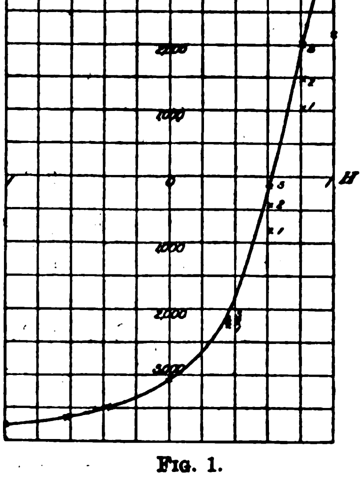


FIG. 1.

We are dealing with a very steep curve in these experiments, that is to say, the rising portion for the large forces is very nearly perpendicular. We observe that it is on the steep portions that these effects have been noticed, and such effects could very easily be produced by a slow change in the magnetising force. Such slow change might arise from the heating of resistances in the circuit, if these be of carbon; this was looked into, and only metal resistances used. The self-induction of the circuit might, if large enough, delay the magnetising current, and produce the effect. We have seen that it is practically the same, whether the applied potential be that due to 10 or 56 cells. In any case the self-induction can be approximately calculated in our case. Take the curve in fig. 1—we see B increases 5,750, whilst H increases 0·6. The total change is 9,860, since the cross sectional area of the specimen is 1·715 sq. cm. H = 0·6 corresponds to a change of 0·117 ampere, and, taking the volt as our unit and the primary turns at 50, we find L = 4·21 × 10⁻⁸, where L is the coefficient of self-induction. If E be the applied potential and R the resistance of the circuit, the current at any time, *t*, after closing the circuit, can be expressed by $\frac{E}{R}(1 - \epsilon^{-\frac{R}{L}t})$. For $t = \frac{1}{2}$ second the current has its maximum value within an exceedingly small quantity. But the method of experiment enabled one to test the rapidity with which the current rises to its maximum value. Let a balance be made, say, when the current is such that the force is equal to the coercive force of the material. Now suddenly reverse the force from its maximum through zero to this value. The immediate depression of a key tells at once if the current is still balanced. The current, immediately after reversal, that is to say, within ½ second, had certainly attained its normal value to within 0·3 or 0·4 per cent.

The condenser had no material effect upon the rapidity with which the current attained its maximum value. We can only conclude that the effect is peculiar to the iron itself, and might be influenced by induced currents, since the ring is not subdivided. The subject of propagation of magnetism as affected by induced currents has been dealt with in the case of a magnet having a core 12 inches diameter,* and a magnet having a diameter of 4 inches.† Imagine that the cross section of our pure iron specimen is circular instead of rectangular—it would have a diameter of 14·8 mm. If we assume equal conductivities and magnetic properties, we can infer, roughly, from the 12 and 4-inch magnets, what the effect of induced currents in our specimen would be.

Take the 12-inch magnet. For reversal of maximum H = 2·4 the effects had died away in about 400 seconds. Similar events will happen in the pure iron core, but at times varying as $\left(\frac{14\cdot8}{305}\right)^2$: that is, we should expect the effects to have subsided in 0·85 second.

Take the 4-inch magnet. For reversal of magnetism H = 1·7, the effects had subsided in about 40 seconds: $\left(\frac{14\cdot8}{101\cdot6}\right)^2 \times 40$ gives 0·94 second.

It is, therefore, probable that the induced currents in the Pure Iron II. may have something to do with the effects observed in this paper, although it is difficult to account for such times as five and 10 seconds, unless the molecule itself is considered. This effect has been observed in laminated specimens.

The difficulty of working with alternate currents, if the core be subdivided, in order to investigate the effects observed, using the method in the *Proceedings of the Royal Society*, Vol. 53, p. 352, is the necessity for the very accurate control and measurement of the magnetising force. Small variations of this force would at once mask the effects observed. In the paper just mentioned a considerable difference was observed between cyclic curves obtained with the ballistic galvanometer, and by means of alternate currents having frequencies of 72 and 125 per second in the case of a laminated hard steel ring for maximum B = 16,000. On the other hand, no such difference was observed in the case of a laminated soft iron ring when maximum B was 4,000.‡ It would seem from the experiments in this paper that the amplitude of induction would not be so great for high frequency and small induction density, B, and this is of importance in the case of iron cores for transformers. It is worth noting that when working on solid rings with the ballistic galvanometer, induced currents may account for apparent magnetic instability.

Mr. H. H. Hodd has helped me in the experimental part of this paper, and I here wish to tender him my thanks.

A $1,000,000 GUTTA-PERCHA SCHEME.§

THE Gutta-Percha Corporation, Limited, with $1,000,000 capital, was "floated" in London in December. The object is to acquire the Sérullas patents for extracting gutta-percha from the leaves of the *Isonandra dichopsis* and other trees of that family.

The London *Financial Times*, not inaptly, headed its notice of the new corporation "Stale Eggs for Sale." Readers of the *India-Rubber World* will remember that, so long ago as 1892, Hippolyte Eugene Sérullas, who had gone to the East Indies at the expense of the French Government to report upon the gutta-percha supply, read before the Société d'Encouragement pour l'Industrie Nationelle, an account of his discovery of a method of extracting pure gutta-percha from leaves and twigs, instead of destroying the trees, as is so common in Borneo. Patents were granted subsequently to Sérullas, in conjunction with Felix E. Hourant, in several countries, and the rights under these patents are involved in the above scheme. In England two patents were granted—No. 11,116 of 1892, and No. 654 of 1896. In the United States there is one patent—No. 575,739. In spite of the publicity of M. Sérullas's idea for so many years, and the fact that the owners of the patents have been ready at all times to realise upon them, the fact that no attempt has been made to work the idea on a commercial scale implies a general lack of confidence in its value.

But Sérullas is not alone in having a method for extracting gutta-percha from leaves. Another Frenchman—Dieudonné Rigole—has been in the field with a patent for this purpose for several years.

* *Journal of Proceedings of Institution of Electrical Engineers*, Vol. 24, Part 116.

† *Phil. Trans.*, Vol. 186, A, pp. 93—121.

‡ See *Electrician*, September 9th, 1892.

§ *India-Rubber World.*

The British issue was No. 4,252 of 1892. The *India-Rubber World* in September, 1893, published a prospectus of the Gutta-Percha Manufacturing Company, with $600,000 capital, to exploit Rigole's method. Nothing coming of this, the Borneo Gutta-Percha Plantation and Produce Company, Limited, with $300,000 capital, was projected, as we reported in May, 1894, but nothing more has been heard of that enterprise.

By the way, the new Gutta-Percha Corporation excepts Brazil from the scope of its operations, the G. P. Brazil Syndicate. Limited, having been registered in London on April 1st, with £5,000 capital, to acquire and develop the rights of Sérullas, so far as they relate to Brazil, in the process for extracting gums from the leaves of trees. The intention is to apply the method to India-rubber. But while all the terrestrial rights under these patents have been monopolised, no doubt the vendors would entertain negotiations for rights to develop the patents on all the seas, in the milky way, and on the next comet that may be headed toward this planet. These might afford a richer field than even the forests of Borneo.

"THE COMING OF THE ELECTRIC HORSE."

Lecture by Prof. S. P. Thompson.

This was the subject of an address delivered on Thursday evening in the Agricultural Hall, Wolverhampton, by Prof. Silvanus P. Thompson, D.Sc., F.R.S., Principal of the City Guilds Technical College, Finsbury, and who is this year president of the Wolverhampton Literary and Scientific Society. The address was exceedingly interesting. Prof. Thompson pointed out that we are reaching the limit of the capacity of steam power, and therefore we must look around for something superior, and that he affirms is electricity. We are, in fact, entering upon a revolution quite as momentous as that of the supercession of animal power by steam power. Electricity has served us in telegraphy for about 50 years, and in lighting for about 20 years, but its use in heavy motive power is just beginning. As far back as the time of the wedding of the Prince of Wales, London Bridge was illuminated by arc lamps, but it was at enormous cost, the energy being derived from Grove's batteries, now we use dynamos. The latter became possible as early as 1831, when Faraday discovered the mechanical mode of generating electricity, by the motion of a magnet within or around a coil of wire, but it was not till 1878 that this motion was supplied by the steam engine. Then it was that electricity began to be available for use on a large scale of lighting, and for heavy mechanical work. The first electric lighting station put up in London was at Paddington Railway Station, and the dynamos there constructed, are still at work. Since then, however, the capabilities of electric lighting plant has enormously extended, and in one generating station, 30,000 horse-power is constantly employed. Many of the larger dynamos consisted of a pulley, girt with wire coils, and rotating within a circular frame, fitted with magnets. Electric motors of 50 H.P. had an efficiency of 92 per cent., with only 8 per cent. of waste, and motors of over 200 H.P. had an efficiency of 97 per cent. In the case of steam power unaided by electrical transmission, the efficiency was much lower. In one notable instance of eight engines of 40 horse-power average, the loss of energy in transmission through belting and shafting was 43 per cent., or nearly one-half. The works of the Electrical Construction Corporation, Wolverhampton, were the first in England to be fitted with electrical motors. The principle was being extensively applied to machine tools, and thousands of pounds were saved annually in consequence. A firm in Chester applied electricity to the cranes used for the carrying of steam billets, and in this case not only were the cranes moved by electricity, but the billets were raised by electro-magnets in place of the customary attachments of chains. Here a great saving of time, labour and fuel was accomplished. Mr. T. Parker, of Wolverhampton, had provided electrical plant for colliery purposes. Electrical motors, no larger than a lady's muff, could work at 2 H.P., and no energy was wasted while work was not being done. Messrs. Siemens, of London, had saved 3,000 tons of coal a year by the substitution of electrical wires and motors for belting and shafting; and much labour had been saved in addition. Some years ago he (Prof. Thompson) suggested that a motor house should be established at Soho, or Clerkenwell, London, for the benefit of the large number of small manufacturers there who required only a little power, and that not constantly. At present each one has to meet the cost of maintaining his own steam engine or gas engine; but under the plan suggested each would have a small electrical motor, connected with the generating station by wires. He would then take only as much energy as he actually required, and there would be no waste.

In concluding, Prof. Thompson spoke of the advance of electrical traction in the United States and the Colonies. The use of horse-power on the world's tramways had greatly declined between 1890 and 1897, the mileage being reduced from 5,000 to 900, while the mileage of electric tramways had increased from 1,262 to 13,000. The province of Ontario had 900 miles of electric tramways—more than in the whole of Europe. In New Jersey one could travel 40 miles at a stretch by electric trams. In many American cities the workers were now able to reside in the suburbs, slum dwellings had declined, and the health, comfort, and morals of the people had improved. Electrical energy was being transmitted from the Falls of Niagara to the neighbouring manufacturing towns, to the great benefit of those towns; and Rome was now lit by electricity, the energy being conveyed from the Tivoli Falls. He looked forward to the time when electricity would warm our houses and be the chief motive power.

Prof. Thompson, subsequent to the lecture, was present at a supper in his honour given by the members of the society, and in reply to the toast of his health, the President said that we in this country were several years behind America in respect to electric lighting, but we benefited by being behind. The Americans had been too anxious to make use of their inventions, and had spent money like water on miniature schemes. We had started later, and had had full benefit of later experiment and research. In America many of the earlier enterprises were not paying, while in England nearly all our electrical companies were in a sound financial condition, and paying a good, and in some cases, a splendid dividend. Electric lighting companies were, indeed, among the best forms of investment. Mr. Chamberlain was responsible for an Act of Parliament which had retarded enterprise of this character; but this retardment had been most profitable, for it had prevented great waste of money in wild-cat speculation in the execution of miniature schemes, and in the laying down of large quantities of imperfectly designed plant. We had waited and had begun on a sound and substantial basis. In Boston, U.S.A., three sets of machinery of electric lighting had been successively laid down, showing that it was possible to pay too dearly for progress.

THE SENTINEL CIRCUIT-BREAKERS.

The automatic circuit-breakers which are being introduced by the Sentinel Electric Company, of Wilmington, Del., depend for their action upon a principle which is claimed to be not only novel, but extremely effective and reliable.

The actual disruption of the circuit is accomplished by the destruction of a brittle metal bar which is included in the circuit, and which is provided with grooves to localise and insure the break.

The illustrations herewith show the single pole style of a type which, in its several sizes, is designed to protect electric light services of from 6 to 200 amperes at any voltage up to 250, and which is said to be adapted to alternating and direct current circuits with an equal degree of efficiency.

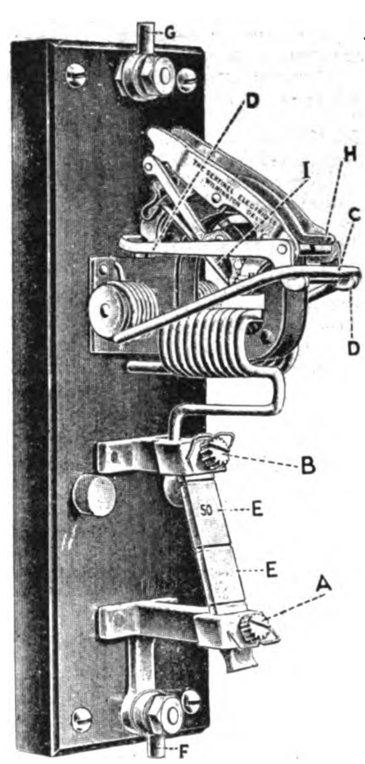


Fig. 1.—Sentinel Circuit-Breaker Set.

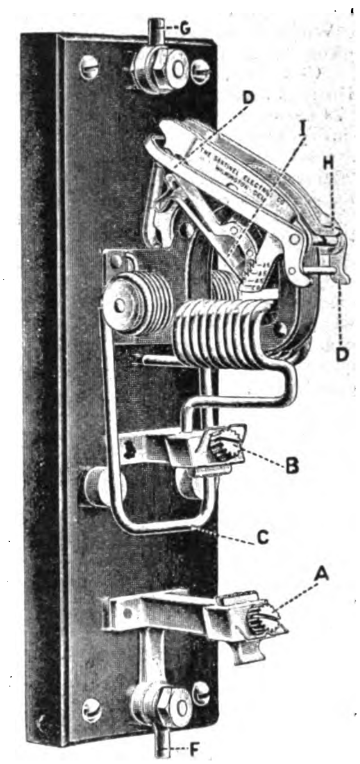


Fig. 2.—Sentinel Circuit-Breaker Discharged.

Referring to the accompanying illustrations, the breaking bar E E, fig. 1, is, upon the discharge of the circuit-breaker, struck and broken by the hammer spring C, as shown in fig. 2. When setting the device, with the upper mechanism D D, as shown in fig. 2, the operator raises the spring C, until it encounters and lifts the trigger H, when the lever D D will fall and leave the hammer spring set. A new breaking bar E E is then inserted after the stubs of the old bar have been removed.

Some of the advantages and important features which are claimed and guaranteed for this device are: (1) An annual inspection is all that the circuit-breakers require. (2) A perfect electrical connection is insured each time the device is recharged by the necessary insertion of the new bar. (3) Owing to their low ohmic resistance and the fact that they introduce no appreciable "lag" on alternating current, fuses may be replaced with no appreciable increase in the total losses. (4) The mechanical design of the device is such that vibrations do not affect it in any way, and once "set" it will remain so indefinitely unless the discharging point is purposely altered.

When the circuit-breakers are employed to protect light services, it is claimed that they perform successfully the functions of both a switch and circuit-breaker, as the circuit may, in all cases, be closed by the insertion of a new bar and opened either by removing the bar or by discharging the hammer spring by hand, thereby destroying it. This feature is especially valuable in the case of a serious short circuit or ground on the service wiring. According to present practice, the operator upon finding a protective device "blown" is required to open the switch controlling the service; he then recharges the device and closes the circuit by closing the service switch. Under similar circumstances the Sentinel circuit-breakers merely require that the spring C be set, the old bar stubs removed by loosening the screws A and B, and a new bar M M inserted. If the abnormal load is still "on" the bar will be broken by the hammer spring the instant the former touches the upper bar holder, and such an action is accomplished without danger of injury to the operator.

A combined switch and circuit-breaker also involving the breakable-strip principle, but adapted especially to the protection of motors, has been perfected by this company, and performs in a novel and efficient manner the functions of both devices.

MOTOR-DRIVEN PRINTING PRESSES.*

As was to have been expected, printers have not been the last to avail themselves of the advantages which recent discoveries by the students of electric science have placed at the disposition of industrial enterprise.

The advantage is obvious of a system which renders it possible to locate presses and other printing machinery in any part of an establishment, exclusive of line shafting, and also to run any one press at any time independent of the others. With presses equipped with direct-connected motors, each can be run at any hour of the day or night, with an expense of power proportionate to the work done, instead of that requisite for running a boiler, engine and heavy friction load of shafting and belting.

What such a saving amounts to may be judged by an estimate made by Prof. Benjamin, of the Case School of Applied Science, of Cleveland, Ohio. In 16 establishments whose plants Prof. Benjamin tested, there was developed 1,808 horse-power, and of this 979 horse-power, or 51 per cent., was expended in driving the shafts, pulleys and countershafts, while all the machines were idle. There are cases on record in which the loss of power in transmission from engines to machines, through belts, is much higher even than this, ranging from 80 to 93 per cent. of the total power generated.

So direct an appeal to economy as is made by such facts as these has a strong tendency to increase the already rapid process of installation of electric power plants.

Another great advantage of direct-connected motor to the press or other machine is that an accident to the power does not affect the whole plant, as the breaking of a belt or the main shaft causes a complete shut-down until repaired. And this by no means infrequent occurrence very often assumes the proportions of a real catastrophe.

*From the *Inland Printer* (American).

NEW PATENTS.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents,* 322, *High Holborn, London, W.C., to whom all inquiries should be addressed.*]

3,645. "Arrangement for transmitting telegraphic messages in contrary directions simultaneously over a single wire." M. Bernstein, proprietor of the firm of J. F. Wallman & Co. Dated February 14th. (*Complete.*)

3,695. "Improvements in magnetic circuits or parts of circuits.' E. Wilson. Dated February 14th.

3,731. "Transmitting drawings, pictures, sketches, and the like by telegraph or telephone." J. M. Martin. Dated February 15th.

3,749. "A method of oxidation and bleaching by means of electrolysis." J. G. A. Rhodin. Dated February 15th.

3,783. "A new or improved method of and apparatus for generating electricity." C. O. Barrows and C. H. Smith. Dated February 15th.

3,796. "Improved means for displacing, dispersing, or extinguishing arcs formed in breaking electrical circuits." S. H. Short. Dated February 15th. (*Complete.*)

3,805. "Improvements in electrical switch apparatus." T. H. Minshall. Dated February 15th.

3,806. "Improvements in apparatus for making and breaking electric circuits at predetermined times." H. O. Swoboda. Dated February 15th.

3,808. "Improvements in impedance coils for enclosed arc lamps." G. Thomas-Davies. Dated February 15th.

3,827. "Improvements in blocks and electros and surfaces for printing from." G. T. Teasdale-Buckell. Dated February 16th.

3,838. "Improvements in electric accumulators." A. Webb. Dated February 16th.

3,841. "Improvements in the method of and means employed for connecting electric glow lamps to main conductors." F. Palm. Dated February 16th. (*Complete*)

3,850. "Improvements in holders for electric glow lamps." W. Giepel, F. M. T. Lange and W. R. Saltrick. Dated February 16th.

3,902. "Improvements in devices for protecting electric incandescent lamps from the action of moisture." H. Beau and M. Bertrand-Taillet. Dated February 16th.

3,905. "Improvements in suspension devices for electric and other lamps." P. G. Pasquet. Dated February 16th.

3,924. "Improved fastening for the heads of electric glow lamps." J. Kremenezky. Dated February 16th.

3,925. "Improvements in electric safety fuses and lamp connections." H. C. Gover and J. M. Moffat. Dated February 16th. (*Complete.*)

3,960. "Improvements in electric switches." J. Williams and W. M. Walters. Dated February 17th.

3,993. "Improvements in, or relating to, electric ignition devices for internal combustion engines." A. J. Boult. (La Société Nouvelle des Etablissements Decauville Aine, France.) Dated February 17th. (*Complete.*)

4,002. "A new and improved telephone support and an automatic circuit controller." L. Duque. Dated February 17th.

4,004. "Improvements in switches for altering the speed and direction of revolution of electric motors, and for altering the course of the electrical current round field magnets." W. R. Edwards and S. F. Beevor. Dated February 17th.

4,046. "Improvements in, or connected with, the distribution of electricity on the three-wire system with the neutral wire at earth potential." A. B. Blackburn, W. L. Spence and E. S. W. Moore. Dated February 17th.

4,075. "Improvements in methods and apparatus for electrothermally treating materials, more particularly for the manufacture of calcium carbide and other carbides, and the reduction of ores." H. Maxim. Dated February 18th.

4,114. "Improvements in telegraphic apparatus." F. W. Golby. (B. Fidler, Austria.) Dated February 18th.

4,121. "Improvements in telephones, telegraphs, and other forms of electrical signalling." E. Wilson and H. Godsal. Dated February 18th.

4,150. "Improvements in electrical accumulators or storage batteries." T. W. Allan and Allan & Adamson, Limited. Dated February 19th.

4,176. "Improvements in the distribution of electricity over electric railways." M. Cattori. Dated February 19th. (*Complete.*)

4,202. "Improvements relating to the displayal of words or devices by electrical illumination." W. J. H. Jones. Dated February 19th.

ELECTRICAL PATENTS OF 1884, EXPIRING IN MARCH, 1898.

We are informed by Messrs. W. P. Thompson & Co. that about 85 applications for electrical patents were filed in the month of March, 1884. Out of these some were never completed, and of those that were, only one has been allowed to run its full length of term, viz., 14 years, and being of interest we give a small abstract below:—

4,828. "Improvements in telegraph posts." J. Oppenheimer. Dated March 13th, 1884. Relates of the construction of forming telegraph posts of metal tubes of various oval sections. Thus strength and lightness are secured, and the attachments have no tendency to turn round the post.

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WEATHERPROOF WIRE.

THE subject of this article is not, as one might be led to suppose from the title, a wire insulated in such a manner as to be unaffected by exposure to the weather, and, therefore, equally good under all kinds of atmospheric conditions; but it is the wire covered with a painted braiding which is so commonly used for overhead circuits in America, and which has been christened "weatherproof" by some humourist, probably because the one absolutely certain characteristic of all such wires is that they are none of them proof against weather. In reply to an article in which the use of these wires was condemned, Mr. Alex. Dow has taken up the cudgels in its favour, and in the pages of an American contemporary, *Electrical Engineering*, gives reasons for his belief that these so-called weatherproof coverings have a value which warrants their use.

It is almost impossible for us, accustomed as we are to judge of such matters from the standpoint of what is necessary in our much-abused English climate, to imagine that any sane man would run circuits under the conditions named by Mr. Dow; and it is therefore interesting, as throwing light on the enormous difference of climatic conditions in the two countries, to learn the opinion of an American engineer who has had considerable experience of overhead lines, and who, although he states that in his opinion all high tension circuits are best underground, believes that overhead lines will continue for many years to come, and that with them will continue the use of the cheap weatherproof wire.

Now what are the conditions under which these wires are used? We are asked to picture to ourselves the overhead trunk lines of a central station, supplying, as is generally the case, alternating current at a pressure of 2,200 volts, and direct current for arc lighting at pressures up to 5,000 or 6,000 volts. We are told that this line will consist of poles 40 feet to 60 feet high, each having from four to eight arms, and carrying from 24 to 64 insulators and the same number of wires (in some cases this number may be increased to 100 or more) of which probably a third to a half are alive continuously during the 24 hours. We will complete the picture in Mr. Dow's own words: "Almost any day during dry weather there may be seen on the poles of such a trunk line workmen taking up slack, changing over, cutting, or taking down wires; or stringing new circuits or branches; and this work goes on while the adjoining circuits are alive—indeed, in many cases, the wires being handled also are alive. The work requires that the linesmen climb through and among the conductors. It is impossible that they should do this without touching conductors which are in use, and it is equally impossible in many cases to prevent the wire which is being manipulated from crossing or twisting around other wires on the same line. Under the conditions of the electric lighting business it is a very great convenience, and almost a necessity, that this work should go on without interruption of service dependent on wires strung on the same poles. With bare wires this would be impossible; with wires continuously covered with insulation no better than the common weatherproofing, it is entirely possible during fair weather, and it should never be attempted during bad weather."

To our English ideas, even though we may think that our own Board of Trade regulations are somewhat too stringent in some cases, it seems as though the engineer who set his linesmen to such work would be inviting an indictment for manslaughter; especially when we read in the same article that Mr. Dow recognises that the measured insulation of such lines would not be materially reduced if the wire were not covered, and that the best of the "weatherproof" wires will pass through a summer shower without breaking down, even though exposed to the full pressure by the crossing of adjacent conductors, but that a rain storm of three or four hours, inevitably means the breakdown of such a cross; and that the first rainy days of autumn may always be expected to produce a fair crop of burn outs and earths. That such operations as are described above, should be possible in any weather without great risk of injury to the linesmen seems inconceivable, especially as the braiding is by no means imperishable, and we are told that most of these weatherproof wires have to be renewed after four or five years; but, even allowing this, we would ask how it is possible to maintain such circuits in wet weather, and whether the objection to shutting down all the circuits, if there is a fault to repair or a branch to connect, does not in many cases lead line superintendents to allow linesmen to take the risk of working on the line at times, when owing to the weather, the covering of the wire cannot afford any appreciable protection.

Even allowing for the difference of conditions due to climate, we cannot but think that the risks incurred are far too great; and, although we fully recognise that there are many cases in which no electric circuits would be possible unless overhead construction were allowed, we do not consider that a trunk line of many circuits is a case in point, and we hope the time is not far distant when all such trunk lines will be put underground.

GAS MANTLES AND GLOW LAMP FILAMENTS.

In the New York *Electrical World* for January 22nd last, in the course of a leader, entitled "Electric Lighting and Gas," it is suggested that the efficiency of the glow lamp might be "enormously increased" by coating the present carbon filament, or incorporating with it, some of those oxides of the rare metals which are used in the manufacture of the Welsbach incandescent gas mantles.

This suggestion is made on the assumption that the light emitted from these oxides is solely due to their being raised to a high temperature; so that if, by any device, they could be coated on, or incorporated with, an electric incandescent lamp filament, the same sort of effect would be produced in a vacuum, as is produced when they are heated in the form of an open network mantle over a Bunsen burner.

As various experiments, and unsuccessful attempts in the direction indicated, have, however, sufficiently shown this assumption is far from representing the truth; for it is essential for the production of the incandescent effect that the oxides should be heated in the presence of oxygen.

If these oxides be heated in a platinum crucible, so that they are somewhat sheltered from the air, to a far higher temperature than can ever be attained with a plain Bunsen burner, no special incandescent effect will be produced.

Again, if a small piece of "mantle" on the end of a wire be placed *in* the hottest part of a Bunsen flame, it will not give out as much light as when held on the *outside* of the flame, just where it issues from the burner; a position in which, although the temperature must be comparatively low, the bit of mantle will be well supplied with air.

With the object of increasing this supply of fresh air in the ordinary mantle and burner arrangement, a chimney has lately been introduced, the lower part of which is perforated with rows of holes, through which a constant stream of air plays on to the mantle. The effect of this chimney is to very greatly increase the light, as compared with that obtained when an ordinary chimney is used. Whether the already sufficiently brief life of the mantle would be further shortened by this increase of brilliancy tests only can positively decide, but that such would be the case is certainly highly probable.

Pointing in the same direction, viz., to the necessity for air, there is the fact that the light from a Welsbach burner is sensibly diminished if the atmosphere in which it is burning is not fairly good.

Thus it would seem that there is little probability of any improvement in the glow lamp, as we know it, by the simple introduction into its filament of the oxides of the rare earths. And some far more radical change in its construction would be necessary before advantage could be taken of the peculiar incandescing properties of these bodies.

We must, therefore, look for improvement, rather in the use of some material for filaments which will stand, without rapid disintegration or breaking, a higher temperature than the carbon now employed.

But there is another direction in which, if any improvement could be brought about, it would greatly facilitate the successful use of lamps of a higher efficiency than those now usually employed; that is in steadiness of supply pressure.

At present the unfortunate lampmaker, who attempts to produce a lamp which will run at, say, 3 watts per candle, has to reckon with the fact that a supply pressure of nominally 100 volts may, for a hour or two during the evening, stand, or rather wobble, at anything between that figure and 109, or even 110 volts. So that, in practice, he is obliged to use a larger "factor of safety" in fixing the efficiency at which he makes his lamps, than would be necessary if he could depend on their being run ~~more~~ closely to the pressure for which they are designed.

Liverpool and its Electrical Engineer.—The City Council has agreed, on the recommendation of the Tramways Committee, that Mr. Arthur Bromley Holmes be appointed electrical engineer-in-chief for both the tramway service and for the electric lighting and other electrical purposes, on condition that he gave up private practice, and that his salary be increased by £600 per annum in lieu of his private practice, to be paid out of the tramway account.

ON SOME RECENT INVESTIGATIONS IN CONNECTION WITH THE ELECTRO-DEPOSITION OF METALS.*

BY J. C. GRAHAM.

(*Continued from page* 279.)

THE result was remarkable. It was seen at once that the current density could be raised far above anything now used, and that the surface of the copper was as bright and as smooth as it is when using such low densities as 100 amperes to the square metre. With this apparatus the current density could be made so great that, if the jet was shut off for a fraction of a second, the whole face of the cathode blackened almost instantaneously, although it remained quite bright as long as the jet was allowed to flow.

The next step was to measure the maximum possible current densities which could be used with this apparatus, consistently with obtaining the proper forms of deposit. It was, however, found that owing to the very rapid growth of tree-like formations of copper which took place all along the edges of the cathode, it was impossible to obtain even approximately accurate measurements of the current density. With such current densities as 2,000 to 3,000 amperes to the square metre these formations will grow to a length of 10 or 15 millimetres in a few minutes, attached at one end to the edge of the cathode, and waving about in the electrolyte like seaweed.

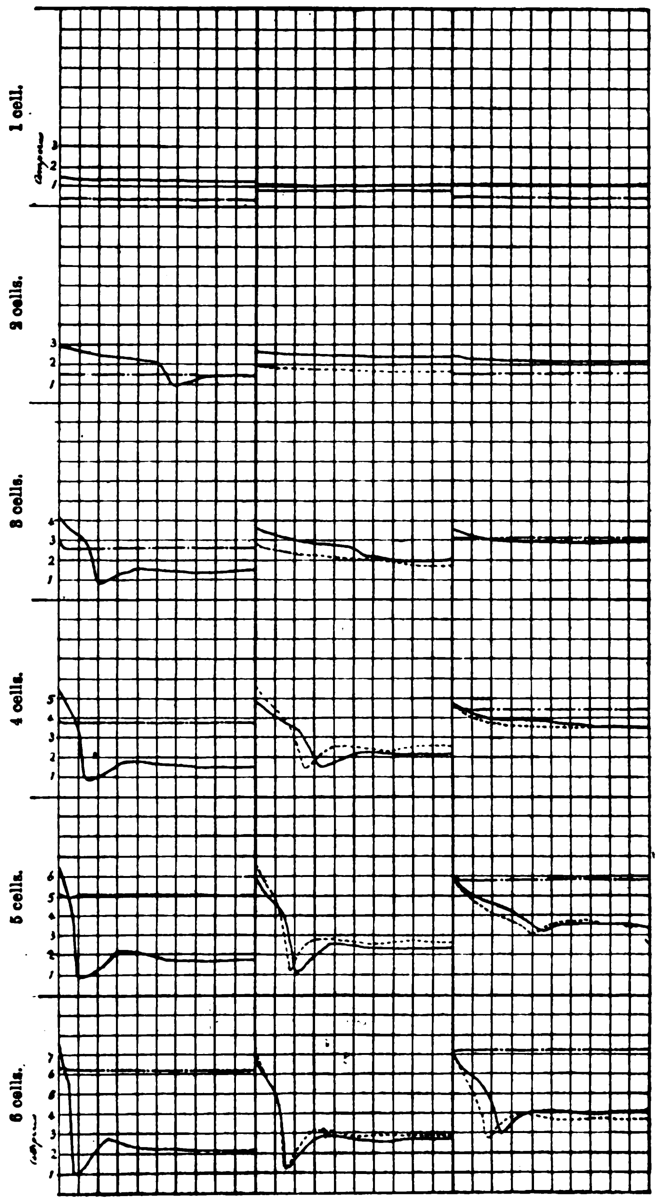
A great many unsuccessful devices were tried with the object of preventing these growths from forming, such as varnishing the edges of the cathode, dipping them in paraffin, covering the edges with thin strips of India-rubber, &c. But it was invariably noticed that the growths began along the line where the insulating material and the cathode met and gradually spread over the face of the insulator, holding on at one end to the cathode.

The cause of these growths appears to be the excessive crowding of the lines of force extending from the anode to the cathode, which takes place along the edges of the cathode, and which causes the current density along these edges to be far in excess of the current density over the rest of the face of the cathode; and acting upon this hypothesis, the difficulty was ultimately overcome by preventing this crowding by means of a shield, as shown by a split line in Diagram C, which was placed at a small distance from the face of the cathode, overlapping the edges, so as to preserve the free circulation of the electrolyte between the shield and the cathode, at the same time shielding the edges of the cathode from the lines of force which would have extended from the anode towards those edges. It is sufficient if the distance between the shield and the cathode is about 6 millimetres, and if the breadth of the shield be about 25 millimetres, so as to overlap the edge of the cathode by about 12 millimetres.

The only remaining uncertainty in determining the current density over the exposed face of the cathode, arose from the difficulty of determining what amount of the current passed under the shield. It was obviously inaccurate to assume that the whole current was passing into the area exposed by the shield, because some of it passed under it. It was found, however, by cutting the cathodes through the middle with shears, so as to get the thickness in section, that the amount of deposit under the shield was very small, and that if the cathode surface was assumed to be about 6 millimetres wider at each edge than the surface exposed by the shield, the results would be fairly accurate for experiments of this character.

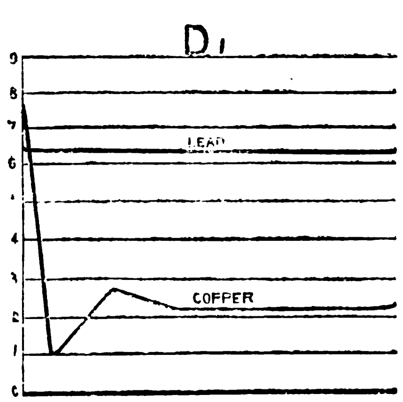
The actual current densities which it was found possible to use with this apparatus will be referred to later on, when all the conditions of accurate measurement have been referred to.

Down to this time copper anodes alone had been used, and although the current could be accurately measured, the readings in the various experiments differed so widely and corresponded so little to the various voltages used that it was obvious that some condition was present to which no attention had been paid; and it was found that this condition was the relation of the size of the copper anode to the number of amperes passing. It was found that if the current density measured on the face of the anode exceeded a certain amount



D.

the current density fell very rapidly after it was switched on, and remained far below what would have been expected according to the voltage.



In order to investigate this matter, a number of copper anodes of different sizes were made and tried at various voltages with a cathode which was the same size throughout.

The first anode was of the same area as the cathode; the the next one was double the area, the next three times the area, and so on, the last one being eight times the area of the cathode.

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* Communicated to the Royal Society.

The cathode was a copper plate, of a square shape, measuring 50 millimetres along the sides, and in front of it was fixed a shield through which was cut a square hole measuring 30 millimetres along the sides.

A jet of about 6 millimetres diameter was used, the fall of the electrolyte being about a third of a metre.

A large number of observations were made with these anodes, each one being tested when connected with one cell, two cells, &c., up to six cells. The results are graphically represented in the Diagram D.

As the curves on this diagram are too small to be seen distinctly, the Diagram D_1 was prepared. It represents the bottom square of the first vertical column in D, considerably enlarged, and may be taken as an example of all the other squares.

Six cells were used, and the curved line, A B, shows how the current fell rapidly to the point, *c*, in about $1\frac{1}{2}$ minutes, then recovered rapidly, but only slightly at the point, *d*, and then became pretty constant. In this case the copper anode was the same size as the cathode.

(*To be continued.*)

ALUMINUM AS A RIVAL OF COPPER AND BRASS FOR ELECTRICAL CONDUCTORS.*

By ALFRED E. HUNT, S.B., President of the Pittsburg Reduction Company.

Copper has been used for electrical conductors very largely in the past, due to its comparatively high electrical conductivity, power of withstanding corrosion, ease of soldering and brazing, malleability, tensile strength and ductility. The exceptions in the past have been in telegraph wires of soft wrought-iron and the brass, iron, and steel used in the parts of electrical machinery.

Aluminum has already been used successfully for the purpose, and this article is written to call attention to its comparative merits as an electrical conductor.

The following facts regarding the metals, copper and aluminum, in bars, rods, and wire suitable for electrical conductors, need first to be considered.

Copper has a specific gravity of 8·93 (authority—Association of Copper Manufacturers of the United States, 1893); an electrical conductivity, when pure and soft annealed reckoned at 100 in the Matthiessen scale, but as ordinarily used in electrical conductors of about 98—97·61 (authority—Prof. W. C. Roberts-Austin); a tensile strength of from 16,500 lbs. per square inch in soft annealed pure copper (authority—Carnegie's Hand Book) to 65,000 lbs. per inch in hard-drawn bars; and a selling price of about 14 cents per pound in the United States, and an equivalent selling price of 130 marks per 100 kilograms in Germany, for wire, bars, and rods such as are used for electrical conductors.

Aluminum has a specific gravity of 2·68; an electrical conductivity (commercially pure metal) of 63·00 (authorities—Chas. F. Scott, of the Westinghouse Electric Company, and Prof. Jos. W. Richards, of Lehigh University); a tensile strength in pure soft wire of 26,000 lbs. per square inch, and in hard-drawn rods or wire of 40,000 lbs. per square inch.

Special selling price: The firm of Aron Hirsch & Son, of Halberstadt, Germany, are ready to sell aluminum conductors in the form of rods, bars, plates, and wire drawn to $2\frac{1}{2}$ millimetres in diameter, at the special low rate of 280 marks per 100 kilograms, for large quantities of metal, and similarly the Pittsburg Reduction Company will sell rods, bars, plates, and wire drawn down to No. 12 Brown & Sharpe gauge (eight-hundredths of an inch diameter) in large special orders for electrical conductors, at the rate of 29 cents per pound at their works in the United States.

These prices are special rates, below the regular prices for aluminum which these concerns have decided to make for electrical conductors alone, in order to favour the introduction of aluminum for this purpose and to overcome the handicap which aluminum has occasioned by its lower electrical conductivity than copper, in the matter of special low relative prices.

From these facts it is evident that:—

1. Any given volume of copper is $\frac{8\cdot93}{2\cdot68}$, or 3·332 times heavier than an equal volume of aluminum.

2. The equivalent price of 14 cents per pound for copper for any length of any equivalent section of aluminum wire or bar, would be 14 cents times the factor 3·332, or 46·65 cents per pound. That is, 1,000 feet of wire of, say, $\frac{1}{10}$th inch diameter, would cost equally as much if bought of copper at 14 cents per pound, or aluminum at 46·65 cents per pound. Aluminum, therefore, sold at 29 cents per lb. is only 62 per cent. of the cost of copper at 14 cents per pound section for section.

3. Reckoning the copper conductor to have its maximum of 100 per cent. conductivity, and the aluminum to have a conductivity of 63 per cent. (which the Pittsburg Reduction Company are ready to guarantee for their special pure aluminum metal for electrical conductors), then for an equivalent electrical conductivity a given section of copper that can be placed at 100 should be increased in area in round numbers to 160 to give an equal conductivity.

4. Due to their relative specific gravities, the weight of the given equal length of the aluminum conductor with 160 sectional area will be only 48 per cent. of the weight of the copper conductor with sectional area of 100, having the same electrical conductivity.

$100 \times 8\cdot93 = 893$, weight of the copper.

$160 \times 2\cdot68 = 428\cdot8$, weight of the aluminum.

$\frac{428\cdot8}{893} = 48$ per cent.

5. As to their relative cost for electrical conductors of equal conductivity, aluminum at 29 cents per pound is the most economical conductor as compared with copper at 14 cents per pound.

Taking, as an illustration, an aluminum conductor to replace a copper wire of No. 10 B. & S. gauge (about $\frac{1}{10}$th of an inch diameter), the aluminum wire of equal, in fact, somewhat superior, electrical conductivity would be of No. 8 B. & S. gauge (slightly over $\frac{1}{8}$th of an inch diameter).

The weight of a mile of No. 10 copper wire is 162·32 lbs., and its cost at 14 cents per pound would be equal to $22.72.

The weight of a mile of No. 8 aluminum wire would be 79·46 lbs., and at 29 cents per pound would cost $23.04.

Forty-eight per cent. of the weight of No. 10 copper wire, which will give equal electrical conductivity in aluminum wire, would only weigh 77·91 lbs.; so that, more accurately, $22.59 would be the cost of a mile of aluminum wire at 29 cents per pound to replace a mile of No. 10 copper wire at 14 cents per pound, costing $22.72.

6. The Continental requirements in tensile strength for soft copper wire, rods, and bars used as electrical conductors is 22 kilogrammes per square millimetre, the English requirement being similarly 14 tons per square inch; and our American requirement is about its equivalent of 32,000 lbs. per square inch.

Aluminum wire, rods, and bars will be furnished of 63 per cent. electrical conductivity, which will have an equal tensile strength per *unit of area* with the copper, and, therefore, with the electrical conductivity equivalent to 48 per cent. of the weight of the copper and sectional area of 160 against the area of the copper section 100, the tensile strength of the aluminum conductors will be as 100 for the copper is to 160 for the aluminum. This would mean, if a square inch of copper conductor was used of, say, 32,000 lbs. per square inch tensile strength, the equal conductivity area of 1·6 inches of aluminum would have a tensile strength of 51,200 lbs.

It has been already determined that with aerial lines, the snow and ice load is practically as heavy on lengths of small wire, as upon larger sections, so that no objection upon this score can probably be found to the use of the larger sections of aluminum wire.

Both on account of having only 48 per cent. of the weight, and on account of having about 60 per cent. more strength, the aluminum conductor could be used in much longer spans between supports, and the number of expensive poles and insulators can be materially diminished. Properly drawn aluminum wire is as tough, and will stand bending as severely without breaking, as soft copper wire. The toughness of aluminum wire is, however, greatly modified by the care and skill used in manufacture. If it is drawn too

* Advance proofs of this paper were courteously forwarded through the Secretary of the Institution of Electrical Engineers.

severely through the dies, or is not well annealed at the proper intervals in the drawing operation, it is finished much more brittle than when properly manipulated.

Hard-drawn copper wire, especially that in the smaller sections drawn through diamond dies, is furnished with a tensile strength of 65,000 lbs. per square inch. What the maximum tensile strength of the best pure hard-drawn aluminum will reach under similar favourable conditions for developing the maximum tensile results, has not yet been determined, but from experiments already made it can quite surely be predicted that at least 50,000 lbs. per square inch can be obtained, and, perhaps, even higher strength still.

Aluminum hardened with a few per cent. of alloying ingredients can be furnished in wire with a tensile strength far in excess of what can be obtained in pure aluminum. Experiments are now being made by the Pittsburg Reduction Company to determine just what alloy will furnish the maximum tensile strength, together with maximum electrical conductivity. From results already obtained, it can surely be predicted that an alloy of aluminum can be furnished which, drawn into wire, will have a tensile strength of at least 62,000 lbs. per square inch, and electrical conductivity of more than 50 in the Matthiessen scale. This material will rival hard-drawn copper wire and the silicon bronze materials which are now in use, where maximum tensile strength, together with good electrical conductivity, are required.

(To be continued.)

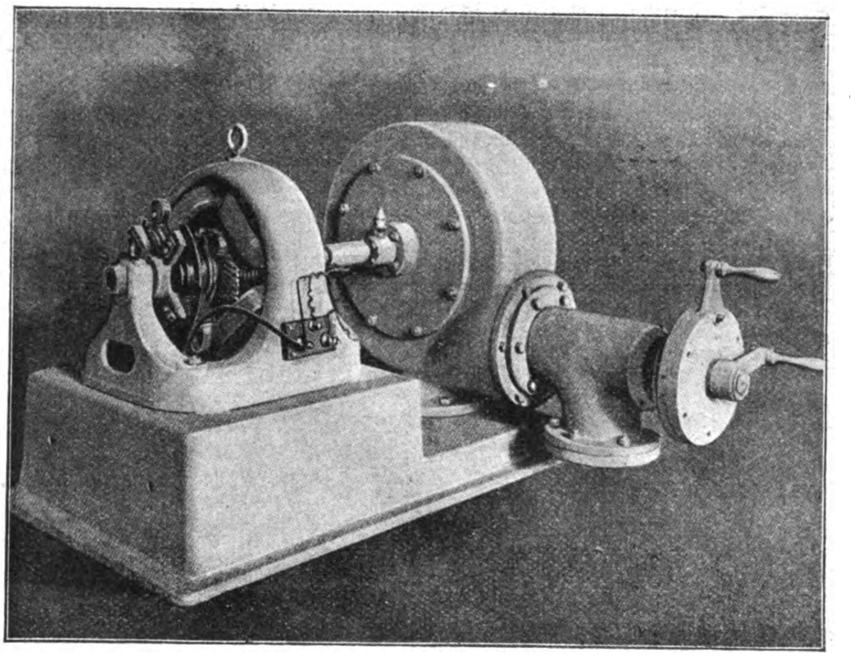
THE USE OF OIL IN STEAM BOILERS.

MUCH has been claimed for kerosene as a scale solvent in steam boilers. The use of this article is, however, strongly condemned by Mr. W. H. Edgar in a paper read to an American society. It is, perhaps, to the abundance of kerosene in America that its use in boilers is due. We believe less use has been made of it in England, but it may be well to regard the opinion of an American who must have seen a good deal of the effects. The effects of kerosene on scale are mechanical. It inserts itself between the scale and the plates and loosens the scale, but the oil is volatile, and passes off with the steam, and is very destructive of the joints in heating apparatus, and generally intensifies grooving and pitting. Further, it dilutes the lubricating oil in the cylinders of engines and generally exerts an oxidising effect on rings and piston rods, and with metallic packing it is difficult to keep this in order. Where the oil gets between the scale and the plate of the boiler it will carbonise by the heat, and, in doing so, will carbonise the iron, and this action will go on all over the boiler below water line. *In toto*, the use of kerosene is a mistake, and its scale-removing effects have been much overstated. The use of too pure a water should also be avoided in boilers, pure water being so general a solvent and requiring something to satisfy its solvent properties. Hence the pitting of boilers fed with pure water, which, however, is often only a name for water containing a little acid. For scale prevention the author asks for sugars and tannins only, not tannic acid, but tannin still combined and containing the inert matter, the sap, the sugar, and the starch. The object is to convert the carbonates of lime and magnesia in tannates. The tannin will not work on the sulphate of lime, but this and sulphate of magnesia will reduce to saccharates by the use of sugar, and these break up into oxalates, tartrates, and carbonates, and part of this goes to the tannin, and forms tannate of lime, and thus a small amount of sugar will serve as a carrier for a considerable reduction of sulphates to the final form of tannate. To sum up, Mr. Edgar advises to use no kerosene and no caustic soda, but a properly proportioned amount of tannin extracts, sugar and starch. Properly compounded there should be no action on the iron. The tannins will deal with the carbonates, and the sugars will deal with the sulphates, while the wood starch assists to prevent the sugars being too stable, and also the tannins, thereby securing easily convertible tannates and saccharates. It is a mistake to use much soda in compounding, say, starch and slippery elm, as the soda kills the gelatinous properties, and tannate of soda is produced which is not wanted. We might add that, where boiler compounds are used, they require feeding in minute quantities with the water, and are best mixed in a tank from which a small pump will put them all day through very dilute into the feed pump outlet or inlet.

LIGHTING A PUMPING STATION BY WATER-POWER.

THE following letter reproduced in the New York *Electrical Review* from the *American Machinist*, relates to a practice which is believed to be new and which has much to commend it. Its principle is the use of water from a steam pumping station as power-water for lighting the station. The economy of the plan over a separate small engine for driving the dynamo is obvious. If the water-wheel has an efficiency of 85 per cent., which can easily be reached in moderate sized wheels of the impulse type, the plan secures a coal economy, for lighting, of 85 per cent. of that obtained by the pumping engine, which latter, being of large size, and of high grade, gives a resulting economy far in excess of what could be secured by any small engine driving the dynamo direct.

The illustration herewith gives an excellent idea of the general arrangement. The handle shown at the top on the right of the illustration adjusts the nozzle to position and the handle below binds it there.



An index plate and pin insures the correct placing of the nozzles with respect to the wheel. The impulse type of wheel has peculiar advantages for this class of work, in which the speed of the wheel must be the same as that of the machine to be driven. With a turbine, a change in size ordinarily changes the power delivered as well as the speed, and it is only by chance that a standard turbine wheel can be found to fit any given case in both speed and power. With the impulse-wheel, on the other hand, the diameter can be varied at will without changing the power delivered, so long as the nozzle remains unchanged, and in proportioning wheels for this class of work it is only necessary, in ordinary cases, to make the wheel of such diameter that when running at the number of revolutions required by the machine to be driven it shall have a peripheral speed equal to that called for by the head of water under which it operates. James Leffel and Company state that the success of this plant has led to the installation of a similar one, but of about three times the capacity, at the Columbus, Ohio, waterworks. The letter is as follows:

"There has been no undertaking in my past experience that has given more satisfaction than this, and in fact it exceeds our expectations as to economy. As we were too far from the city electric plant to receive light from them, we concluded to put in a plant of our own, and purchased a 40-light machine—which will easily carry 50 lights—and connected it direct to a 12-inch Leffel Cascade wheel, which is connected to our main service pipe inside the station. The discharge is piped to pump-well to obviate any waste of water. Under 70 lbs. pressure—our minimum—we can run 80 lights, 16 candle-power, 110 volts, with $\frac{21}{32}$-inch jet, which gives a theoretical flow of 90 gallons per minute, making a total of 54,000 gallons in 10 hours' run, which actually cost 23 cents per 1,000 gallons for coal burned while pumping, as all other items, such as salaries, banking fires, &c., remain a constant, showing the exact cost to us of running 80 lights 10 hours to be 12·42 cents. Our coal costs us $1·75 per ton, delivered in shed at station. The data are based on my last year's report of the triple-expansion pumping engine.

"The Cascade motor has five different size jets—$\frac{5}{16}$-inch, $\frac{9}{16}$-inch, $\frac{21}{32}$-inch, $\frac{11}{16}$-inch and $\frac{23}{32}$-inch in diameter—made on the smooth taper plan. The nozzles are all in one brass disc, 4 inches thick, bored longitudinally, the disc being 5 inches in diameter. The jets are laid off on a circle having six spaces, one being left blank to close main opening when not in use. I enclose rough sketch to give a better idea.

"The generator is a multipolar, compound, shunt-wound machine, the speed being 890 turns per minute.

"W. C. Powell,

"Engineer Springfield, Ohio, Waterworks."

THE ELECTROLYSIS OF MAGNETIC SALTS.

Revue d'Electricité of February 12th prints an interesting article by Prof. Hurmezescu, of the University of Jassey, on the behaviour of iron in electrolytic cells placed in strong magnetic fields. Two principal observations are made: one that the rate of deposition and dissolution of iron electrodes

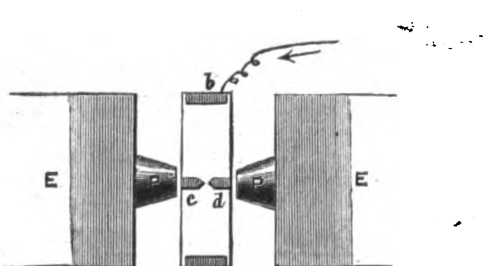


Fig. 1.

is greatly affected by the magnetisation of the iron; the other that electrolytes containing magnetic salts, placed in a magnetic field, show vortical movements, or eddies, when a current of electricity is passed through them.

A number of experiments are described, among which the following are perhaps the most striking. A solution of copper sulphate is poured into a shallow tray of thin sheet iron placed on the poles of a magnet. The iron is dissolved, and the copper deposited along lines, which are roughly at right angles to the field, and are described by the author as being approximately the lines of equal magnetisation. The appearance of the tray is figured in the paper. The arrangement of another experiment is shown in fig. 1. Here a b are iron electrodes placed in an electrolytic solution of the following composition:—

Water	1,000 grm.
Double sulphate of iron and ammonia...	100 "
Sulphate of soda	100 "
With glycerine to prevent oxidation of the iron salt.	

At c d are placed what the author terms parasitic electrodes, also of iron, nearly dividing the cell in half, and having sharp opposed edges. The electromagnet, P P, strongly magnetises c d, the intensity of magnetisation being more intense at the sharp edges than elsewhere. On passing a current through the cell iron is deposited on c d, opposite the anode, and dissolved opposed the cathode. The deposition of iron is found to be much greater on the highly magnetised edges of c d, than on the other parts.

In a third experiment the cell was arranged as shown in fig. 2, having two gaps left in the divided iron partition,

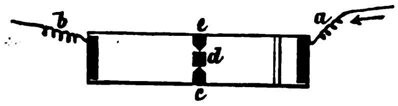


Fig. 2.

c, d, e, and a porous diaphragm across the anode to prevent diffusion of the oxygen. The electrolyte was of the same composition as before. On placing this cell in a magnetic field across c, c, and passing a current from a to b, the eddies shown in fig. 3 were observed. The speed of the eddies

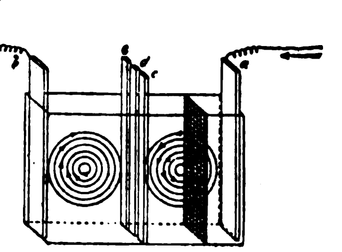


Fig. 3.

increased with the strength of the field, but did not occur at all with non-magnetic electrolytes. On replacing a, b, fig. 2, by copper electrodes, and the electrolyte by copper sulphate, c, d, e being, as before, of iron, no eddies were seen until the copper in the solution was partly replaced by iron from c, d, when slow eddies began to form.

The article is well illustrated with figures taken apparently from photographs. Before leaving this subject we may perhaps refer to an experiment shown some years ago to the present writer by a French electrician. A steel wire held

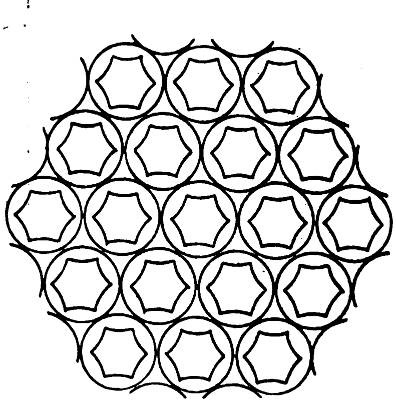


Fig. 4.

vertically in a solution of common salt and alum, forming an anode, is eaten away very smoothly and regularly into the form of a long tapering and very sharp point. It had been proposed to sharpen needles in this way by lowering them in bundles into the electrolyte, and passing a current through them as the anode. Under these circumstances, however, they did not form circular conical points, but pyramidal ones with hollow sides. The circles in fig. 4 represent the sections of the bundled needles before the action has begun, and the hexagons the sections of the taper points where electrolysis has removed parts of the material. Another proposal made was to use this property to maintain the sharp edges of rotating circular knives. These were to run in an electrolytic solution and a current of electricity constantly passed through them. The plan might have many applications in other directions.

COMPARING RESULTS OF TESTS ON ACCUMULATORS.

[COMMUNICATED.]

If the batteries or cells to be compared are of the lead and lead peroxide types, one of the safest, fairest and most correct comparisons is to give the watt-hours discharge per lb. of plates, at equal rates of discharge. It is still more correct if we take the watt-hours per lb. of positive plates at equal rates of discharge in amperes per lb. of said plates, taking the weights without connectors. The reason for this is, that by taking positives only, and all at same discharge rate per lb., the results are fairly correct when cells of different sizes are compared, whereas when cells of different sizes are compared by watt-hours per lb. of plates or per lb. of battery the results are altogether misleading, unless the cells are of same size, that is, have plates which give same rate of discharge per lb.

Reports made on tests of batteries, especially those made by supposed experts in teaching establishments, sometimes do not recognise the foregoing precautions, hence such reports for purposes of comparison are valueless as a rule.

Another rule which should be observed in making tests is, that the rate of discharge in watts ought to be maintained constant from start to finish of the discharge, few reports state whether this or any other rule was observed. Some tests are made with constant resistance in which the watts fall nearly 25 per cent. from start to finish. Others are made with a variable resistance maintaining constant ampere rate of discharge. Both these methods give a higher watt-hour capacity result than the method of testing at a constant rate of watts with a variable resistance.

That constant rate of watts is the correct method is undoubted, for if we use a battery for power or traction, it may be called upon to work at the same rate at the end of 6 or 8 hours as at the beginning of a run. In any case, however, it must be remembered that there are three methods, and the results obtained by one method is not comparable with the others; and again, unless a report states which method has been used it is not comparable. Following is a table of comparison as it should be:—

Name of cell.	Rate of discharge + watts per lb. constant.	Watt-hours capacity per lb. of positives.
A	5·5	32 8
B	5·5	21 8
C	5·7	19 0
D	4·5	26·6

In this table, A, B, results are strictly comparable, for the discharge rate is same in both.

Although C gives 19 watt-hours against B 21, C is probably the best battery, as the rate of discharge of C is much higher. D, again, gives 26.6 at a rate of 4·5, but is probably not much better than B, if the rate had been raised to 5 watts discharge per lb. of positive.

These figures are results actually obtained on tests on small cells, and they are quite comparable with results on large cells.

An examination of the best and most used cells in the market proves that all of them run at about 5 watt-hours rate of discharge per lb. of positives, and at that rate give a capacity of 25 watt-hours per lb. of positive plates.

These figures refer to everyday working batteries, and cells giving these results when made up into batteries give 8 to 9 watt-hours per lb. of battery, it is obvious that this result is one which depends much, on the boxes used, also on the nature of the connectors, and also on the amount of acid solution used. The amount of acid solution can be reduced to a very much smaller quantity than was formerly considered necessary. In good traction cells 61 watt-hours per lb. of acid solution can be got easily in large cells; this is a very remarkable fact and one which is very significant from an electro-chemical point of view.

From these figures, *i.e.*, the rate of discharge in watts per lb. of positives and the discharge in watt-hours per lb. and the watt-hours per lb. of acid, the watt-hours per lb. of any cell or battery can be calculated approximately from tests made on one positive only, thus reducing the testing of batteries from a clumsy rule of thumb state to an almost exact science.

The antiquated expert cannot, from observed results on one plate, calculate results for 11 or 13 plates; there are so many things he does not know, that he does not make the attempt.

Up till recently the accumulator has been pretty much where the dynamo was before the application of the doctrine of the magnetic circuit was applied. It will be strange, indeed, if such an important electrical apparatus cannot be reduced to exact science.

Improvements have been made by trial and error, but much greater improvements are possible, when exact knowledge is obtained regarding the proportions and proper consistency of the elements, and the exact knowledge of the chemical and electro-chemical reactions involved must be elucidated.

THE TESTING OF INSULATORS FOR HIGH TENSION SERVICE.

In a recent issue of the *Electrical World* Mr. J. R. Haskin gives some interesting and useful information with reference to testing of insulators for high tension power service. Unless each insulator is thoroughly capable of withstanding the pressure and strain to which it is to be subjected when in service, there will necessarily be one or more unknown weak spots, which, by their breaking down, will necessitate the discontinuance of service until, after more or less trouble and delay, the particular location of the trouble is found. Too much attention therefore cannot be paid to the thorough testing of the insulators before installing them.

When the Niagara-Buffalo transmission line was about to be constructed, the question of insulation received very careful attention from the electrical superintendent of the company, Mr. Paul M. Lincoln, who after careful deliberation designed for the purpose two transformers, each capable of producing a pressure of 20,000 volts.

The insulators to be tested were placed in an inverted position in a square iron pan capable of holding a dozen or more; the pin holes were filled up half full with salt water, and the insulators were also submerged in the same to within about an inch of the edge of the outer petticoat. One lead from the transformers was attached to the pan and the other to a short bar of zinc or copper, this being placed in the pin hole of each insulator in turn.

During the early tests a pressure of 20,000 volts was first applied, and if the insulator stood this test the pressure was gradually increased to 40,000 volts, but after the first few had been tested it became customary to apply the entire 40,000 volts pressure at once. If the insulator is satisfactory, nothing will be noticed except a subdued humming sound, caused partly by the transformer and partly by the discharges due to a condenser action on the surface of the insulator, with oft times a snapping blue, static spark jumping from the edges of the pin hole to the outer petticoat edge of the insulator, this latter phenomenon generally appearing when the surface of the insulator is at all moist, or has upon its surface a few drops of the salt water accidentally spilled upon it. But if there is a slight flaw in the make-up of the insulator a yellowish spark will immediately manifest itself, and if the breakdown is at all serious this spark may be seen coming through the top surface of the inverted translator, below the level of the brine.

Experiment showed that when fresh water was used instead of brine, a much larger proportion of the insulators passed the test, and were apparently sound and well made. It is rather difficult to say why this should be, but the fact remained nevertheless.

The reason for the poor insulating properties of defective insulators was easily made apparent by breaking up one of the insulators and examining the porcelain, which was found by the application of red ink to an unglazed surface to be very porous. In nearly every case also, flaws caused by imperfect kneading of the clay were found, poor lots of insulators being often filled with these imperfections, while only one or two flaws would be found in the imperfect ones from a lot which gave a high percentage of satisfactory insulators. Too much importance cannot be given to this matter, as it is above all the prime requisite of a porcelain insulator. A perfect piece of porcelain, $\frac{3}{16}$ths of an inch in thickness, is for all practical purposes non-puncturable.

The necessary size of the insulator to be used appears to vary somewhat according to the climatic conditions of the locality in which they are to be installed. The writer has been informed that in certain sections in the West where the climate is very dry and the air thin, power has been and is now being transmitted at a pressure of 50,000 and 60,000 volts on wires insulated only by the ordinary glass insulator in common use by the telegraph and telephone companies. In such a locality as Niagara Falls this would be impossible, as the moisture and dust collecting on the surface of the insulator would be sufficient to allow the current to leak across even when but 10,000 or 15,000 volts were being used. Therefore, a large insulator made of the first quality of porcelain, well baked and vitrified, is the only one that will stand the pressure and wear of a high tension transmission line in such a locality.

No better proof of the satisfactory nature of the test described can be given than the working of the overhead system of the Buffalo transmission line since the commencement of its operation. Except for a few cases of breakdown among the insulators that had been installed temporarily, it has been necessary to remove only two or three insulators out of the whole set of more than 12,000.

STANDARD CLAUSES FOR SPECIFICATIONS.

We have received a circular, with a copy of certain agreed standard clauses, from the Electrical Engineering Plant Manufacturers' Association and the Municipal Electrical Association, which has reference to a point on which we recently commented, namely, the relation of customer, engineer, and manufacturer. The circular refers to the feeling that has been found to prevail, that the regulations which commonly govern building contracts are unsatisfactory when applied to electrical contracts. Manufacturers have felt that they are at the mercy of the purchaser's engineer, and engineers have felt that they are called upon to exercise judicial functions not strictly appertaining to their duties. The attention directed upon the subject has led to the above associations taking the matter in hand for discussion, and with a view to agreement upon a model specification. The clauses agreed to we publish in full further on, so as to make them as widely known as possible. So far only commercial conditions have been dealt with, but it is hoped that there will be standardising of more technical features, whereby a purchaser will be able to buy better and cheaper goods at an earlier delivery than where new patterns are called for, as well as being able to avoid the inevitable risks of new patterns. Perhaps there is no more unpleasant portion of an engineer's duties than the enforcing upon a contractor of requirements in respect of entirely new work of the engineer's own design. There is always ample room for dispute, and even in respect of the business clauses of a specification, there is room for dispute as to the true meaning and intent. With standard clauses there would very soon be arrived at a general consensus of opinion as to what each clause really signified, and many loopholes now open for shirking on the one hand, and perhaps unfair demands on the other, would be closed. This is a much to be desired blessing. Engineers should be glad to be relieved of the judicial functions imposed upon them in specifications, functions for which neither their position entitles them fairly to exercise, nor their training fits them. The clauses now published bear upon a number of points on which there has been much friction, and it is proposed to add to them as occasion offers, until a complete specification is available to cover all essential contingencies of electrical contracts.

Undoubtedly there should be an effort to standardise technical features, and especially the testing requirements of specifications. Such standardising might be subject to periodical revision, and this could very easily be arranged as knowledge advanced. To standardise is not necessarily to crystallise: it is rather to direct men's minds upon details and conditions, so that much thought is directed in a concentrated manner in a given direction, in order that improvements may be made by concentrated thought that are now not made by the system for diffuse energy. We hope to return to this subject at an early date.

The Electrical Engineering Plant Manufacturers' Association and The Municipal Electrical Association.

Approved Standard Clauses.

For adoption among the General Conditions of Specifications for Electrical Engineering Plant.

Drawings.—The contractor shall, at his own expense, supply to the purchaser copies of the drawings necessary for the erection of the works under the contract, but shall not be called upon to furnish constructional details further than in the opinion of the engineer are required for the purposes of the contract. If the contractor shall be called upon to supply additional copies of the drawings, they shall be paid for at a fair price to be arranged. The engineer shall, in addition, have the right at all reasonable times to inspect any drawings of any portion of the plant contracted for at the works of the manufacturer.

Powers of Engineer to Reject Materials or vary Works.—The engineer may from time to time during the execution of the contract, vary, increase, or reduce the contract works, and may order any work or portion of work executed, or partially executed, to be removed or altered; and the difference of cost occasioned by any variation, addition, omission, removal, or alteration, as aforesaid, shall be added to or deducted from the contract price as the case may require, and the amount of such difference shall be ascertained and determined in accordance with the rates specified in the schedule of prices set out in the schedule to the contract so far as the same may be applicable, and where the same are not applicable, then according to such rates or prices as shall be fair and reasonable; such prices in cases of dispute shall be referred to arbitration as herein provided. No addition shall, however, be made to the contract price in respect of any such variation of, or addition to, the said works, unless the instructions for the same shall have been given by the engineer in writing, nor unless such instruction shall state that the matter thereof is to be the subject of an extra charge.

A decision of the engineer to reject materials, or require workmanship which is in his opinion defective, to be amended, shall be obeyed by the contractor. If the contractor shall so desire, and of such desire shall give notice in writing to the purchaser within 72 hours after receiving notice from the engineer, the question involved in any such decision of the engineer may be submitted to arbitration, as herein provided. The contractor shall not, under these circumstances, cease to proceed with the execution of the contract, to the prejudice of the purchaser.

Date of Completion of Works and Penalties.—The contractor shall within a period of from the date of the order of the engineer to commence the contract works (and time shall in this respect be of the essence of the contract) complete the whole of the contract works, and make good all damage done to the roads, buildings, or other property of the purchaser and fill up all holes, and trenches which may have been dug, and level any mounds or heaps of earth that may have been made, and reinstate all works, property, matters, and things disturbed or damaged, and deliver up to the purchaser the said works complete to the satisfaction of the engineer; and in case the contractor shall make default in performing and observing the provisions of this clause within the period hereinbefore limited or within any extension of the same period which may be granted under the powers herein contained, the contractors shall and will pay to the purchaser on demand as ascertained and liquidated damages, and not as a penalty, the sum of £ * for each and every week which shall elapse between the expiration of the period limited by this clause or any extension thereof which may be granted as aforesaid, and the actual performance and

* N.B.—Under no circumstances to exceed 1 per cent. per week of the contract value.

observance by the contractor of the provisions of this clause, unless the execution of the contract works shall have been delayed by an unreasonable strike of workmen, by excessive inclement weather affecting the work of the contractor, or by any circumstances over which the contractor shall have had no control; provided that no such damages shall accrue as payable by the contractor to the purchaser after the time when the plant is complete and ready to be set to work.

Power of Purchaser to use Works during Execution.—The purchaser shall have power to use any portion of the plant reasonably capable of use at any time during execution of the contract, and also pending any arbitration. In such case, however, the contractor shall be entitled to receive, by way of rental, a sum equal to 5 per centum per annum upon the amount withheld in respect of any machinery put into beneficial use, and not paid for.

Payments.—During the progress of the works, and as soon as possible after the expiration of each month, the contractor shall be entitled to payment, on the engineer's certificate, of 75 per cent. of the value of the work executed on the site and plant delivered on the site during the month, until the balance of 25 per cent. of the value of the executed work retained by the purchaser is equal to 10 per cent. of the total value of the contract. Thereafter the contractor shall be entitled to monthly payments as before equal to 90 per cent. of the value of the remainder of the executed work, until the contract works are completed for continuous effective usage by the purchaser, whereupon he shall become entitled to one-half of the retention monies. The remaining half of the retention monies shall be payable * months later.

The purchaser shall, however, be entitled to retain such sum of money as, in the opinion of the engineer, fairly represents the prejudice to the purchaser arising out of incomplete or defective details, until the adjustment of such details to the satisfaction of the engineer.

In cases where the contractor, although willing so to do, is unable to repair defects in certain parts of the contract works in consequence of the purchaser not being able to place such parts into his hands for the requisite time, owing to their being in use, the contractor shall be paid in full for such portion of the contract works on giving an undertaking, with security to the satisfaction of the purchaser if required, to remedy the defects so soon as the same can be placed in his hands for the purpose.

Certificates of Engineer.—The engineer shall, from time to time, issue his certificates in accordance with the clause relating to payments, and payment shall be made to the contractor at the earliest possible date. Certificates of the engineer, other than the final certificate, shall not be considered conclusive evidence as to the sufficiency of any work or materials to which they relate, nor shall they relieve the contractor from his liability to make good all defects as provided by the contract. The contractor, when applying for a certificate shall, if required, furnish to the engineer an approximate statement of the value of the work executed and materials delivered, based on the original estimate.

When the contract works shall be completed, as referred to in the clause relating to payments, the contractor shall be entitled to call upon the engineer for a certificate to that effect. In case of the refusal of the engineer to grant such certificate when called upon by the contractor so to do, this refusal shall be subject to appeal under the Arbitration Clause herein contained.

Maintenance and Limitation of Responsibility of Contractor.—The contractor shall be responsible for, and shall effectually maintain and uphold in good and substantial condition, in accordance with the specification, fair wear and tear only excepted, all and every part of the contract works for a period of months † from the date of completion of the contract as certified by the engineer.

Arbitration.—In case any dispute or difference shall arise between the purchaser, or his engineer on his behalf, and the contractor, either during the progress of the works, or after the determination abandonment, or breach of the contract, as to the construction of the contract, or as to the reasonableness of any extra charge, or as to the withholding by the engineer of any certificate to which the contractor may claim to be entitled, then either party may, within 72 hours, but not later, give to the other notice in writing of the existence of such dispute or difference, and such dispute or difference may be referred to arbitration, which arbitration shall be deemed to be a submission to arbitration, within the meaning of the Arbitration Act, 1889.

Approved on behalf of the Electrical Engineering Plant Manufacturers' Association.

R. Percy Sellon, Brush Electrical Engineering Company, Limited.
R. E. B. Crompton, Crompton & Co., Limited.
A. B. Blackburn, Electric Construction Company, Limited.
S. Z. De Ferranti, S. Z. De Ferranti, Limited.
A. Fowler, John Fowler & Co., Limited.
W. B. Esson, Johnson & Phillips.

On behalf of the Municipal Electrical Association.

A. H. Gibbings, *President.*
C. H. Wordingham, } *Past Presidents.*
A. Wright, }
A. Gay, }
G. Pearson, } *Members of Council.*
T. P. Wilmshurst, }
A. B. Mountain, }

February, 1898.

* Under no circumstances to exceed 12 months.
† N.B.—Under no circumstances to exceed 12 months.

CORRESPONDENCE.

Knots.

In the account of the meeting of the T.C.M.C. in the Electrical Review, of the 4th inst., Admiral Sir A. Hoskins is reported to have said that the company were manufacturing a cable "60 knots in length," and that their new cable steamer would have a speed of "12 knots per hour."

I submit that such phrases are inexact and wholly unscientific, and their employment by the chief of a large company, which earns its money by applied science, most improper. The use of these phrases are a sure and certain indication of a neglected professional education. Hence they are in daily use by masters and officers of cable and mail steamers, pilots and seamen generally of the merchant service, also by naval officers of the pre Royal Naval College period. Needless to say, laymen, such as yachtsmen, shipowners, newspaper writers, Members of Parliament, and even judges and barristers of the Admiralty Court offend in the same way, but, of course, they may be pardoned.

In the Royal Navy and in the Staff College one never hears such expressions. I, however (dare I say it), have even known cable engineers and electricians guilty of this offence. *They* ought to know better.

For the edification of the gallant Admiral and of others who may feel disposed to stick to their knots as well as to their guns, permit me to say what a knot is. A knot is a speed, and a knot is the unit of nautical speed; it is the product of a length 6,080 feet into a unit of time 1 hour. It is not in itself a length, but the word is used to denote an interval (a length) between one or more marks on the log line, which instrument is a *speed* measurer. In this sense only can knot be regarded as a length, and in this sense only is it employed by Lord Kelvin in his "Navigation." According to Prof. Greenhill, F.R.S., who I need hardly say is an authority on dynamics, a "knot per hour" is an acceleration; hence a steamer going "20 knots per hour" would make the passage between Liverpool and New York in something like 17·3 hours. Prof. Cotterill, F.R.S., and M. Slade, R.N., in their "Mechanics" say, "the expression (knots per hour) is erroneous, and should be guarded against." I am sorry to say that a length of so many knots and knots per hour are tacitly acquiesced in by cable engineers and electricians. I did manage to convert one cable man, but I fear he has through evil communication lapsed from the narrow path of accurate definition. I also converted a shipmaster, but his employer did not grasp the subtle distinction between knots and knots per hour. Why not use the word "naut" to denote a length of one sea mile as proposed by Lord Kelvin? then the knot would be a speed of one naut per hour.

Geo. Herbert Little,
Master Mariner, late Student Royal Naval College.

Re Salaries of Assistant Electrical Engineers.

Having followed with great interest and sympathy the recent protests in your columns against the absurdly low salaries paid to assistant electrical engineers, I should like to point out that your correspondent "Fiat Justitia" is saddling the wrong horse when he places the entire onus of this case of sweating on the borough councillors. Surely Mr. Boot has enough influence with his committee to place his staff in a somewhat better position if he tried, and could ensure at least those men who do the work, for which he takes all the credit, and probably a salary as large or larger than the combined salaries of all his staff, at least a "living wage."

Also, I think it must have escaped the notice of Mr. L. D. Collins that the advertisement in question was for an *experienced* man, thus prohibiting anybody taking this job for the sake of experience.

By the bye, would Mr. Collins be so kind as to give the derivation and meaning of "horse-sense." I have not yet been able to find anybody capable of furnishing me with this information.

Tom.

D

Electrical Driving of Cotton Mills.

I am glad to see you are taking interest in the correspondence now going on in *Engineering* on the electrical driving of cotton mills.

This subject is of immense importance to the electrical industry, because if this scheme can be shown to be feasible and profitable, every cotton mill will take as many units per annum as *an average provincial town*, and the demand for motors and dynamos will exceed anything that we have hitherto experienced. Your interest, and that of your friends, lies entirely with the progressives, but to make Fortune smile you must tickle her; you have not tickled her much yet.

For instance, your contributor says, "Nevertheless he (Mr. Herschmann) is sceptical of Mr. Raworth's 15 per cent. for electricity"—of course, I quite expected you to say "on this head Mr. Raworth is all right, and even if he had said 14 or 13 or even 12 per cent. loss between indicated and electrical horse-power, many of our friends would have been quite ready to accept orders on his specification." You know these facts quite as well as I do, probably better.

Now take the cotton mill engine—it averages 500 to 1,200 H.P. indicated—quite a good-sized engine, but not much of an engine for economy; it could not compete with an engine of 6,000 H.P., fitted with modern appliances and giving a H.P. for 1 lb. of coal.

Again consider the motors, they are now too high in speed for the spinner's frames, but these latter have been designed to suit the speed of line shafts, they can be modified considerably for electric driving; how much, it is impossible to foretell, but when we remember that the speed of the spindles is from 7,000 to 9,000 revolutions per minute, it is apparent that the speed difficulty is not likely to be insuperable.

Your contributor says "a cotton mill is *not* a large cube." Now, this is either a misprint or your contributor has never seen a cotton mill; he is, however, quite right in pointing out that the power required for driving a cotton mill is almost entirely absorbed in friction, much less than 1 per cent. is put into the cotton—this is where we come in; not only does electricity transmit power with less friction than iron and leather, but it uses neither oil nor laces, it has no cogs to crack, no ropes to ravel, no belts to break—it is always ready and always willing.

It is an open question whether the application of electricity will not permit of sufficient saving being made in the cost of the machines to pay for the motors, if it should do so, the question is settled—the genius of Lancashire has not yet been directed to this problem, but whenever it may take it in hand it will solve it.

A "mule," for example, is a factory in itself, it contains a book full of mechanical motions, and he would be a bold man who would say off-hand that electricity will not simplify some of them and reduce the friction of the internal driving gear.

Mr. Herschmann's figures of ¼ to ¾ H.P. per machine are very misleading, they apply only to the card room, whereas the bulk of the power is absorbed in spinning and doubling in, which processes a single frame will absorb from 4 to 10 H.P.

Mr. Herschmann considers it a defect that the power is not intermittent, but electrical engineers will not grumble at that, it is just what they hanker after, to me it opens up the possibility of supplying electrical energy at something less than a halfpenny per unit, at which price electricity would take the first place as an angel to redeem mankind from the incidental curses of jerry built civilisation.

John S. Raworth.

Dublin Cables.

With reference to the letter from Mr. Ruddle, the superintendent of the Dublin Electricity Works, which was published in your last issue, it may be well to state that, of the cables supplied to the Dublin Corporation by this company, a considerable portion was delivered in 1892, and was used, we understand, in the high tension alternating incandescent lamp circuits. Of these cables, we believe, no complaint is made. Faults, however, have occurred in the arc lighting circuits, the cables for which were supplied since 1893; the conductors of the latter are 7/16s, the thickness of the dielectric being 1/13". In no case were these cables laid underground by this company.

Through the courtesy of Mr. Ruddle the cables were examined by us in April of last year. As the result of our examination we found that at the junction boxes the cables were seriously damaged, and that even where a breakdown had not yet occurred, we found in some cases the cables to have been punctured or wounded; we therefore submit that this does not point to faulty material, but rather gives evidence of mechanical injury, for which a manufacturer should not be considered responsible.

As regards the cable, apart from these faults the rubber appeared to be in very good order; a length returned to our works for examination was tested with 5,000 volts alternating current, and showed no signs of weakness. Under these circumstances it cannot with justice be held that a dielectric of India-rubber fails in its object, and calls for the substitution of some other material, which in addition to its own inherent defects would be subject to the same mechanical disadvantages. The trouble, in our opinion, lies in the handling of the cables, and the want of complete understanding between the manufacturers and the contractor, or persons to whom the work of laying is confided. Whether or not other manufacturers may be better able to establish such an understanding, we are unable to state, but we may assure you that we spare no pains to place at the disposal of the contractors for laying, such knowledge as we possess on the subject.

Wm. Gray,

Electric Light Department, The India-Rubber, Gutta-Percha, and Telegraph Works Company, Limited.

"Is the Nervous System a Coherer?"

In the Electrical Review, of March 4th, there appears a very interesting notice of a communication made by M. Branly to the Académie des Sciences, on December 27th, in which some striking analogies are pointed out between coherer action and the conductivity of the nerves for nervous currents. That this is not the first time such a suggestion has been made will appear by the following extract from an article by me, headed "Apologia pro electricitate jus," in the *Lancet*, of May 4th, 1895:—"It seems conceivable that other histological arrangements, *e.g.*, those nerve fibrils which conduct, yet only touch and do not anastomose, those motor nerve endings which are only in contact with the sarcous substance; indeed, any conducting arrangement in the animal body which may be classed as a 'bad contact'—may constitute the physiological analogue of what would be electrically known as a 'coherer.'"

W. S. Hedley, M.D.

March 6th, 1898.

Cost of Long-Running Plant.

The letter of your correspondent, "Atlas," raises an interesting question. Along with the engineer to the South Staffordshire scheme, the writer had occasion to go very thoroughly into the question of the probable generating costs, and, from the mass of information which we collected, it was perfectly evident that with ordinary good luck the project could be made to pay very well with customers paying at the rate of 1d. a unit and discounts. In the case of Niagara, it should be remembered that a town had practically to be built at short notice, in order to create a demand for power, but in South Staffordshire the town, or rather towns, with their multitudinous industries, already exist, and if only the various representative bodies can be got to pull in one direction, a few more years will undoubtedly see energy being distributed over the area bounded by Wolverhampton and Birmingham, Walsall and Dudley at under a 1d. per unit.

At the St. Helen's Chemical Works where the generators are comparatively small (300 kw.) and, moreover, driven in the old fashioned way from slow running horizontal engines, the writer has it on good authority that the total cost of generation, including fair amounts for rates and taxes, interest and depreciation is nearer a ¼d. than a ½d. per unit. The load is, of course, a 24-hour one.

The Manchester central station, which has a very considerable day load, due partly to motors and also, no doubt to the peculiar atmospheric conditions of that salubrious place, is at the present moment generating current at a figure well under 1½d. per unit, and this is with the coal bill at the comparatively high (considering the position of the district) figure of ·4d. per unit (coal at Edinburgh is ·31d. and at Leeds ·25d.). At the present time the plant is some 30 per cent. overloaded, and all repairs, &c., have to be carried out during the night by men paid time and half, and those who know anything of night work will recognise how it "plays the bear" with the cost sheets. Mr. Day, the engineer in charge, stated to the writer that when they got the load well in hand (two 1,500 kilowatts are on order from the Electric Construction Company, Limited, and Siemens Bros. & Co.), and these extras were stopped, he quite expected the generating costs to drop well below 1d. per unit.

E. Kilburn Scott.

CORRESPONDENCE.—We have received, too late for insertion in this issue, a communication from Mr. A. J. Liversedge on "The Burning Question." This letter, and a reply thereto, will appear in our next issue.—EDS. ELEC. REV.

BUSINESS NOTICES, &c.

Electrical Wares Exported.

WEEK ENDING MARCH 8TH, 1897.

		£	s.
Albany ...	... ...	131	0
Alexandria	... ...	25	0
Amsterdam	... ...	20	0
Bilbao ...	... ...	12	0
Boca.	Teleg. mat.	72	0
Bombay	... ...	132	0
Brussels ...	... ...	18	0
Buenos Ayres	... ...	724	0
Calcutta...	... ...	49	0
Cape Town	... ...	415	0
„	Teleg. mat.	1,400	0
Colombo.	Teleg. mat.	79	0
Danzig ...	... ...	19	0
Durban ...	... ...	1,139	0
East London	... ...	336	0
Flushing	... ...	27	0
Fremantle.	Teleg. mat.	27	0
Havana ...	... ...	12	0
Port Elizabeth ..	...	146	0
Singapore.	Teleg. mat.	10	0
„	Teleg. cable (2,598 tons)	...	
Sydney ...	... ...	242	0
Teneriffe	... ...	10	0
Valencia	... ...	18	0
Venice ...	... ...	6	0
Yokohama	... ...	15	0
Total ...		£5,084	0

WEEK ENDING MARCH 8TH, 1898.

		£	s.
Adelaide	... ...	13	0
Albany ...	... ...	45	0
Amsterdam	... ...	50	0
Antwerp.	Elec. fuses	174	0
Barcelona	... ...	12	0
„	Elec. light cable	1,170	0
Beira.	Teleg. mat.	1,995	0
Bombay	... ...	40	0
Boulogne	... ...	32	0
Buenos Ayres	... ...	542	0
„	Teleg. mat.	115	0
Cape Town	... ...	1,216	0
Christiana	... ...	34	0
Colombo	... ...	17	0
Durban ...	... ...	101	0
„	Teleg. mat.	529	0
East London	... ...	594	0
Gibraltar	... ...	26	0
Gothenburg	... ...	76	0
Hamburg	... ...	121	0
Liban ...	... ...	60	0
Lisbon ...	... ...	935	0
Madras ...	... ...	1	0
Malaga ...	... ...	156	0
Melbourne	... ...	57	0
„	Teleg. mat.	695	0
New York.	Teleg. mat.	1,654	0
Penang.	Teleg. mat.	16	0
Port Elizabeth...	...	411	0
Rosario ...	... ...	39	0
Santander	... ...	59	0
Shanghai	... ...	6	0
Singapore.	Teleph. mat.	265	0
Stettin.	Teleg. wire	91	0
Stockholm.	Teleg. cable	365	0
Suez ...	... ...	12	0
„	Teleg. cable	140	0
Sydney ...	... ...	51	0
Tientsin ..	... ...	36	0
Yokohama	... ...	270	0
Total ...		£12,221	0

Foreign Goods Transhipped.

		£	s.
Barcelona	... ...	3,174	0

Appointment Vacant.—An electrical and mechanical working engineer is wanted to take charge of electric lighting and motor plant, &c., of a large works near Manchester. Applications have to be lodged with the Committee, Co-operative Wholesale Society, Limited, 1, Balloon Street, Manchester, by 14th inst.

Bankruptcy Proceedings.—At last Wednesday's sitting of the London Bankruptcy Court, John Dewhurst, 52, North End Road, West Kensington, electrician and sanitary engineer, was allowed to pass his public examination upon accounts showing total liabilities £860 (unsecured £390), and assets £196. He stated that he had traded as an electrician for 13 years, and he attributed his insolvency mainly to having paid an excessive amount to buy out a former partner in the sanitary engineer's branch. His failure was further caused by loss through embezzlement of money by a traveller, and by depreciation in the value of his stock-in-trade.

The British Thomson-Houston Company, Limited.—This company announces that owing to increased business, it has become necessary to take further premises at 26 and 27, Bush Lane, Cannon Street, E.C., where new showrooms have been opened. This address is now the head-quarters of the supply department, under the management of Mr. A. J. Ireland, as heretofore.

The "Cabinet Maker."—A copy of the *Cabinet Maker and Art Furnisher* (edited by Mr. J. Williams Benn) for March, is before us, and is a trade publication of the first class. There is much artistic talent bestowed upon electric light fittings and their arrangement in house and mansion lighting, and in this work the art furnisher and the electric lighting man have a kindred interest. There is plenty of room for the two trades to work together in the matter of electric light casings and mouldings, so as to prevent them becoming an eyesore. The work of Messrs. J. F. & G. Harris in this line is made the subject of a short article. Matter of interest is afforded by the article describing the new factory of Messrs. C. & R. Light, at Finsbury, the wood-working machinery in which is operated by electric power, a 30 H.P. electric motor being employed. A 20 H.P. motor is shortly to be added. An electric lift is used, and the building is lighted electrically.

Cole, Marchent & Morley.—This firm, of Prospect Foundry, Bradford, has just issued a new catalogue of steam engines and condensing plant. The list is got up in what we are accustomed to consider the American style of arrangement, with small pages and very neat illustrations. In the letterpress we observe a discussion of the points affecting the selection of a suitable type of engine for the required purpose, the question of space, character of load, water and fuel supply, and boiler pressure, being dealt with. Among those described is the Corliss engine, the firm's own standard Corliss engine, details being given of general arrangement, and of the construction of the principal parts, also Corliss engines with positively driven valves, high-speed vertical engines, and the steam Barring engine with automatic throw-out gear. One section to which we referred last week, is devoted to independent condensing plants. We understand that Messrs. Cole, Marchent & Morley have, during the past few years, practically remodelled their works, and laid themselves out for the production of the highest class of engineering work.

Crompton & Co., Limited.—This company have decided to close the office at 35, Queen Victoria Street, at which address they have hitherto been carrying on the sale of electrical cooking and heating appliances, and from March 1st this branch of their business will be carried on at the Arc Works, Chelmsford. In future they will supply their electrical heating and cooking appliances to the trade only.

Diversified Uses for Storage Batteries.—Our New York namesake recently gave a list of some of the battery contracts being carried out by the Electric Storage Battery Company, as signifying the diversified uses to which secondary batteries may be put. The latest contracts cover batteries to be used in connection with electric elevators; large plants for the Chicago Edison Company and the Buffalo Railway Company, and for private residences. Also in Mr. Howard Gould's new steam yacht *Niagara*, and Mr. Lloyd Phœnix's yacht *Intrepid*. The American Fire Insurance Company's building in Philadelphia is being equipped with a battery for night lighting. The Germantown, Pa., Hospital, is increasing the capacity of its plant by 50 per cent. Batteries have been furnished to the Cleveland Telephone Company and the Southern Bell Telephone Company; also for fire-alarm work at Portland, Ore., Augusta, Ga., and St. Paul, Minn.; for telegraph work on the Lehigh Valley Railroad, the Southern Pipe Line Company, the Great North-western Telegraph Company, the Chicago, Milwaukee and St. Paul Railway Company, the Postal Telegraph and Cable Company, and the General Electric Company. The Patton Motor Company and the National Electric Car Lighting Company are installing them in connection with their systems, and the State School of Mines, Colorado, has equipped its laboratory with them.

Dortmund Electrical Exhibition.—Arrangements are in hand for the holding of an electrical exhibition at Dortmund, Germany, in July next.

Electric Timepieces.—The Swansea Free Library Committee has had under consideration the tender of Mr. Gans for the supply of six electric timepieces for the library and one for the exterior of the building, at a cost of £84 14s. The matter was deferred.

A Gas Chairman on Incandescent Gas.—A shareholder in the Cheltenham Gas Company raised the question of street lighting at the meeting of the company held on Tuesday last week. He said there was a strong desire outside the area of the electric light for an improved illumination by gas. Many people were of opinion that an improvement could be made by the adoption of the incandescent burner. He hoped to have an assurance that the directors would consider this matter, make experiments, and give the Corporation the opportunity of judging whether a better light could not be supplied, and at what cost. The contrast between the electric light and gas light was so unfavourable to gas, that the Town Council were justified in asking for something better than was now given. Unless the lighting of the streets by gas was greatly improved, the lighting of them by electric light would make speedy strides. The speaker was differed from by another shareholder as to the result of the use of the incandescent burners in Liverpool. He had seen the lighting of the front of St. George's Hall in that city, and he came to the conclusion that it was an utter failure. The chairman, in reply, said the directors would only be too delighted to improve the lighting of the streets by any means in their power, and at several meetings lately they had considered the merits of incandescent and other burners; but the incandescent burner was not at present a perfect light, and certainly was not adapted for street lighting. Far from having the slightest prejudice to the incandescent burner, they would be glad to adopt it when they found it to be quite satisfactory.

List.—The British Bundy Company, of 100c, Queen Victoria Street, E.C., sends us a list of the Bundy time recorder. It is claimed that this system will tell the exact time each workman arrives at and departs from the works, even to the time devoted in the department where employed. The process of registering can be performed so quickly that no loss of time is entailed thereby. Each employé is given a numbered key, and upon arrival in the morning, whenever he goes out and returns during the day, and upon leaving at night, he registers the time and his number by inserting the key in the proper place in the recorder and giving it a quarter turn. In registering when going out, the lever at the left of the clock is held down, thereby printing a star opposite the number, showing departing time. A printed impression is thus made on the paper ribbon inside the clock of the hour and minute that each employé registers, together with his number. The recorders can be placed at convenient points at entrances or in departments. At each registration a bell rings.

"Lithin."—This is the name of a new insulating material being supplied by the firm of Hirschmann & Co., of Rummelsburg, b. Berlin, a German list of which is before us.

Motor Omnibuses.—Negotiations are in progress to start a service of motor omnibuses. Daimler petrol engines, of from 8 to 10 horse-power would be employed.

New Company.—The Compagnie d'Electricité Thomson-Houston de la Mediterranée, recently formed in Brussels, has a capital of £200,000. Its operations are restricted to Egypt, Greece, Spain, Portugal and Italy.

Rochefort-sur-Mer Exhibition.—We are informed that the buildings and other operations in connection with this exhibition are progressing. The exhibition is under the esteemed patronage of MM. les Ministres du Commerce, de l'Industrie, de la Marine et des Colonies, du Department, de la Municipalité et de la Chambre de Commerce. It will be both international and colonial, and will embody all the products of commerce, industry, marine and fine arts. Applications to be addressed to the Administration de l'Exposition, Mairie de Rochefort-sur-Mer.

The "Sans Pareil" Reflector.—Messrs. Webster and Co., Theatre Royal, Leeds, have sent us particulars of their "Sans Pareil" reflector, for diffusing the light of incandescent lamps. The reflector is of cardboard, lined with foil, which can be had in various colours, thus, to a certain extent, minimising the loss of light from colouring the lamps. Some of the reflectors which we have seen had been in use since July last, and had not tarnished, as is the case with metal and silvered reflectors. There should be a large demand for them in the smaller theatres throughout the country. Messrs. Webster have also patented an arrangement of battens made of bamboo to take the place of the cumbrous and heavy battens hitherto in use. The proprietor of the Theatre Royal, Leeds, speaks highly of both reflectors and battens.

The Shannon Water-power Scheme.—The scheme of the Shannon Electric Power Syndicate, which proposes to utilise water-power from the Shannon, is being pushed forward. A committee of the Limerick Fishery Conservators is to confer with the syndicate on the matter.

South African Notes.—Our contemporary, the *British and South African Export Gazette* for March, has the following notes on electrical work:—An electric lighting installation is under contemplation for the Monastery diamond mine, Orange Free State. An electrical tram installation is in contemplation at the Sheba gold mine, to replace the present steam tram. The provision of an electric light installation for Woodstock, Cape Colony, is under consideration by the Town Council. A dynamo for the electric lighting equipment of the Glen Deep mine has been ordered. The proposed electric lighting plant for East London will include 43 2,000-C.P. arc lamps, 327 32-C.P. glow lamps, 2,304 16 C.P. glow lamps, five continuous current machines for arc lighting, three direct coupling alternators for the glow lamp service, two switchboards, and other accessory material. Tenders ranging from £12,000 to £30,000 have been received by the Bloemfontein (Orange Free State) Town Council for the proposed electric lighting installation in that town.

Winding-up Petition.—A petition, presented by Mrs. Jones and Messrs. Ross, creditors, for the winding up of the Ariel Arc Lamp Syndicate, is to be heard by Mr. Justice Wright on March 16th.

ELECTRIC LIGHTING NOTES.

Acton.—The Council last week considered the electric lighting question in committee, interviewing Mr. Lacey and Mr. Trentham, the two experts who have been engaged to report.

Bath.—At the last meeting of the Electric Lighting Committee a statement was presented of accounts in connection with the Electric Lighting Works for the year 1897, from January 17th to December 31st, which showed the following figures amongst others:—Revenue account: Public lighting, £2,184 11s.; other consumers, £4,115 14s. 5d.; meter and transformer rents, £219 1s. 9d.—total, £6,519 7s. 2d.; repairs, £395 2s. 8d., stores on hand and sundry receipts, £358 11s. 4d.; total income, £7,273 1s. 2d; total expenditure, £5,001 8s. 9d.; gross profit, £2,271 12s. 5d.; special expenditure, £1,626 7s. 4d.; net profit, £645 5s. 1d. As regarded the income the first three items of receipts for current amounted to £6,519 17s. 2d., as compared with £6,332 15s. 8d. received by the company for 1896, showing an apparent increase of £186 11s. 6d. The actual increase, however, was much greater if they took into account the shortening of the year by seven days at its commencement, and, this adjusted, the increase was about £330. The following is a summary of the capital expenditure to December: Original purchase, £24,830 18s. 5d.; additions since—sundries, £1,168 2s. 7d; builder's contract, £6,175; further works sanctioned, £19,676 16s. 8d.; total, £51,850 17s. 8d. The profit was £1,952 7s. 5d., which it was proposed to deal with as follows: Interest on loans, £707 2s. 4d.; depreciation fund, in view of sinking fund, £600; balance carried forward to next year, £645 5s. 1d.

In respect of the complaints *re* the efficiency of the light, Alderman Taylor reports to the Council that night after night his colleagues and himself had been round making the necessary tests. In nearly every instance they had found that where there was a bad light it was not their fault, and did not arise from the works. The power supplied was quite equal to the demand. He hoped people were not going to throw on the committee the blame when the lamps were not properly cleansed. He was making a report.

Bedford.—Consumers are dissatisfied with the charges for current, and a meeting was held in the Town Hall last Friday, when it was considered that the charge should be reduced to 4½d. per unit.

Belfast.—The Engineer has reported the alternative arrangements he had proposed to the Acme Gas Company for the purchase of the engines at present on hire from them, and it has been decided to return the engines to the owners.

The Gas and Police Committee is taking steps to secure the best method of lighting the leading thoroughfares within the present area of the city.

Bromley.—The Bromley Urban District Council has received the information required by them from the Bromley Electric Lighting Company, and have finally decided to transfer the electric lighting powers to the company. The Council's seal has been affixed to the deed of transfer of the electric lighting powers to a company.

Bury.—At the last Town Council meeting Mr. Pickup stated that after allowing a sufficient reserve for the electric lighting plant, they were able to supply current at the rate of 180 units per hour, whilst the demand at present is for only 90 units per hour.

Calcutta.—The Bengal Government has nominated Mr. Mearn for the appointment of Inspector of Electric Lighting in the City of Calcutta.

Camberwell.—It is stated that the General Purposes Committee of the Camberwell Vestry, intend to repeat their recommendation to purchase the vested interests of the County of London and Brush Provincial Electric Lighting Company in that parish, at a premium of 33 per cent. upon the capital expended, with an additional dividend of 5 per cent.

Canterbury.—The Council has accepted Mr. A. J. Brewster's tender for the erection of their electric light station as follows: Buildings, £4,032; boiler seatings, flues, &c., £910.

Cardiff.—The electrical engineer (Mr. Appelbee) has submitted a proposed scale of reduced charges. The present rate is 6d. for the first two hours' average daily use and 3½d. afterwards. The new rate suggested was 7d. for the first hour and 3½d. afterwards, while in the case of that small class of consumers who only use the light on an average one hour a day the charge should be a uniform one of 5d. per unit. The supply of electricity for 1897 had increased by 34,000 units over the preceding year, the total revenue was £6,968, and the surplus on the year's working would probably be about £230. The chairman advocated a slightly further reduction by making it 3d. instead of 3½d. after the first hour. Consideration of the question was deferred to a future meeting.

Chelsea.—The Vestry will oppose the Bills to be introduced into Parliament by the Chelsea Electricity Supply Company and the Metropolitan Electric Supply Company.

Croydon.—At the last County Council meeting it was reported that the plans and quantities for the extension of the electric light station buildings were nearing completion, but as the matter was urgent the borough engineer had been consulted and had obtained prices for excavation and for putting in the foundations to the ground level and the engine beds. A tender had been accepted for the work. The mains are to be extended in Addiscombe Road at a cost of £200. 15 alternating arc lamps are to be employed for the lighting of South End.

Darlington.—Prof. Kennedy was last week appointed by the Council to report and estimate *re* electric lighting for the borough.

Dartford.—The District Council does not approve Mr. H. S. McKrell's proposal to apply for a provisional order. A municipal order is already applied for.

Dorking.—A public meeting was called by the District Council and held on Thursday last week, for the purpose of giving information to ratepayers on electric lighting, previous to their voting on the question. Mr. Warden-Stevens was present and gave, in reply to a question, figures of the progress made in other towns. He recommended the alternating current high tension system. He also recommended a municipal supply. Mr. Gripper, managing director of Edmundson's Limited, was also present, and he contended for the low tension system.

Dundee.—Some of the electric arc lamps for street lighting were lighted for the first time on 1st inst.

East Grinstead.—At the next meeting of the District Council, Mr. Steer will move a resolution in favour of making application to the Board of Trade for a license or provisional order to enable the Council to supply electricity for public and private purposes within their district, or such other area as the Council may determine. This was done at the request of the General Purposes Committee, of which Mr. Steer is chairman.

East London (South Africa).—Specifications and plans are about being prepared for the electric lighting and tramway scheme for East London. The Borough Engineer's report suggests supplying the present public and private requirements of the town and furnishing the Harbour and Railway Departments with supply. The *British and South African Export Gazette* says that the supply of electric energy for the tramways is also included in the scheme. The locality of the generating station has been fixed near to the new wharf extension and also to the railway line for coal supplies. The scheme makes provision for a reserved plant, spare or duplicate engines, dynamos, boilers, &c., being contemplated. For the incandescent street and private lighting service, two direct-coupled alternators, with one spare one, are recommended. For the arc lighting service, two continuous current machines are proposed, one being for the Harbour Board's requirements, and the other for the Railway Department and the streets jointly. For the tramway service, one continuous current machine is apportioned. A spare continuous current machine is to be provided, to be available for arc lighting or tramway, the switchboard being so arranged that the current can be used for either lighting or traction purposes. For lighting power the scheme contemplates an energy equal to 2,804 16-C.P. glow lamps and 43 arc lamps per hour, *plus* the energy required for the three miles of trams, or 18 B.T. units per hour. The lamp provision comprises—for street lighting, 18 2,000-C.P. nom. arc lamps and 300 32-C.P. glow lamps; for the Harbour Department, 21 2,000-C.P. nom. arc lamps and 725 16-C.P. glow lamps; for the Railway Department, four 2,000-C.P. nom. arc lamps and 27 32-C.P. glow lamps. For private lighting, 1,500 16-C.P. glow lamps are recommended. High tension mains would deliver the current to transformers for the service of the low tension mains supplying the street and private incandescent lamps. It is proposed to place the street lamps in duplicate, arranged so that the second is automatically lit when the first is extinguished. The tram track, three miles in length, passes through St. Peter's Road, Oxford Street, Fleet Street or Caxton Street, Currie Street, Inverleith Terrace to the Beach. Future extensions contemplate the crossing of the Buffalo bridge to the West Bank. It is proposed to adopt the overhead trolley system, the track being laid with 60-lb. rails, and the cars constructed to carry 25 persons. The Town Council appointed as expert Mr. Lewis Cousens, M.I.E.E., Johannesburg, to draw up specifications and plans for the Council's approval, upon which tenders will be called for.

Edinburgh.—Various proposals are under the consideration of the Cleaning and Lighting Committee for using electricity in many streets where gas is now employed.

Edmonton.—After inquiries made by the architect, in conjunction with a London electrical engineer, the Board of Guardians Electric Lighting Committee finds that the adoption of electricity instead of gas for lighting the Edmonton House will result in a considerable saving. The Committee has now been instructed to obtain plans, specifications, and estimates, with power to employ a consulting electrical engineer.

Glasgow.—The arc lighting of St. Andrew's Hall, which has not given satisfaction to the Council, was discussed again last week, and a resolution was passed, "that in view of the unsteady character of the lighting, of the noises emitted by the arc lamps, and of the fact that the roof is practically invisible under the present method, a system be adopted which will be both efficient and silent." The Bazaar Committee was already considering the matter.

Gloucester.—When the Council had electric lighting matters before it last week, it was resolved to purchase part of the Bearland estate for a site for the electric lighting and dust destructor works, at a cost of £7,125, instead of either of the sites previously suggested. The tenders, of which we gave details last week, were afterwards accepted.

Greenock.—The Sub-committee on Electric Lighting is recommending the Police Board to extend the electric light in town at a cost (including site) of about £28,000. The proposal provides for the erection of about 40 arc lamps and pillars along the main streets, and the extension of the installation should such a demand arise.

At a special meeting of the Police Board on 28th ult., held to consider the electric lighting question, it was agreed to ask the Board of Trade for another month's extension of time to allow of the matter being more carefully considered. Mr. Teague's supplementary report has not yet been submitted to the Board.

Hampstead.—In the estimates for the ensuing financial year just placed before the Vestry, show that it will be unnecessary to make any demand on the rates in respect of electric lighting. The income from private consumers for the year 1898-9 under this head is estimated at £19,000, and the expenditure, including working expenses, establishment charges, interest, and repayment of principal of loans, at £13,500, thus showing an estimated net profit for the year of £5,500.

The Lighting Committee has had under consideration the question of providing additional plant for the winters of 1898 and 1899, and the Vestry has decided that additional plant be obtained at an estimated cost of £17,000. Tenders will be invited for the supply of the plant. The new plant at present fixed is almost ready for working. Mains are to be extended along several roads.

Hartlepool.—The borough engineer is to report on the cost of laying down, in connection with a dust destructor, electrical plant for public lighting.

Islington.—At a recent Vestry meeting the treasurer, replying to a question, said the number of public gas lamps in 1892 was 4,548, and the cost of the gas for each lamp £2 17s. 9d. In 1897 the number was 4,725, and the cost of gas for each was £3 0s. 11d. In 1897 the number of public electric lamps was 100, and the cost of the current to each lamp was £40 6s. 1¾d.

Kingswood.—The question of the municipal purchase of the electric lighting undertaking of the Western Counties Electric Lighting Syndicate has been raised on many occasions, but up to the present has not been actually settled. The last meeting of the Kingswood Council had before it a letter from the syndicate asking when the purchase was likely to be completed. The chairman of the Council said that a letter was written to Messrs. Parfitt some time ago, stating that as soon as the Local Government Board inquiry took place and the loan was sanctioned, a time for settlement of the purchase could be arranged. Mr. Parfitt's list of the extension was received, and would come up at the inquiry. There is about 18 months of the lease with Messrs. Parfitt for lighting the district to run, during which period they have to keep the plant, &c., in repair.

Leeds.—The Parliamentary Committee has approved a draft of the provisional order to be asked for in connection with the purchase by the Corporation of the electric light undertaking. The following are the terms of the purchase proposed by the Town Clerk in a recent letter to the company. "(1) The purchase to take effect as from March 1st, beyond which date, of course, there could be no further expenditure by the undertakers upon the undertaking chargeable to capital account; (2) that the Corporation issue or transfer to the undertakers, as purchase money, Leeds Corporation Redeemable 2½ per cent. Stock in lieu of Irredeemable Stock, the former to be of such an amount as would equal in value in the market a Leeds Corporation Irredeemable 5 per cent. Stock; this amount or value to be determined by arbitration in case the parties differ; (3) should it be found that any sum is payable to the undertakers to make up the dividend on capital expenditure to 5 per cent., the Corporation will be prepared to pay that amount in cash. The like also in regard to any agreed expenditure on capital after the date mentioned; (4) that in order to save time in the completion of the purchase, the Corporation be permitted forthwith to investigate the company's books and accounts, with a view of ascertaining to their satisfaction the sum properly expended by the undertakers upon the undertaking and chargeable to capital account." The offer is made without prejudice to the application of the Corporation to the Local Government Board for a provisional order empowering them to issue Irredeemable or other stock for the purpose of the purchase, and subject to confirmation by the Parliamentary Committee and the Council.

Leyton.—The electrical engineer is to have provided a sub-station in High Road, Leytonstone.

Lincoln.—The City Council expects to start the electric light works in October next. The Electric Lighting Committee and the electrical engineer, Mr. C. Vesey Brown, are pushing the works forward. The City Council last week arranged the positions of a number of street lamps.

Liverpool.—The Lighting Committee has agreed to extend the electric supply mains into Manchester Street and School Lane. A new design of electric lamp is to be tried for Bold Street.

Manchester.—At the last City Council meeting, Sir John Harwood mentioned that the Waterworks Committe had requested Mr. Hill, C.E., to obtain the opinion of an electrical engineer and such other assistance as in his opinion might be necessary, and report as to whether the water supply from Longdendale could in any satisfactory way be utilised for the purpose of generating power in connection with the supply of electricity. There was, Sir John said, a difference of opinion on this subject, and they wanted to get at the facts. Mr. Alderman Higginbottom suggested that Mr. Wordingham, head of the Manchester Electrical Works, should be the engineer called in by Mr. Hill. Sir John Harwood said the suggestion was rather premature. No doubt Mr. Wordingham would be consulted.

The City Council has, on the recommendation of the Electrical Committee, advanced the salary of Mr. F. E. Hughes, secretary, from £225 to £250 per annum, and that of Mr. A. A. Day, chief assistant engineer, from £250 to £275 per annum.

Mardy.—On Thursday night last week the new electric lighting works put down by the Mardy Electric Light Company were opened. The plant was supplied by Messrs. Crompton & Co., and erected under the supervision of their local agent, Mr. Hughes. The plant has a capacity of 1,300 8-C.P. lamps, which is considered sufficient to light 2,000. The installation has cost about £1,600. The plant comprises a steel locomotive multi-tubular boiler generating steam at 150 lbs. pressure for a 60-brake H.P. compound vertical engine. There is a duplex feed pump capable of pumping 1,000 gallons per hour against the boiler pressure of 150 lbs. The Crompton dynamo is of the firm's latest patent shunt-wound type, having an output of 168 amperes at 220 volts when running at 750 r.p.m. A booster is used for raising the voltage to 300 for accumulator charging. At present about 600 lamps are supplied, but it is anticipated that very shortly the plant will be working at its full capacity. The Mardy Company is itself wiring and fitting consumers' premises. The fittings have been supplied by the Ediswan Company. Mr. Harris has been appointed electrician to the company. It is expected that the District Council will shortly go in for public street lighting by electricity. The price of gas is 4s. 6d. At a supper held after the inauguration ceremony there were various toasts proposed and responded to.

Newcastle.—It having been stated that the electric lighting works are to be removed from Pandon Dene to another spot, the question of purchase by the City Council has again arisen.

Nottingham.—At the new Empire Theatre of Varieties the electric light is largely used. In the auditorium alone there are over 100 lights; while for the footlights, lamps of various colours are employed. Mr. Joseph Blackburn carried out the electrical work.

Plymouth.—The Electric Lighting Committee intend to run the wires in the direction of the infirmary owing to the number of public and other buildings requiring the light. It is intended to wire buildings free of cost at first, and spread the payment over two years.

Poplar.—After a long discussion, the Board of Works has decided to undertake the electric lighting itself, without the intervention of the company that has been seeking a provisional order.

Reading.—The minutes of the Lighting Committee read as follows: On February 11th the Town Clerk was instructed to confer with the Board of Trade as to the powers of control of the Corporation with reference to changes proposed from time to time in the system of supply of the Reading Electric Supply Company, and the effect of such changes upon the question of the capital properly expended, which was to form the basis of the sum to be paid by the Corporation in the event of their purchasing the undertaking. On the 18th the Town Clerk reported that a further alteration of the system of supply was in contemplation, and it appeared to him the only mode in which the Corporation could exercise effective control over capital expenditure was by themselves becoming the undertakers under the order.

Saltburn.—The Cleveland and South Durham Assets Company proposes erecting plant, &c., for the supply of electricity to private and business premises, and a plan of the streets which will be traversed and crossed by overhead wires was submitted to the Saltburn Urban Council last week for approval. Mr. T. P. O. Yale, A.I.E.E., attended for the company. The Council will hold a special meeting to consider the scheme.

Sheffield.—The *London Gazette* of March 4th contains notice of the Bill to be applied for by the Corporation for the purpose of the purchase of the Electric Light Company's undertaking.

Shoreditch.—At the last Vestry meeting it was reported that the Lighting Committee had received from the makers of the engine a letter admitting their responsibility for not supplying relief valves to the cylinders, from which omission the Committee were advised the accident at the electricity works, recently referred to in the ELECTRICAL REVIEW, arose. After considering and being advised upon the circumstances, the Committee instructed the Vestry Clerk to write a letter to the company under whose contract the engine was supplied, informing them that owing to the non-supply of relief valves as promised by the contractor, they would be held responsible for the accident and any resulting damage to the works of the undertaking. The term of maintenance of this engine after completion for which the contractor is responsible has not expired. Postcards have been sent round to a number of consumers stating that unless the accounts were paid at once the supply would be cut off. These have given offence to many consumers.

Shoreham.—The Southern Cross Ship Yard and Engineering Company is to have an interview with the Urban Council *re* supplying the Shoreham district with electric light.

On Thursday last week the scheme was explained to the District Council. The total cost is estimated at £6,000, and this would provide 56 1,000-C.P. arcs, and 1,500 16-C.P. incandescents. Mr. R. E. Churchill-Shann explained the scheme. It does not yet seem to be settled whether it will be carried out as a municipal or a private undertaking. The matter is to be discussed in committee.

Southampton.—The Corporation is considering the subject of entering into an agreement with the Electric Free Wiring Company.

Stirling.—The Police Commissioners, last week considered the question of electric lighting in conjunction with Prof. Kennedy's report, from which we quoted last week, on the water power at the Touch reservoirs. According to the *North British Daily Mail* account, Bailie Lawson moved that the report be received, its conclusions adopted, and the Lighting Committee instructed to proceed with the carrying out of the instructions from the Commission at the point where they were interrupted in December. Mr. Ferguson seconded. Ex-Provost Yellowlees moved as an amendment that Prof. Kennedy's report be laid on the table, and the Commission remit to the Lighting Committee to get from an electrical engineer, who is a specialist in the use of water power, at a cost not exceeding 20 guineas, a further report, with guaranteed estimates, as to the utilisation of the water pressure available at the reservoirs for the electric lighting of the town. Mr. Yellowlees held that the report by Prof. Kennedy on the water power available at the reservoirs was founded on wrong data, and that his conclusions were entirely misleading. He had based his calculations not on the quantity of water available at the reservoirs, but on the quantity of water delivered in the town after deductions, which brought it down to one-half of the actual amount. Mr. Hay seconded the amendment, which was carried by 11 votes to 8.

Stockport.—It is stated that the electricity works will be in operation about September next.

Torquay.—Electric light was switched on at the Town Hall on 1st inst.

Wallasey.—Mr. Ellery said at the last Council meeting that the Gas, Water, and Electricity Committee was making a reduction of 17 per cent. on the charges for electrical energy.

Wells.—The Town Council has received a letter from the Electric Light Supply Corporation asking if the Council would sell its electric light provisional order, and the Town Clerk was instructed to reply that it was not in the market.

Worcester.—The electric lighting accounts for 1897 show that the receipts were £6,291 against £4,757 in 1896, and there was a loss on the year's working of £1,474 10s. 9d., against £1,616 in 1896 and £1,443 in 1895. The expenditure of capital up to the end of 1897 was £67,293. The enterprise, says the *Worcestershire Echo*, has not even earned the interest payable by nearly £500, to say nothing of depreciation, a word which is not to be found in the accounts. A most startling item is to be found in the table showing what has become of the electricity generated. The total in Board of Trade units was 559,275, of which there were used for public lamps 83,700; sold to private consumers, 325,130; used in works, 5,155; *quantity not accounted for*, 145,290, *more than one-fourth of the total!* Thus, roughly speaking, for about 25 per cent. of the expenditure, representing £1,000, there is no return whatever! When the accounts came before the City Council on 1st inst., Mr. Rushton complained that statements made by the chairman of the Electricity Committee (Alderman Williamson) as to the value of the water power had been falsified by the results. Alderman Williamson said the statements were made on the authority of the experts employed by the Council. Mr. Rushton moved a long resolution asking for reports upon various features of the working of the department. Mr. Charge suggested that the works at Powick should be abandoned, and a generating station started in the city. An amendment was eventually carried asking the committee for a report on the year's working similar to one given in the previous year.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Berlin.—In the annual report of the Great Berlin Horse Railway Company, it is said in reference to the electric working of the street railways: the existing electric working of the street railways first introduced in May, 1896, and extended on April 28th, and again on June 5th, has on the trolley section given the greatest satisfaction, and all the doubts and prejudices with which it was regarded at first have been dissipated. The power of despatching crowds of passengers by means of trailer cars has given especial satisfaction to the public, and it is to be hoped, in the public interest, that the use of trailer cars may be extended by authorities when the network is re-modelled. In accordance with the decision of the authorities, a number of sections, especially in the inner city, are to be worked by accumulators, which are to be charged from the trolley wire. The present conduit in the Lindenstrasse and in the Dennewitsplatz are to be done away with, and no more conduits will be constructed. This will obviate many difficulties in working and much blocking of traffic. A more important point for the future working of the lines is, that the authorities have directed that bogie cars shall in future be used. These have accommodation for 28 passengers inside; they run smoother, and the resistance on curves is greatly reduced. It is intended to construct these bogie cars in large numbers.

Berlin.—An electric tramway running east and west across Berlin and taking in the Leipziger Strasse, and traversing the Potsdamer Platz, the busiest thoroughfares in the city, was tried for the first time on Tuesday last week. It is intended to replace the horses gradually on all the urban tram lines.

Bournemouth.—The British Electric Traction Company has written to the Town Clerk, stating that it is still hopeful of laying such a scheme for electric tramways before the Corporation as might be satisfactory to all concerned. The directors are taking steps with a view to such a scheme being formulated.

Brighton.—Mr. Magnus Volk, who is now sole proprietor of the electric railway, has arranged to take the power necessary to run his cars from the Corporation electricity works in future.

Bristol.—Although a week or 10 days ago the prospects of a settlement being arrived at between the Corporation of Bristol and the Tramway Company with regard to the adoption of electricity on all the existing Bristol lines and on several new ones, were distinctly hopeful, the position has so far changed that popularly it is described by one word: "deadlock." The company (as reported in the ELECTRICAL REVIEW last week) replied in detail to the terms submitted by the Bristol Sanitary Committee, accepting some, rejecting others. Their answer was considered at a private meeting of the Sanitary Committee, at which some members expressed considerable surprise at the publication of the report of their electrical engineer, Mr. Faraday Proctor. This report had been sharply criticised by the company, and its statements with regard to the cost of electric traction denied in the most emphatic terms. Mr. Faraday Proctor, in consequence of his report being challenged, gave an explanation to the Committee, with which the Committee were satisfied. The Committee's decision on the question of terms raised two points of difficulty which at present there is no likelihood of settling by negotiation. The Tramway Company, in addition to the Bill which will empower them to adopt electric traction, has a second Bill authorising extensions of the system in several parts of the city. The new lines would amount to between 7 and 8 miles in length. The Sanitary Committee required agreement to the following condition: "The date at which the Corporation's power to purchase the power station and the proposed extensions will arise, to be the same as for the present horse tramways." In other words, that would be rather less than 15 years hence. The company agreed to arrange for the power station to pass when their existing lines are bought, but insisted on the full term, 21 years, of the Tramways Act for the extensions. The Sanitary Committee refused to give way, and the company talk of withdrawing their Extensions Bill. The second difficulty was not foreseen, and details cannot be given about it. It appears, however, that the Sanitary Committee has objected to the use of the trolley system in certain streets in which they do not think overhead wires are permissible. The company contends that the overhead system—the only one they had contemplated—is, practically speaking, the system which holds the field, and that other municipal authorities have selected it. Should the Extension Bill be withdrawn, the company will proceed with the Electrical Power Bill, and will be opposed by the Corporation. Meanwhile, several notices of Parliamentary opposition to the company's Bills have been given and the Great Western and Midland Railway Companies are among the opponents.

Cable Trams for Leith.—Mr. Colam, C.E., has been reporting to the Town Council on the cabling of tramways, and he estimates the cost of the conversion of the lines and the equipment, with all the necessary pits and machinery in same, at about £45,000.

Cambridge.—The directors of the Cambridge Street Tramways Company in their report say that they have had under consideration a proposal from the British Electric Traction Company for substituting electricity for horse traction on their system. The report stated "the great majority of the public recognise the superior facilities afforded by electric traction, and it was proved that such is the development of traffic on its adoption, that horse traction has no chance alongside it."

Dublin.—The Blackrock Town Commissioners are supporting the Bill of the Dublin Southern District Tramways relating to the speed.

Dundee.—The Corporation Tramway Bill (purchase and electric power) is being opposed by the North British Railway Company and the Caledonian Railway Company.

Ealing.—The proposed electric tramway scheme was again brought up at the last District Council meeting, a member having a good deal to say against the overhead trolley system. In fact, he deprecated even the laying of tram rails when there existed a likelihood that electric traction would shortly be possible without such disfigurements.

Finchley.—The District Council and the Hampstead Vestry are conferring for the purpose of opposing the electric tramway scheme.

Glasgow.—For the purpose of rendering it possible to use double-deckers on the Springburn electric tramway route, the level of Springburn Road underneath the Caledonian Railway bridge is to be lowered 15 inches, at a cost of £2,280, to be paid by the Tramways Department.

Hull.—The tenders for the remainder of the work in connection with the electric tramways, are now being discussed. The tenders for the supply of rails, and for hard wood, have been given out, also for the electrical plant, &c. The Board of Trade have made an order sanctioning a loan of £150,000, repayable in 30 years, for the purposes of the Hull Corporation tramways, such sum to be apportioned as follows, namely:—Permanent way, £123,200; land and buildings for electric generating station, £14,800; car sheds and depôts, £12,000. The Corporation estimates covering the balance of the loan requires further consideration, and the Board's decision will be communicated shortly. Tenders have been accepted for the supply of creosoted redwood stringers for tramways.

Leeds and Bradford Light Railway.—This scheme, which recently formed the subject of an inquiry by the Light Railway Commissioners, was before the Leeds City Council again last week, and the terms of the promoters were rejected, the previous resolution to oppose the scheme being confirmed.

Liverpool.—A deputation from the Tramways (special) Committee is going to Hamburg to inspect the working of the tramways there.

Manchester.—The representatives of about a dozen of the district councils affected by the Manchester Tramways Company's Bill have been conferring, with a view to arranging for opposition.

Norwich.—The Standing Orders Committee last week decided that the standing orders might be dispensed with on the condition that the provisions relating to Tramways Nos. 2 and 3 were struck out of the Bill of the Norwich Electric Tramways Company.

South Staffordshire Tramways Company.—At the annual dinner of the employés of the South Staffordshire Tramways Company last week, an important statement was made by one of the directors, Mr. S. R. Blundstone, M.I.M.E. He stated that the company last year was slowly but surely drifting on to the rocks, which meant liquidation. On one side they had £50,000 assets, and on the other side liabilities amounting to £73,000, but he was pleased to say their difficulties now seemed to have been overcome. The South Staffordshire Tramways Company had never paid a dividend, but at the next half-yearly meeting the shareholders would be asked to declare a dividend on the preference shares. Another important matter to the residents of Birmingham and Black Country districts was this, that it was proposed the South Staffordshire Tramway Company should form part of a vast overhead electric system, similar to those in vogue in America, and to cover a radius of 25 miles in Birmingham and the Black Country districts.

Swansea.—The British Electric Traction Company has taken formal possession of the property of the Swansea Tramways and Improvements Company. Possession was taken on Tuesday last week, by Mr. Emile Garcke, the managing director of the Traction Company, while Mr. E. W. Ruck, a director of the Tramways Company, with Mr. Kincaid, the engineer, represented the former owners in the transfer. The *South Wales Daily News* understands that there is no intention of making any change in the local management, and that directly the necessary authority is obtained electric traction will be applied. Our contemporary remarks that the British Electric Traction Company has taken up tramway concerns in different parts of the kingdom, which involve a capital of about £3,000,000.

TELEGRAPH AND TELEPHONE NOTES.

Delays in Australian Telegrams.—Australian papers recently to hand throw some light on the causes to which the interruptions on the Australian landlines are to be attributed. Under date, Adelaide, January 31st, we read that "The superintendent of telegraphs reports a partial telegraphic interruption on the Port Darwin line, owing to thunderstorms which have been raging between Powell's Creek and Port Darwin for the past two days. The line is also down between Perth and Roebuck Bay, all messages being sent *via* Port Darwin, adding greatly to the difficulties."

The Glasgow Telephone Report.—The report of Sheriff Jameson on the recent telephone inquiry held at Glasgow has not yet been placed before the public, though there seems some probability of its being issued any day now. The *Edinburgh Evening Dispatch* of 4th inst. thinks that the report will be issued in the course of this week, and adds: "On one vital point the Treasury has, it is said, satisfied itself. It may be assumed that the report pronounced the existing service to be unsatisfactory, and that some recommendation was made in the direction of a municipal licence. It has, however, been ascertained that there is a Parliamentary difficulty which, as the Treasury authorities believe, blocks the way. A telephone licence could not be taken up by the Corporation without the special authority of a Private Bill, inasmuch as the service extends beyond the municipal boundaries, and it is not competent for the Town Council to undertake any enterprise outside its own area."

In the House of Commons, last week, Mr. Caldwell asked the Secretary to the Treasury, as representing the Postmaster-General, if he was prepared to lay upon the table of the House the report and evidence taken by the Treasury Commissioner at the telephone inquiry in Glasgow, so that the same may be in the hands of members before the House goes into Committee on the Civil Service Estimates. In reply, Mr. Hanbury said that they had been laid on the table the day previous, and he would see that there was no delay.

Landlines in the Western Soudan.—As long ago as in August, 1895, we directed the attention of our readers to the steady progress with which the French Government landlines were being advanced eastward from Senegal. At that time the line was on the point of reaching Bamaku, on the Upper Niger, a distance of some 670 miles from the town of St. Louis on the coast of Senegal. We learn that since then the lines have been gradually extended, until, at the present day, they reach Waghadugu, which lies in the hinterland of the Gold Coast; a distance of 1,200 miles from St. Louis. We also learn that, running inland from Wydah northward through Dahomey, the line has reached the town of Pama, a distance of 360 miles; the gap now remaining between Waghadugu and Pama is about 170 miles, and when the junction is effected it will be possible to telegraph from the Bight of Benin to the Senegal coast by landline, a distance of 1,750 miles, by French landlines. We are glad to notice that the necessity of a system of landlines on the Lower Niger has been recognised by the British Government, and that it is proposed, at a cost of some £25,000, to effect communication with the Lower Niger through the districts to the north of Lagos and Forcados, the report running as follows: "It has been found necessary to incur special expenditure for the administration and defence of the northern territories of the Gold Coast Protectorate, and as the Colonial revenues are insufficient to meet such expenditure, the Imperial Government has agreed to give immediate assistance to the colony. The Imperial Government has undertaken to bear the cost of constructing a line of telegraphs from Lagos to Saka and Ogbomostro, thence to the Niger, and down the river to Forcados." A provision of £10,000 is asked for, to cover the cost of that portion of the line within the jurisdiction of the Colony of Lagos, which, it is believed, will be completed this year.

The Privacy of Telegrams—Speaking in the Commons last week on the question of the greater privacy of telegrams, Mr. Hanbury said the way in which telegraph offices were now arranged for the reception of telegrams was the result of long practice and experience, and the Postmaster-General thought they were on the whole conducive to the convenience of the public. Special inquiry would be made as to whether any further precautions were necessary.

Cable Interruption.—Amazon Company's cable beyond Obidos down March 9th, 1898.

The Telegraph Estimates. — The estimates for the Civil Services and Revenue Departments for the year ending March 31st, 1899, were issued last week. Under the Foreign and Colonial services the estimate for subsidies to telegraph companies has risen by £8,000 in consequence of the new subsidy to the Direct West India Cable Company in respect of the cable from Bermuda to Jamaica. In the Revenue Department, under "Post Office Telegraphs," a net increase is shown of £181,645 in addition to the sum of £28,800 voted as a supplementary grant last session. The grant for Post Office Telegraphs in 1897-98 was £3,182,990, and the total estimate for 1898-99 is £3,364,635, showing the increase of £181,645 as above.

The Telephone Service.—A deputation from the Belfast Merchants and Manufacturers' Association laid the question of municipal telephony before the City Council last week. The matter was referred to the Law and Improvement Committee for immediate consideration.

The Norwich Town Council has decided to petition the Postmaster-General for a municipal telephone license.

The Eastbourne Chamber of Commerce has passed a resolution in favour of municipal telephony.

A proposal to refuse to enter into negotiations with the National Telephone Company on the question of underground wires, was before the City Council last week.

The new Mutual Telephone Syndicate is still engaged communicating with various districts and towns in the provinces, endeavouring to get them to approve the principle of telephone competition. In some places the syndicate is receiving support.

CONTRACTS OPEN.

Belgium.—April 1st. The Municipal Authorities of Seraing are inviting tenders for the concession for the supply of electrical energy in the town for public and private lighting purposes during a period of 30 years. Particulars may be had from, and tenders to be sent to, the College des Bourgmestre et Echevins, Seraing, Belgium.

Bengal.—According to *Daily Tenders* the Bengal-Nagpur Railway Company wants tenders for the supply and erection of electric lighting plant for the bridges on the Bengal-Nagpore Railway over the Mahanadi River. Further particulars from the Superintending Engineer, Southern Division, Bengal-Nagpore Railway, Cuttack.

Berlin.—March 15th. The Municipal Traffic Deputation of the Town Council has opened a competition for the construction of several new electric tramways in that city. Exhaustive details concerning this project are contained in the *Elektrotechnische Zeitschrift* of the 13th inst., which mentions that proposals will be received by the Stadtische Verkehrsdeputation Rathhaus III, Berlin, by March 15th.

Blackpool.—March 22nd. The Corporation wants tenders for a tubular boiler, superheaters, condensers, rectifiers, boosters, transformers, lead-covered cables, arc lamps and pillars. Borough electrical engineer, Mr. R. C. Quin. See our "Official Notices" February 25th.

Darwen.—March 28th. The Corporation wants tenders for the supply of steam engine and dynamos, piping, accumulators, switchboards, mains, arc lamps, pillars, &c. See our "Official Notices" this w

Denmark.—March 12th. Tenders are being invited for the supply of the engines, dynamos, accumulators, &c., required in connection with the new central station at Frederiksberg, near Copenhagen. Tenders to be sent to the Frederiksberg Sporveis-og Electricitets Aktieselskab, Gammel Kongerie, 140, Copenhagen V., from whom particulars may be obtained.

Derby.—March 24th. The Corporation wants tenders for the electric wiring of the Lunatic Asylum and premises at Rowditch. See our "Official Notices" March 4th.

Devizes.—March 21st. Tenders are wanted for the supply and delivery of two 40 kw. continuous current belt-driven dynamos for the Wilts County Asylum, Devizes. Engineers, Messrs. Massey & Allpress, 25, Queen Anne's Gate, Westminster. See our "Official Notices" March 4th.

Edinburgh.—The City Council is inviting tenders for a host of stores and sundry articles. Among the items are "electric lighting materials for the Powderhall destructor," and "upholding of electric light installations." Particulars, &c, from the electrical engineer, Dewar Place.

Edinburgh.—March 22nd. The Council wants tenders for the additions and extensions to the electric lighting at the City Chambers. See our "Official Notices" this week for particulars.

France.—March 31st. Tenders are being invited by the Municipal Authorities of Saint Chamond (Loire) for the concession for the lighting of the public streets of the town, either by gas or electricity. Particulars from, and tenders to be sent to, La Mairie de Saint Chamond (Loire).

Leyton.—April 4th. The District Council wants tenders for the supply of two dynamos, one transformer, two gas engines and connections, and switchboards for extension of the electricity works. Electrical engineer, Mr. H. C. Bishop.

Manchester.—March 15th. The Great Central Railway Company (M. S. & L.) wants tenders for the supply of various materials and stores during 12 months ending April 30th, 1899. Among the items are asbestos packing, brass sheet and tubing, electrical materials, India-rubber, tin and zinc sheets, wire, &c. Particulars from Mr. A. W. Longden, storekeeper, at Junction Street Mills, London Road, Manchester.

Plymouth.—March 23rd. The Corporation wants tenders for the supply of alternating current meters for the year ending March 31st, 1899. Particulars from Mr. J. H. Rider, Borough electrical engineer, East Street, Plymouth.

Roumania.—March 15th. Tenders are being invited by the General Direction of the Roumanian Post and Telegraphs in Bucharest for the supply of 56,000 metres of galvanised iron and steel wire.

Southgate.—March 14th. The District Council wants tenders for an installation of electrical communication for fire brigade purposes. Surveyor, Mr. C. G. Lawson. See our "Official Notices" March 4th.

Spain.—March 21st. The Municipal Authorities of Santona (province of Santander) are inviting tenders for the concession for the electric lighting of the public streets of the town during a period of 20 years. Tenders to be sent to El Secretario del Ayuntamiento de Santona (Santander) from whence full particulars may be obtained.

Switzerland.—April 30th. Plans and estimates are being invited, says the *Contract Recorder*, by the Government authorities of Fribourg, Switzerland, until April 30th next, for a projected electricity generating station to be established at Hauterine. Water-power is to be utilised, and the station will have a capacity of about 6,000 H.P. A premium of £120 will be awarded to the three schemes submitted which are considered to be the best. Plans and estimates are to be sent to the Department des Travaux Publics, Fribourg, Switzerland, from whence full particulars of the competition may be obtained.

The War Office.—April 27th. The Secretary of State for War is prepared to receive offers, competitive designs and specifications for the supply of portable electric search light apparatus. Particulars from the Director of Army Contracts, War Office, Pall Mall, S.W. See our "Official Notices" February 4th.

Victoria.—March 21st. The Telegraph Department of the Victorian Government Railways is inviting tenders for the supply of alternating current transformers and one main switchboard. Tenders to the Telegraph Superintendent's Office, Spencer Street, Melbourne.

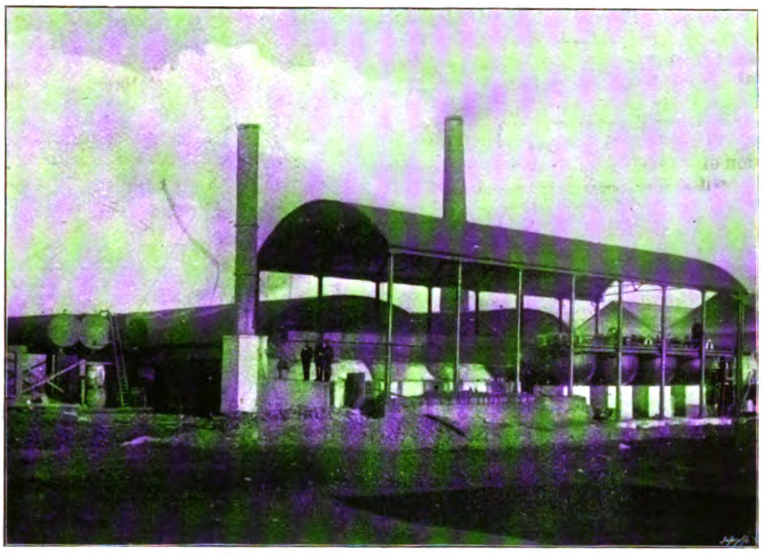
Victoria.—June 24th. The Council of the city of Hawthorne (Colony of Victoria, Australia) is inviting tenders for the supply and erection of buildings, boilers, engines, dynamos, transformers, mains, meters, arc lamps, poles; also running the plant for three years. See our "Official Notices" for particulars.

Wallasey.—March 17th. The District Council wants tenders for the supply of engine, alternator, exciter, two Lancashire and one water-tube boilers, and condensing apparatus. Engineer, Mr. J. H. Crowther. See "Official Notices" February 11th.

Watford.—March 16th. The District Council wants tenders for the supply and erection of various plant for the electric lighting of the district. For details of the seven sections see our "Official Notices" February 11th. Mr. W. C. C. Hawtayne, consulting engineer.

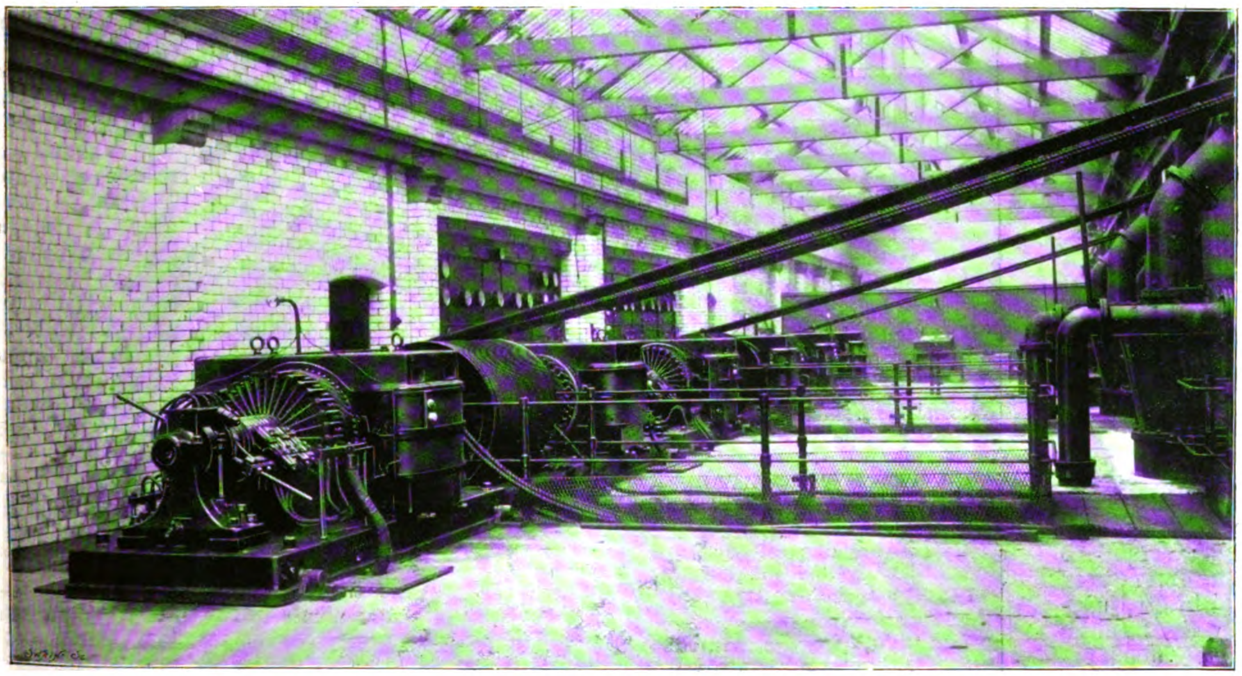
THE MANUFACTURE OF ELECTRO-CHEMICAL PRODUCTS.

There has been always more or less mystery associated with the electro-chemical industries, and probably the difficulty of penetrating into the inner recesses of such processes has been to some extent responsible for much of the legendary lore that has gathered round them. Occasionally the corner of the veil has been lifted, and one has been permitted to gaze upon what after all has been neither very mysterious nor especially wonderful; but, speaking generally, it is as difficult for a stranger to enter the gates of electro-chemical works as it is for an explorer to reach the City of Lhassa. With one or two conspicuous exceptions, there have been no places so jealously guarded from the inquisitive eye as copper depositing works. So rigorous are the rules in one well-known manufactory, that if it is necessary to introduce an outsider into the works for repairing plant or other specific purpose, he is usually conducted blindfolded to the spot where his services are required; yet the quality of the electrolytic copper produced at these works is not higher than that deposited in places where less secrecy prevails. With the migration of officials and workmen, and occasionally from other causes, it would seem almost impossible to keep any chemical or electrical processes completely concealed. There may be certain details of plant or process that it is desirable to keep within the four walls of the place where they have been evolved, but we do not think that there is much to be gained from a complete seclusion. Moreover, we think that where persistent attempts have been made to keep the details of a process secret, there is always more difficulty in dealing with supposed infringers.



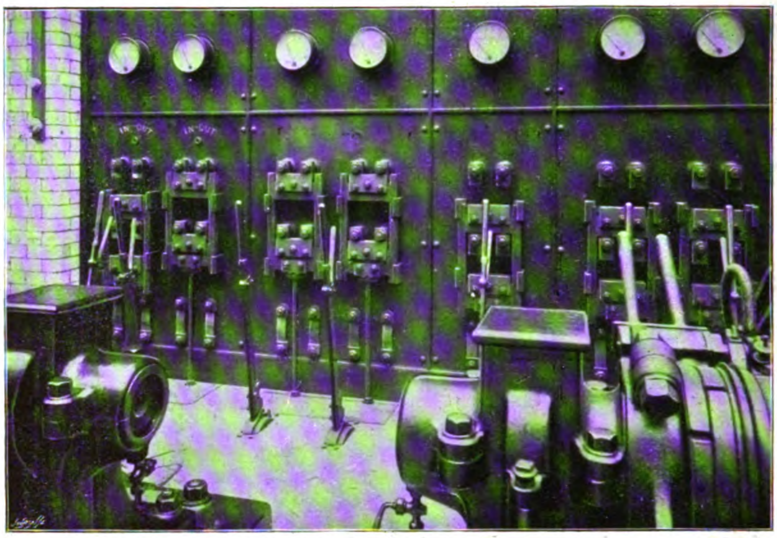
Chlorate of Potash Plant.

It is hardly necessary to say that electricity in many chemical processes has proved to be invaluable, and that this application of electricity is destined to be one of the most fruitful, is strikingly shown by the rapid development of the electro-chemical industry. Although considerable commercial success has been achieved in the use of electro-chemical processes, they, at any rate in their initiatory stages, call for extraordinary care; they may be, and no doubt when compared with older methods, are delightfully simple, but unless some regard be paid to the economical apportioning of the electric current for the necessary function of electrolysis, it is not difficult to realise that the process might prove an expensive one. The whole basis of the electro-chemical industry is that electricity offers a cheaper means of obtaining certain products than can be obtained by ordinary chemical methods; but the operations necessitate the continuous running of electrical machinery, and even with the most economical engines, the amount of coal burnt per annum, even in works of moderate output, must be considerable. As Mr. Andreoli pointed out in these columns some years ago, electrolytic works ought to be established in districts where coal and salt are cheap, and this is a necessary condition of the possibility of the competition of electrolysis with the chemical production of chlorine and caustic soda. It can, we suppose, be said of almost all the electro-chemical companies in this country, that they have settled in districts that are contiguous if not actually in the coal fields, and where salt is at the same time abundant.



General View of Engine Room.

It is not proposed in this article to deal generally with the subject of electro-chemical production of chemicals, but rather to give an account of the methods adopted in one well-known works for the manufacture of caustic soda, bleaching powder, and chlorate of potash. The Electro-Chemical Company, of St. Helen's, have been courteous enough to comply with our request to inspect their works, and to show the various processes in operation. There are some details connected with the works that the company has been compelled to withhold from us, but in spite of that there is probably considerable interest attaching to the following descriptions and illustrations.

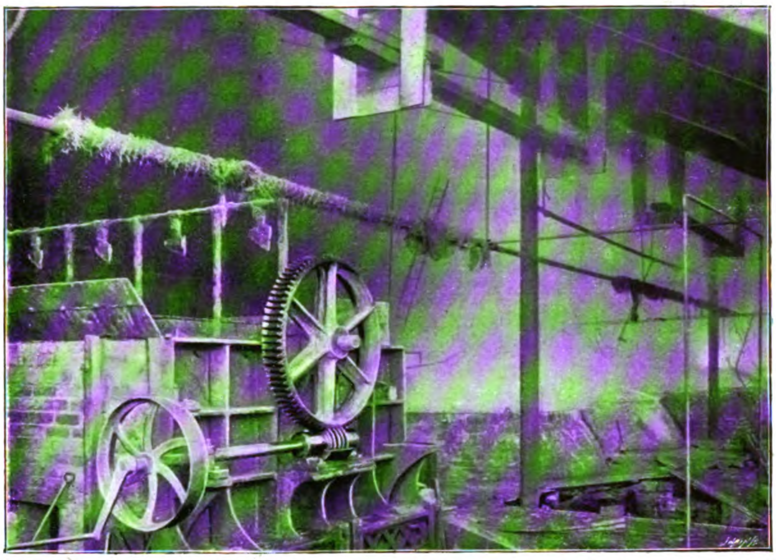


View of Switchboard.

In 1892 we drew attention in these columns to the establishment of works at Snodland, in Kent, for the purpose of demonstrating the production of caustic soda and bleach by means of electrolysis. The process was known as that of Holland and Richardson, and it may be reasonably conceived that a considerable measure of success attended the Snodland experiments, for sometime afterwards the Electro-Chemical Company was formed to work the system on a commercial scale at St. Helen's, Lancashire. It is hardly necessary to say that this town forms practically the centre of the electro-chemical industry, it being in close proximity to the coal pits and within a short distance of Cheshire, from whence salt is procured, which is, of course, the basis of the electro-chemical products manufactured here. The site upon which the electrical company's works are erected seems to be an eminently suitable one, judging by the facilities of transport furnished by the adjoining mineral line of the London and North-Western Railway Company. The works are connected by sidings to this line, while a portion is bounded by the St. Helen's and Mersey Canal.

Electrolytic Tanks.

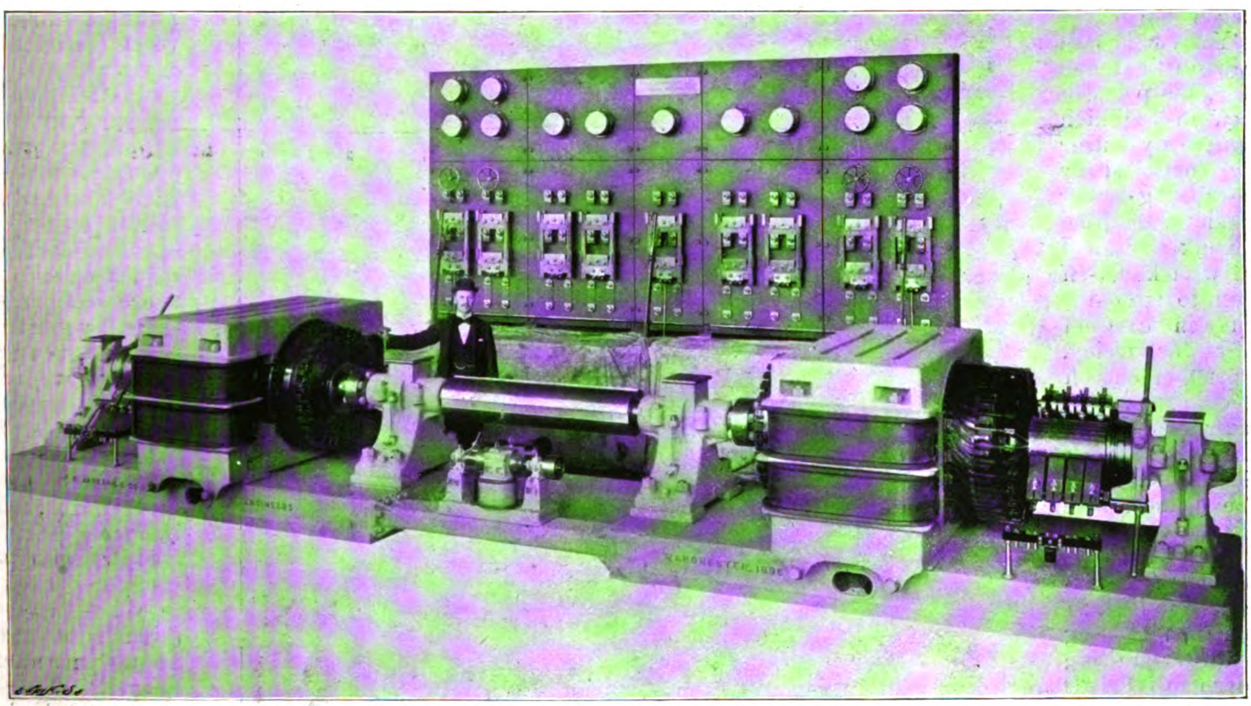
The three principal products have been already alluded to. The caustic soda is very extensively used in the manufacture of paper and soap, the chloride of lime (bleaching powder) is used to a great extent in the various processes of bleaching, and chlorate of potash which forms the third branch, constitutes a very important part of modern explosives. The production of these by an electro-chemical process is comparatively simple. Reduced to its elemental form, it is practically the decomposition of salt by means of electric current which gives chlorine gas at the anodes; the solution becomes gradually weaker in salt and stronger in alkali, and forms caustic soda. To be a little more precise, we may say that salt is first dissolved in what is known as the brine house. It is placed with water in a tank, in which it is agitated by mechanical stirrers until it has reached the requisite strength. The next operation is to run off the brine thus formed into settling tanks. The liquid being eventually drawn off into a final settling tank placed at a higher level. From this level the decomposing tanks are supplied with brine as required, the feeding of the tanks being a very simple operation, permitting each and every cell to be fed by merely turning on a few taps. The decomposing cells next merit our attention, and a glance at one of the illustrations will give a rough idea of the size of this plant. The cells are in what is known as the tank house, and are arranged in tiers. The tanks are 20 feet long × 3 feet wide and 1 foot 3 inches deep, and are divided into 16 cells. The anodes take the form of irregular blocks of carbon embedded on a lead strip, which is fixed in an earthenware box, as shown in the illustration. The anode box is inverted in the cell, but does not quite reach the bottom, thus permitting the liquid to circulate freely inside. A simple wrought-iron grid forms the cathode. As the current enters the cell chlorine gas is given off in the anode chamber, and the solution, after decomposition, becomes, as we have said, stronger in alkali and weaker in salt. In order to maintain the solution at the requisite strength, brine is fed into the tanks, and after a period a certain percentage of alkali is reached, and the solution becomes, to all intents and purposes, caustic soda. The hydrogen which is formed passes off into the atmosphere, the construction of the tank house permitting air to pass through freely. Having now obtained, by electrolytic methods, chlorine gas and caustic soda, the next step is to conduct them from the tanks for treatment. The chlorine gas, as it is given off, passes through a port hole into a closed conduit running the whole length of the tank, this conduit being connected to an earthenware main which runs from the tank house to the bleaching chambers and to the chlorate of potash plant. The use of the chlorine gas, to which we shall draw attention first, is in the making of chloride of lime. Lime is first prepared, and after being well riddled is spread upon the floors of bleaching chambers to a depth of about 6 inches; in order to present a greater surface it is arranged in furrows. There are five bleaching chambers, which are shown in one of the illustrations; the dimensions of each being 80 feet by 30 feet, and 5 feet 6 inches in height. When the lime has been spread upon the floor, the doors are sealed, and the chamber made



Caustic Soda Plant.

difficulties arising from the formation of CO_2 do not trouble them, they have no difficulty whatever in maintaining their bleaching powder at market strength. The next operation in which the chlorine gas figures is in the manufacture of chlorate of potash. In this case the chlorine is passed over milk of lime in absorbers, and the calcium of chlorate formed is run off and settled. The clear liquor is concentrated in pots, to 60° twaddle, chloride of potassium is then put in; from this potassium chlorate is obtained, which is run off into pans. Crude crystals are then obtained, and the mother liquor being drawn off, the crude crystals are re-dissolved by steam. This is run into lead coolers for final crystallisation; then comes the washing and drying process, and the chlorate of potash is ready for market. One of the illustrations shows an exterior view of the chlorate of potash plant.

The second product of the electrolytic process, viz., the caustic soda, is run off into large tanks in the caustic soda shed. There is a certain percentage of salt present in the solution when it has left the decomposing tanks, and the fluid is treated to a kind of preliminary evaporation process, in which the salt is precipitated and removed. The method of removing the salt is the employment of a revolving frame,



View of Switchboard and Dynamos before Erection.

air-tight in every way. The chlorine gas is then admitted into the chamber through connections in the roof. After the chlorine has acted upon the lime for some four or five days, there is formed chloride of lime, which is known commercially as bleaching powder, the strength of which varies from 35 to 37 per cent. of available chlorine. When this stage has been reached, the chloride of lime is discharged through shoots in the floor of the chambers into casks, and is then packed. It is claimed by the Electro-Chemical Company that as the

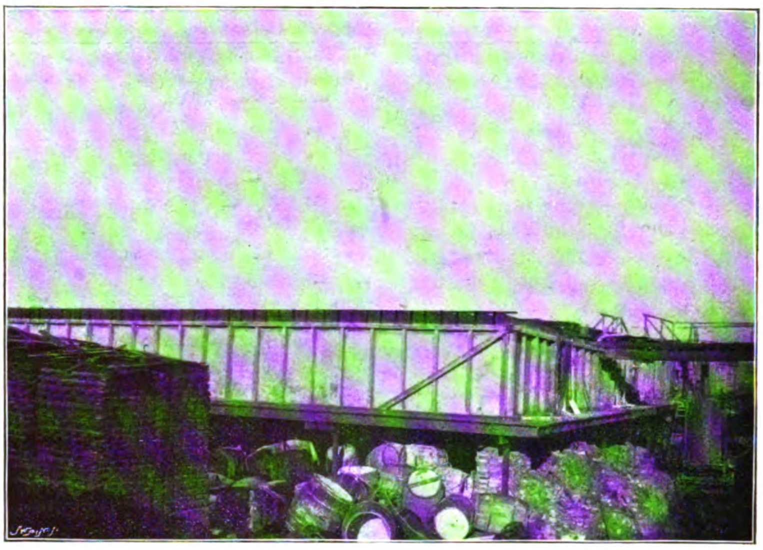
shown in one of the illustrations, which practically shovels out the salt from the bottom of the receiving tank. This salt is re-dissolved and used over again in the electrolytic tanks. In the caustic soda shed are 14 concentrating pots in which the solution is finally treated. Each pot has a furnace underneath, and in these the caustic soda is evaporated down to the required density and becomes ordinary commercial caustic of varying degrees of strength, according to requirements, the principal demand being for caustic having a strength of 70 per cent. The caustic, while in a fluid state, is run off into iron drums, in which it immediately solidifies.

That is practically a rough account of the chemical process. Turning from this to the generating plant, we find what is undoubtedly a very interesting section of the Electro-Chemical Company's works. The steam raising plant consists of 10 Lancashire boilers by Beeley & Co., of Hyde, which are constructed to work at 160 lbs. pressure.

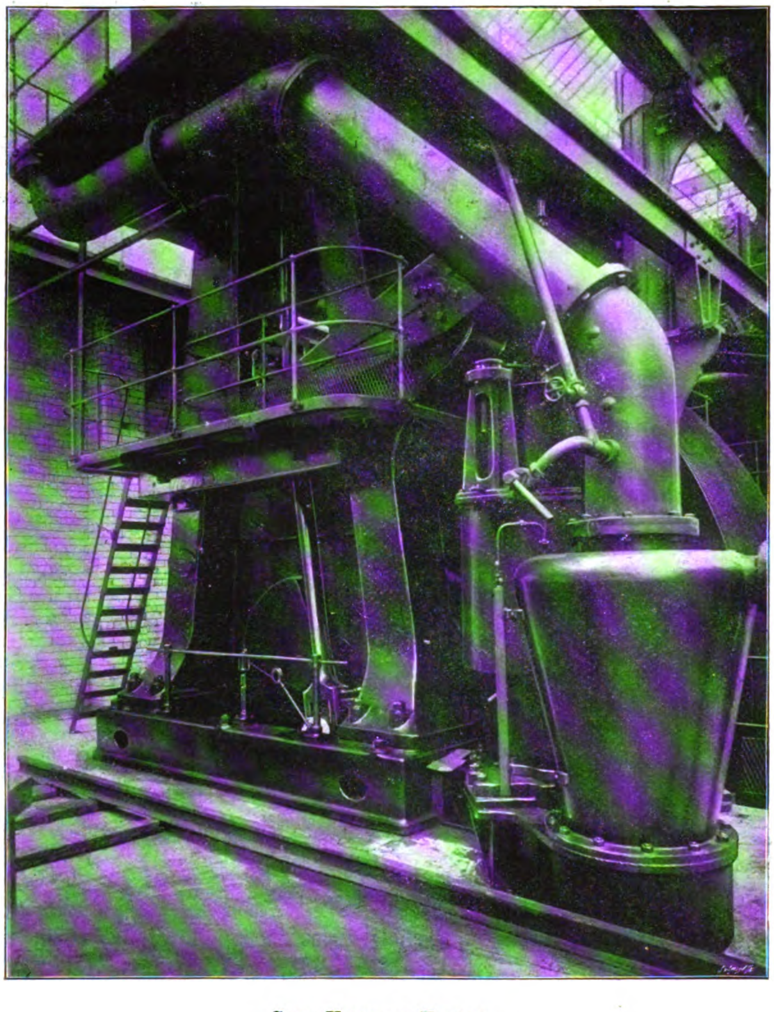
The engines have been made by Yates and Thom, and are excellent specimens of the marine type. They are vertical, inverted, compound, condensing, with cylinders 22½ inches and 46 inches diameter, 4 feet stroke, of very strong construction; the cylinders are jacketted in the bodies, and fitted with Corliss valve gear throughout, the valves and passages being constructed to give the minimum amount of clearance; the steam valves of both cylinders are fitted with Yates & Thom's patented release motion, the point of cut off in the high pressure cylinder being controlled by a high speed governor driven by wheels from the crank shaft, and fitted with knock-off motion to stop the engine in case of accident or racing, the point of cut off in the low pressure cylinder is adjustable by hand whilst the engine is running.

The cylinders are placed side by side with cranks at right angles, the fly-rope pulley wheel, 21 feet diameter, being placed between them; the dynamo is driven from the periphery of the pulley by 26 ropes, each 1½ inches diameter. The crank shaft and crank pins are of steel, with large bearing surfaces suitable for continuous running.

The air pump and condenser are placed behind the low pressure cylinder on the floor of the engine house, the air pump being worked by levers from the low pressure cross head; the injection water is taken from the canal, and the hot well is placed at such a level that the water, after being drawn from the condenser by the air pump, returns to the canal by its own gravitation.



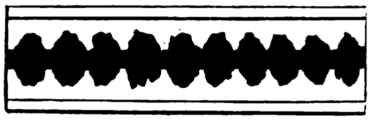
The Bleaching Chambers.



Side View of Engine.

The present working steam pressure is 135 lbs. per square inch, for which pressure the engines have been constructed. The engine house has been designed for five engines, of which three are at work, and a fourth on order, but there is still ample room left for the arrangement of additional plant. On August 25th last, No. 2 engine was tested for steam consumption, and this, as measured by the actual amount of feed-water pumped into the boilers, worked out to 14 lbs. of steam per horse-power per hour throughout the test, which lasted six hours. During this test the average indicated horse-power of the engine was 711·35.

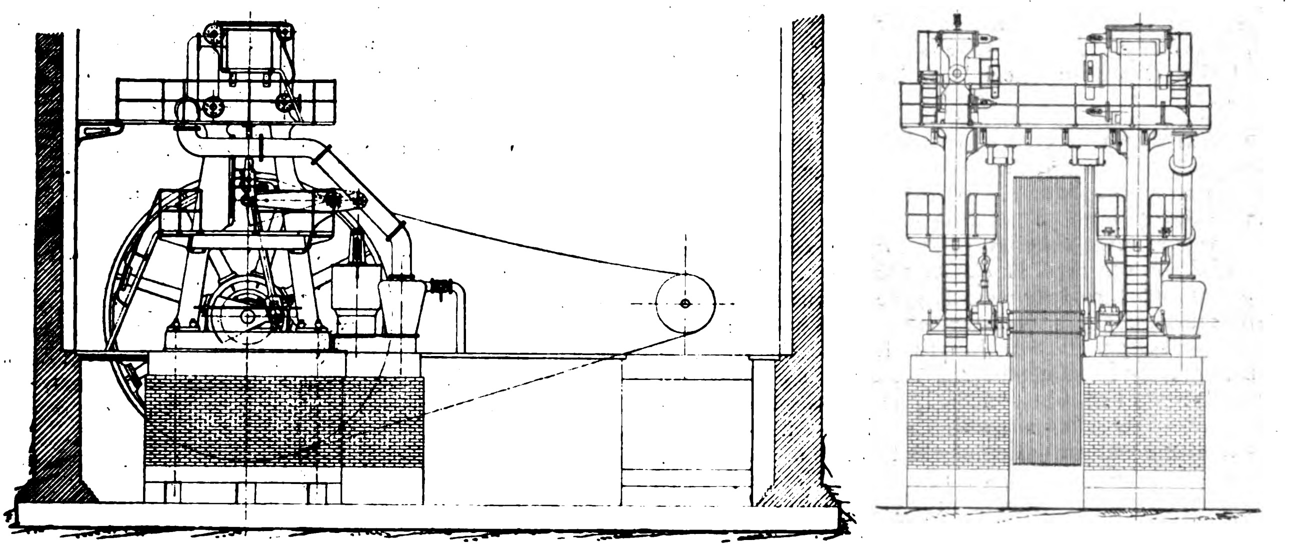
The dynamos, which are of a special type, built by Messrs. P. R. Jackson and Co., of Manchester, with Sayer's windings, are arranged in pairs, the engine driving on to a shaft connecting the two machines together. They each develop 1,250 amperes at 180 volts when driven at 400 revolutions. The pedestals of the machines are of the self-oiling type, and are fitted with anti-friction metal of a special brand. The armature shafts are of mild steel, with solid flange couplings on the pulley shaft. End play is taken up by the collars in the centre of the pedestals on either side of the pulley. The armature core plates are of Swedish iron, and are insulated from one another with copal varnish which is applied evenly through the medium of a pneumatic sprayer. The core plates are held firmly on the shaft by keys and heavy end-plates, and the interior of the core ventilated by means of longitudinal channels provided along the interior of the discs. The main armature bars are of solid copper, and are first insulated with unbleached tape of good quality, and then varnished with a special composition. They are afterwards insulated with mica cloth, and finally protected all round with thin strips of well seasoned mahogany. It is claimed that this insulation has effectually withstood the injurious effects of chlorine gas, though probably only traces of this reach the engine room. The pole pieces and field magnet castings are of Messrs. Jackson's special mild steel of their own manufacture. The top and bottom halves of these castings have been designed to provide for Sayers's



ANODE BOX SHOWING ARRANGEMENT OF CARBONS.

auxiliary poles, and at the same time to reduce the number of joints. The lateral position of the field magnets, which, together with the pedestals, are insulated from the bed plate with thick zinc blocks, can be adjusted at will by set screws. The switch gear, which has been built under Mr. Slater Lewis's patents, is of the simplest possible character, and is worked by a system of railway levers, a long and quick break being provided by this means. The distribution is accomplished through a bare stranded cable, and an interesting feature about it is that there are no joints at places where branches of the mains are taken, the method adopted being simply to untwist a strand.

The generating plant is arranged in a lofty well-arranged building, shown in one of the illustrations, which has been prepared from a photograph lent by Messrs. Jackson.



SECTION AND END.

CONTRACTS CLOSED.

Belfast.—The Corporation last week confirmed the Electric Committee's acceptance of the tender of Messrs. T. Parker, Limited, to supply by October next an additional 200-kw. steam dynamo for lighting and traction at £2,646. The reference of the electric traction matter to a committee for investigation was also approved.

Brighton.—For the supply of dynamos, motors, switchboards and wiring work for the Municipal School of Science and Technology, the contract has been given to Messrs. Warburg and Dymond at £481.

Hammersmith.—The Vestry last week accepted a tender from Messrs. Ferranti for supply, &c., of new switchboard for electric lighting extensions at a cost of £473, and gave a contract to Messrs. Babcock & Wilcox for boilers at a cost of £1,060. Messrs. Ferranti will also alter panels on the present switchboard at a cost of £12.

Italy.—La Società Italiana di Elettricita, Sistema Cruto, of Turin, has secured the contract for the supply of the incandescent lamps and lampholders required by the torpedo and electrical material department of the Navy Yard at Spezzia.

Shoreditch.—The Vestry has entered into a contract with the British Insulated Wire Company for laying about 2,000 yards of conduit for electric lighting mains, at 9s. 8d. for three-way and 8s. 6d. for two-way conduits, these prices including excavating and reinstating the street, and supplying material.

NOTES.

London Electric Omnibus Company, Limited.—The report of the committee of this company, which can be seen in our City pages, forms pretty reading, and the practical test which Mr. Spagnoletti considers most encouraging and very satisfactory only goes to show he must be very easily satisfied. Mr. J. Elliott Condict, too, boasts of the satisfactory nature of last month's test, because, forsooth, they were able to find *the exact amount of voltage and the number of amperes used!* Can it be possible that these figures have never been ascertained previously? The results obtained with the 26-passenger 'bus, carrying, however, only 17, have been submitted to us, and briefly stated are as follows:—The vehicle ran from Trafalgar Square to Hammersmith Broadway, and back to Whitehall, a distance of 14 miles, in 1¾ hours, inclusive of a 17 minutes' wait at Hammersmith. The day was perfectly dry, the roads clean, and with one exception, viz.:—Haymarket, the route to Hammersmith is fairly level. The return was made on a road still more favourable for the 'bus, but had the day been wet, with greasy streets, it is doubtful whether it would have reached home without assistance. Readings of current and voltage were taken every 5 minutes, the amperes averaging 39 and the volts 230, or an average of 12 horse-power electrical. It is stated that at the end of the run enough electrical energy remained in the battery for 11 miles further; but we need not, at the moment, consider this. The question is, whether there is not a great loss of electrical energy somewhere. 18,000 watt-hours taken from the battery during a trip of 1¾ hours means 9 units per hour, and when we take into consideration the loss between the terminals of the charging dynamo and the battery, it appears to point to the fact that radical changes are required, both in the technical and managerial departments of this company before commercial success is likely to be assured, or the horse-drawn 'bus become a thing of the past. Can it be that motor and gearing are both inefficient; if this is so, no battery, however good, can show to much advantage; but the claims made for the Sola accumulator have certainly yet to be verified.

Secondary Battery Testing.—A correspondent calls our attention to a description of the Lamina accumulator in a recent issue of the New York *Electrical Engineer*, in which is published an abstract from a report made by Prof. S. P. Thompson. "The 14 watt-hours per pound weight (gross) of the cell," says the writer, "has been obtained by a particular method of testing and calculating out the results. The Lamina people themselves claim only 9 watt-hours for their best cells of large size." The sooner experts adopt some uniform method of testing accumulators the sooner will the various types on the market be properly comparable amongst themselves.

New York Electrical Society.—An interesting sequel to the reading of Mr. Dana Greene's paper on "The Relations between the Customer, Engineer, and the Electrical Manufacturer," is the passing of the following resolution by the New York Electrical Society, before which the paper was read :—

Resolved.—That in view of the excellent suggestions and recommendations on standardising apparatus embodied in Mr. S. D. Greene's paper, the Society hereby expresses its approval of efforts in that direction, and invites the American Institute of Electrical Engineers to consider some comprehensive plan for such standardisation of American apparatus for electric light and power.

The Society, which appears to be a very energetic one, desirous of bringing the "public into more intimate relations with the scientific aspect of all classes of electrical work," will have a booth and *rendezvous* for its members and friends at the electrical exhibition which is to be held at Madison Square Garden in May. The exhibition will last a month, and it is proposed to make it surpass anything of the kind ever done in New York. The Society has received a grant from the exhibition authorities for its educational work. The Electrical Society is anxious to put itself prominently before the public, and to show that, though the oldest electrical body in America, it is not suffering from senile decay, but has yet much energy left. Before the Society, on February 11th, Mr. Joseph Wetzler gave an illustrated paper on "Electricity Direct from Coal." A discussion followed.

The American Eagle.—Some eagles recently alighted on an electric transmission line in California, and in consequence nothing was left of them but one skull, four feet, and part of legs. The talons were clutched tightly to the line wires. Not a vestige of the bodies or feathers of either bird, nor the head of one of them, could be found. The *Journal of Electricity* recently gave a gruesome sketch of the remains. The circumstances are as follow:—The generating plant of the San Joaquin Electric Company, of Fresno, Cal., was one day pumping 10,000 volts serenely into the transmission line, when suddenly one of the circuits developed a dead short circuit, with the almost instantaneous open-circuiting and grounding of the two legs of the circuit, which were on the upper cross arm. This, of course, interrupted the service in Fresno, and the ground thus thrown on was so severe, that it became impossible to burn it out. After a few minutes' delay the service was resumed over the second transmission line, which had remained uninjured. Linesmen were sent out at once to ascertain the cause of the trouble and repair the broken circuit, and after having gone over nearly 30 miles of line, they reached a mountain top about five miles from the power house, where the break was discovered, also the eagles' remains. A specimen was found which shows the terrific heat of the electric arc. The soil along the pole line at the place indicated consists of pure granitic sand, which, wherever the wire touched the ground, had become melted into glass, and even a piece of quartz had been fused and run in together with the glass. The circumstance of the accident suggests a theory for it, as evidently the two eagles alighted on different legs of the three-phase circuit, within close proximity to each other; that they actually came into contact, and in so doing, formed a short circuit, which not only incinerated the eagles, but threw the wires into short circuit, and burned them off.

Engineering Strike.—The newspaper press says that last week Messrs. Tangye forwarded a cheque for £500 to the Engineers' Federation of Masters, and one of similar amount to the Men's Association, to help to cover the loss incurred in the recent strike. The Masters' Federation have returned the cheque, on the ground that Messrs. Tangye would give them no assistance during the struggle. The federated firms in Birmingham hope to contribute a cheque of the same amount.

It is also stated that trouble has arisen at the Hull Engineering Works. The employers proposed to overtake the arrears of work by starting night shifts, and the men demanded pay at the rate of a day and a half, whereas the employers would only consent to a day and a quarter. Last night a number of the men at various establishments declined to accept the employers' terms, and this morning the employers refused to allow them to start again.

Annual Dinner.—The annual dinner of the London Electric Supply Corporation's engineers, past and present, was held in the Hotel Florence, Rupert Street, Piccadilly, on Tuesday evening, the 1st inst. Among those present were Mr. P. Walter D'Alton, Messrs. S. Z. de Ferranti, G. W. Partridge, H. W. Kolle, C. S. V. Clirehugh, Reginald P. Wilson, J. K. Stothert, G. K. B. Elphinstone, Henty, A. M. Billington, McDougall, and J. Hardie McLean. After dinner, to which some two dozen sat down, Mr. Ferranti proposed "Success to the London Electric Supply Corporation," coupling with the toast the name of Mr. D'Alton. He regretted the absence of Mr. C. P. Sparkes, who had been associated with the undertaking from the first until his retirement a few years ago, and who had rendered signal service in the initiation of the system. He was pleased to see the success which had attended the undertaking. Being the pioneer system of supplying vast areas from one centre, it had to pass through a trying period inseparable from a pioneering concern of such magnitude. It had at last emerged triumphant, and this was no doubt a source of gratification to them all. Our American cousins had acknowledged the correctness of the principle, and were in some cases even closing their present stations and establishing one centre of generation for each city. He had much pleasure in giving the toast of "Success to the London Electric Supply Corporation," and in coupling with it the name of Mr. D'Alton, its capable engineer, who had by his untiring energy and careful management, assisted by an efficient staff, contributed materially to its success. Mr. Walter P. D'Alton in a few appropriate words acknowledged the compliment to himself and staff, and confidently spoke of the continued success of the corporation. Mr. Kolle replied to the toast of "The Engineers of the Past," and in a happy speech recalled some incidents peculiar to central station engineers of the early days, which one can afford to laugh at after a period of 10 years, but which were regarded in quite another light at the time. Contributions to the enjoyment of the evening were supplied by Mr. Elphinstone in his screamingly-funny stories told in native dialects, by Mr. Partridge with his banjo and his song, "Wait till the fogs roll by," and by Messrs. Wilson, Kolle, Stothert, and Hardie McLean, in songs of a more or less varied character.

Electric Pumping Plant in Collieries.—An electric pumping plant, recently installed at the collieries of the Delaware, Lackawanna and Western Railroad Company at Bellvue, Pa., differs somewhat from the type common for this class of work. The usual design followed consists of a three-throw pump with plungers driven by cranks placed at 120° from one another. In the present case, double-acting ram pumps, having plungers in front and behind, the latter coupled by outside rods to the cross-head, are used, and there are two sets of such pumps side by side, each 10 inches diameter × 15 inches stroke, so that in all there are four pairs, and these driving cranks are set at 90°. The motor is of the four-pole type, with carbon brushes, and allow of a variation from no load to overload without movement of the brushes. The work done is 800 gallons per minute against 150 feet head, about 36 actual H.P. in the water, the rated capacity of the motor being 50 H.P. The plant was built by the General Electric Company at Schenectady, N.Y.

The Royal Society.—The following papers were down for reading yesterday afternoon:—(1) "On the Rotation of Plane of Polarisation of Electric Waves by a Twisted Structure." (2) "On the Production of a 'Dark Cross' in the Field of Electro-Magnetic Radiation," by Prof. J. C. Bose. "An Extension of Maxwell's Electro-Magnetic Theory of Light to include Dispersion, Metallic Reflection, and Allied Phenomena," by E. Edser. "On the Relative Retardation between the Components of a Stream of Light Produced by the Passage of the Stream through a Crystalline Plate, Cut in any Direction with Respect to the Faces of the Crystal," by J. Walker. "On the Relation between the Diurnal Range of Magnetic Declination and Horizontal Force, and the Period of Solar Spot Frequency," by W. Ellis.

Correction.—On page 288 of our last issue, first column fourth line, 500 volts should read 5,000.

Removing Rust from Iron Electrically.—A very simple and effective way of cleaning rusted iron articles, no matter how badly they are rusted, consists, according to Carl Hering in the *Electrical World*, in attaching a piece of ordinary zinc to the articles, and then letting them lie in water to which a little sulphuric acid is added. They should be left immersed for several days, or a week, until the rust has entirely disappeared, the time depending on how deeply they were rusted. If there is much rust a little sulphuric acid should be added occasionally. The essential part of the process is that the zinc must be in good electrical contact with the iron; a good way is to twist an iron wire tightly around the object and connect this with the zinc, for which a remnant of a battery zinc is suitable, as it has a binding post. Besides the simplicity of this process, it has the great advantage that the iron itself is not attacked in the least as long as the zinc is in good electrical contact with it. When there is only a little rust, a galvanised iron wire wrapped around the object will take the place of the zinc, provided the acid is not too strong. The articles will come out a dark grey or black colour, and should then be washed thoroughly and oiled. The method is specially applicable to objects with sharp corners or edges, or to files and other articles on which buffing wheels ought not to be used. The rusted iron and the zinc make a short circuited battery, the action of which reduces the rust back to iron, this action continuing as long as any rust is left.

Researches in Magnetism and Diamagnetism.—At the Royal Institution on Thursday, last week, Prof. J. A. Fleming gave the first lecture of a course on "Recent Researches in Magnetism and Diamagnetism." The lecturer said he had selected his subject before he became aware that this course constituted the annual series of lectures delivered to commemorate the late Prof. Tyndall. There seemed, however, a special appropriateness in the selection he had made on account of the attention bestowed on the subject of diamagnetism by the late distinguished occupant of the chair of Natural Philosophy in the Royal Institution. Prof. Fleming introduced his subject with a few remarks on the terminology of magnetic science, which he stated to be now based on the view that magnetic effects were due to actions taking place in the space-filling ether. He proceeded, says the *Times* report, to illustrate, by simple experiments, the production and measurement of magnetic force, magnetic flux, and magnetisation. Devoting the rest of his lecture to the study of the so-called ferro-magnetic metals, iron, nickel, and cobalt, he pointed out that their unique qualities showed them to possess, in the solid condition, a special molecular structure not found in other materials to anything like the same extent. Numerous interesting experiments were then performed to illustrate the changes produced in an iron bar when subjected to magnetisation. The discovery made by Joule in 1842, that an iron bar lengthened on being magnetised, was demonstrated with the aid of an ingenious piece of apparatus, as also was the fact more recently noticed by Bidwell, that under very strong magnetisation it actually became shorter. The slow establishment of the magnetic state in large masses of iron, and the sluggishness with which magnetic changes in iron followed the magnetising force, were illustrated by instructive experiments. The molecular changes or magnetic noises occurring in iron on rapid magnetisation and demagnetisation were next discussed, the lecturer observing that they really formed the starting point for the invention of the telephone. A concluding series of experiments illustrated the remarkable effects produced on the magnetic qualities of nickel by twisting or pulling it. The second lecture of the series was to be delivered yesterday afternoon.

Electricity in a Brickyard.—According to the *Peterborough Express*, some new brickyards which are to be laid out at Whittlesea will not only be lighted by electricity, but the machinery will be electrically driven. The boiler, engine and dynamo house are to be conveniently placed near to water supply, sufficient to allow of the employment of the most economical form of condensing engine. The power required for driving the machinery will be conveyed from the dynamos to motors fixed in each machine house. The plant at present contemplated is capable of turning out about 500,000 bricks a week.

Electric Floor Scrubbing Machine.—Our American exchanges describe an electric floor scrubbing machine, invented by Mr. H. F. Ackerman, of Cleveland, which is claimed to do work in one-fourth of the time required in the old way, at a saving of 75 per cent. of the cost. The machine is operated by an electric motor, which receives its current through a flexible cord, connected to any convenient incandescent socket. A reel at the top of the trolley pole takes up the slack cord, and unwinds it in the operation of the machine. The frame carries three scrubbing brushes, which are pressed against the floor with a spring pressure. The brushes are geared with the motor, so as to revolve at a speed of 400 revolutions per minute. The gearing between the motor and the brushes is by means of a sprocket chain, leading from the motor to the axle, on which the larger wheels loosely revolve, and from that axle by another sprocket chain to a shaft connected by bevel gears with vertical shafts, to which the brushes are attached. This permits of the machine being used as a hand machine, in case no electric current is available to operate it by electric power. For the scrubbing brushes, sandpaper blocks or blocks of stone may be substituted, and thus the machine may be used to dress down wood floors or mosaic. The springs always keep the brushes in proper contact with the floor. A suitable rheostat or governing device is provided on the handle, and the motor is fully protected by fuses. The machine weighs about 300 lbs., and its frame is about 30 inches square. The three brushes are so arranged in relation to one another, that the short axis of the middle one is always parallel with the longer axis of the side brushes, and *vice versa*. Hence, in operation, the machine scrubs a path as wide as the distance between the outer ends of the side brushes, when they stand end to end.

The 1900 B.A. Meeting.—A large meeting of Bradford gentlemen was held on Tuesday at the Town Hall, in response to a circular issued by the Mayor, for the purpose of considering a proposal from the Bradford Philosophical Society that the British Association should be asked to hold its annual gathering in the city in 1900. The next two meetings of the association will be held at Bristol and Dover respectively, while Glasgow will be the *venue* in 1901. The Bradford Philosophical Society has already approached the association on the subject, and it is considered probable that the city will be favoured with a visit. The last time the association held a meeting at Bradford was in 1873. It was suggested that a guarantee fund of £2,000 should be raised. A large and representative executive committee was appointed.

Electric Welding.—A lecture was given at Finsbury Technical College, on Monday, March 7th, by Mr. Reginald J. Wallis-Jones, A.M.I.C.E., M.I.E.E., on "Electric Welding." The various systems in use, such as the Benardos, Zerena, Coffin, "Voltex," Hoho-Lagrange (hydro-electro-thermic), and the Thomson (incandescence system), were described and illustrated by experiments and lantern slides. Many unique and interesting samples of "snap" or rapid electric welding (Thomson process) as applied to the manufacture of cycle parts, &c., were shown. Apparatus and samples were lent by the Electric Metal Working Syndicate and the Electric Welding Company, Limited.

Electrical Engineers Royal Engineers Volunteers.—By kind permission of Colonel Josselyn the corps has been able to commence squad drills at the head-quarters of the 1st Middlesex Royal Engineers Volunteers in College Street, Chelsea. Technical drills, which count towards efficiency, will be commenced at the end of the present week.

Mishap at Yarmouth.—With reference to the mishap which occurred at the Yarmouth electricity works on Saturday last, we learn from Mr. A. W. Ranken, the borough electrical engineer, that the breakdown was due to sudden priming from the boilers, which blew off the steam tops and H.P. cylinders from two engines before they could be reached. The public lighting plant was only saved in time by shutting down. Supply to public lamps, and part of the private lighting, was resumed in the course of an hour, and since 11 p.m. the same night the plant has been running as usual.

Power Transmission at 50,000 Volts.—A trans-Atlantic contemporary says that a trial was recently made for a period of two weeks of transmission at 50,000 volts from the water-power plant at Telluride, Col., to the Gold King Stamping Mills there. The original transmission plant, which consisted of a single-phase 3,000-volt alternator with direct transmission to a synchronous motor three miles, has been replaced by a three-phase transmission with step-up and step-down transformers, and while the change was being made, the experiment of transmitting at 50,000 three-phase alternating current was tried. The transformers used were those now employed on the three-phase transmission there, the transformers being arranged to give a number of different voltages from 50,000 down, according to the way they are connected. No accidents occurred during the fortnight. The line consisted of galvanised iron telegraph wires supported on glass insulators. It is stated that it was found that the self-induction afforded by the iron wire had a beneficial effect in counteracting the capacity of the line. The experiment was not continued for a longer time because the rainy season came on, and proper provisions against lightning were not at hand. The transmission line is three miles long, and runs up a steep mountain side and over a very wild country.

The Northampton Institute.—The Lord Mayor and Sheriffs have kindly consented to pay a State visit to this Institute on the 18th inst., for the purpose of inspecting it and formally declaring it open. It is interesting to note that the buildings and equipment have up to the present cost over £80,000, and the expenditure upon the latter is not yet complete. In addition, the land, over 1¼ acres, generously given by the late Marquis of Northampton is estimated to be worth not less than £25,000. The Institute is a branch of the City Polytechnic, and is situated in one the busiest parts of the Metropolis, immediately north of the City boundary.

Edison and his Interviewers.—So many absurd interviews alleged to have been held with Mr. T. A. Edison have appeared in the newspapers and other journals, both on this side of the Atlantic and in America, that it is only just to that gentleman to say that in a communication to the *New York Sun* he protests "against the many articles appearing in the sensational papers . . . . . purporting to be interviews with me about wonderful inventions and discoveries made or to be made by myself. Scarcely a single one is authentic, and the statements are the inventions of the reporter."

Baden.—The new clubhouse provided by Messrs. Brown, Boveri & Co. for their technical and commercial staff was opened on the 8th inst. The firm has purchased the old Café Schwert, and placed it gratis at the disposal of the club. The reading room contains about 40 daily, weekly, and monthly papers in various languages, including the Electrical Review, the *Standard*, *Punch*, and others. A restaurant is also provided in connection with the club. The picturesque old building is familiar to all visitors to Baden, and it is interesting to note that it is, in a measure, the birthplace of the firm of Brown, Boveri & Co., as the temporary offices were situated there before the erection of the present buildings.

Lectures.—On 2nd inst., at the Merchant Venturers' Technical College, Bristol, Prof. J. Wertheimer repeated his lecture on "Wireless Telegraphy."

Before the Architectural Section of the Philosophical Society of Glasgow, Mr. W. Arnot recently lectured on "The Distribution of Electricity in the House."

Mr. W. B. Hird, B.A., read a paper on "Electric Transmission of Power" before the Salford Technical College Scientific Society, on 26th ult.

Mr. Richard Kerr, F.G.S., delivered a lecture on "Wireless Telegraphy" at the Geographical Institute, Newcastle, on 1st inst.

Mr. G. L. Addenbrooke, M.I.E.E., read a paper on Saturday evening on "Electrical Power Supply from Central Stations" to the members of the South Staffordshire Institute of Iron and Steel Works Managers, at Dudley.

Appointment.—Mr. A. E. Briscoe, head of the Physics and Electrical Department at Battersea Polytechnic, has been appointed by the West Ham Town Council principal of the new Technical Institute now building in Roman Road, Stratford.

Obituary.—We regret to hear of the death of Mr. Radcliffe Sanders, of the Penarth firm of electricians.

We also regret to announce the death of Mr. John Main, which took place on Wednesday last, at the comparatively early age of 51. Mr. Main was probably unknown to the younger generation of electrical engineers, but to the pioneers of the arc lighting industry his name is familiar as one of the joint inventors of the Fyfe-Main lamp.

Will.—The *City Press* says that the will has been proved of Major Alexander Wood, of Dar-el-Saleem, Abbey Wood, for many years the managing director of the Western and Brazilian Telegraph Company, the value of the personal estate being £11,704 17s. 8d. gross, and £7,221 13s. 8d. nett.

Battersea Vestry v. County of London and Brush Company.—In this case, which came before Sir Francis Jeune in the Chancery Division on Wednesday and Thursday, the plaintiffs claimed that the defendants had no right to open Trinity Road, Battersea, and lay electric mains therein, as they had done. The chief question in dispute was whether that portion of the road was in Wandsworth or Battersea parish. For the defence it was contended that this was not a case for a mandatory injunction, even if defendants were in default. The Judge thought the company might very well recognise the plaintiffs' right and take a license from them. The case was adjourned for a month to enable his Lordship's opinion to be submitted to the Vestry.

FORTHCOMING EVENTS.

1898.

Friday, March 11th, at 5 p.m.—Physical Society at the rooms of the Chemical Society, Burlington House. Agenda:—(1) "On Dynamical Illustrations of certain Optical Phenomena," by Prof. J. D. Everett, F.R.S.; (2) "On Properties of Liquid Mixtures," by R. A. Lehfeldt.

Saturday, March 12th, at 7.30 p.m.—At the Westminster Palace Hotel. *Conversazione* of the Institution of Junior Engineers.

At 10.30 a.m.—Institution of Electrical Engineers. Students' visit to the stations of the Metropolitan Electric Supply Company. Applications to join the party should be made at once to the Students' Hon. Sec. (Mr. S. Grant, 28, St. Mary Abbot's Terrace, W.).

Monday, March 14th, at 8 p.m.—The Northern Society of Electrical Engineers, at the Palatine Hotel, Hunt's Bank, Manchester. Paper on "The Practical Operation of Multiphase Currents" will be read by Mr. T. Hawkins, member.

Tuesday, March 15th, at 8 p.m.—The Institution of Civil Engineers "Calcium Carbide and Acetylene," by Henry Fowler, Assoc.M.Inst.C.E.

Wednesday, March 16th.—The Institution of Electrical Engineers. Students' meeting at 7.30 p.m. A paper will be read on "Polyphase Motors," by E. E. Tasker, student.

Latest date for Watford District Council electric lighting tenders.

Thursday, March 17th, at 8 p.m.—Chemical Society, Burlington House. Papers to be read:—"The Reduction of Bromic Acid and the Law of Mass Action," Winifred Judson, B.Sc. and J. Wallace Walker, M.A., Ph.D.; "The Action of Ferric Chloride on the Ethereal Salts of Ketone Acids," R. S. Morell, M.A., Ph.D. and J. M. Crofts, B.A., Ph.D.; "Note on the Volatility of Sulphur," T. C. Porter; "Action of Ammonia and Substituted Ammonias on Acetylurethane," George Young, Ph.D. and Ernest Clark.

At 3 o'clock.—Royal Institution. Prof. J. A. Fleming, M.A., D.Sc., F.R.S., M.R.I., on "Recent Researches in Magnetism and Diamagnetism," Lecture III. (The Tyndall Lectures).

At 11 a.m.—The Institution of Civil Engineers. Students' visit to the ventilating, heating, lighting, and drainage arrangements of the Houses of Parliament.

Latest date for Wallasey District Council electric lighting tenders.

Friday, March 18th.—State visit of the Northampton Institute for the purpose of inspecting it and formally declaring it open.

Saturday, March 19th.—Students' visit to the works of Messrs. Easton, Anderson and Goolden, Limited, Erith.

Thursday, March 24th, at 8 p.m.—The Institution of Electrical Engineers. "Cost of Generation and Distribution of Electrical Energy," by R. Hammond, member.

NEW COMPANIES REGISTERED.

North London Electric Supply Company, Limited (56,275).—Registered March 1st, with capital £100 in £1 shares, to carry on the business of electricians, electrical engineers, suppliers of electricity, and electrical apparatus manufacturers. The subscribers (with one share each) are:—F. J. Leslie, 15, Union Court, Liverpool, solicitor; A. E. Haptie, 5, Durham Road, Seaforth, Liverpool, cashier; F. W. Lintern, 104, Northbrook Street, Liverpool, clerk; J. Atherton, Singleton, Huyton, Lancashire, manufacturer; W. M. M. Forwood, 15, Union Court, Liverpool, solicitor; C. O. Grindrod, 11, Knowsley Road, Rock Ferry, gentleman; A. Buckley, 8, York Road, Seacombe, Cheshire, clerk. Registered without articles of association by T. T. Hull, 22, Chancery Lane, W.C.

Edison-Bell Consolidated Phonograph Company, Limited (56,304).—Registered March 2nd with capital £110,000, in 10,000 preference shares of £10 each and 10,000 ordinary shares of £1 each, to acquire the business of the Edison-Bell Phonograph Corporation, Limited, to adopt a certain agreement, and to manufacture, sell, let on hire, and deal in phonographs, graphophones, telephones, phonogram-cylinders, motors, batteries, and electrical apparatus. The subscribers (with one share each) are:—Earl of Denbigh, Newnham Paddox, Lutterworth; Lord Farquhar, 7, Grosvenor Square, W.; M. Van Raalte, 22, Austin Friars, E.C., merchant; E. F. Coates, 99, Gresham Street, E.C., stockbroker; Count de Torre Diaz, 41, Moorgate Street, E.C., merchant; S. J. Waring, jun., 28, Park Lane, W., manufacturer; W. A. Smith, 6, Hanover Street, Glasgow, merchant. The number of directors is not to be less than three nor more than eight; the first are—The Right Hon. the Earl of Denbigh, J. Annan, Sir W. H. Q. Jones, R. C. Wyatt, W. A. Smith and S. F. Moriarty; qualification, £500; remuneration, £300 each per annum (£400 each for the chairman and deputy chairman), and a percentage of the profits. Registered by Ashurst & Co., 17, Throgmorton Avenue, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Westinghouse Electric Company, Limited (29,334).—This company's annual return was filed on January 13th. The capital is £600,000 in £10 shares (30,000 preference). 18,955 preference and 27,500 ordinary shares have been taken up, and 15,800 of the former and all the latter have been issued as fully paid. £10 per share has been called and paid on the remaining 3,155 shares.

Ventnor Electric Light Company, Limited (53,823).—This company's statutory return was filed on November 11th, when seven shares were taken up out of a capital of £10,000 in £5 shares. No calls have as yet been made.

Crystal Electric Lamp Company, Limited (53,651).—This company's statutory return was filed on January 3rd. The capital is £10,000 in £1 shares, of which 6,667 shares have been taken up. 1,667 are considered as paid, and £5,000 has been received.

Crystal Palace District Electric Supply Company, Limited (18,532).—The registered office of this company was removed on February 4th to Dashwood House, 9, New Broad Street, London, E.C.

Municipal Electric Light and Power Corporation, Limited (29,091).—This company's annual return was filed on February 12th. The capital is £25,000 in 2,490 £10 ordinary, and 100 £1 founders' shares. 37 ordinary and 30 founders' shares have been taken up, and £400 has been paid.

Morley Electrical Engineering Company, Limited (52,358).—This company's statutory return was filed on February 9th, when 1,024 shares were taken up out of a capital of £5,000 in £1 shares and paid for in full.

CITY NOTES.

Directors' Fees. It is stated that at the meeting of the County of London and Brush Provincial Electric Lighting Company to be held next Monday, a resolution will be proposed to raise the remuneration of the directors from £1,000, as fixed in the articles of association, to £2,000 for 1898, £2,500 for 1899, and £3,000 a year afterwards.

We should scarcely think the ordinary shareholders will feel in the mood to agree to the somewhat premature demands of the board; indeed, the shareholders would be amply justified in resisting any attempts to double the directors' fees until a dividend on the ordinary shares has been paid.

Westminster Electric Lighting Company. The principal features of the year's business of this company have been already set forth in these columns, and little more remains to be done, except to give an analysis of costs for the year. The increase in the cost of coal is mainly attributable to important alterations in plant, which have caused a slight break in the economical *régime* that has hitherto been a characteristic feature of the system.

The following table gives the cost per unit:—

	1897.	1896.
Total capital expended	£560,388	£478,870
Number of units sold	4,416,877	3,503,054
Number of lamps connected	290,561	249,318
Revenue from sale of current	£100,561	£81,214
Net revenue	£49,585	£40,431
Average price obtained per unit	5·46d.	5·5d.

Cost of production.	£		Per unit.	1896.
Coal	11,450		·62d.	·54d.
Oil, waste, water and engine room stores	1,737		·09d.	·10d.
Salaries and wages at generating station	7,663		·42d.	·45d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	3,648	Works' cost 1·33d.	·20d.	·29d.
Rent, Rates and taxes	5,002		·27d.	·25d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	9,249		·50d.	·56d.
Total	£238,749		2·10d.	2·19d.

Not included in above.	
Repairs and maintenance of meters.	£1,183
Wages of meter readers	745
Sinking fund and depreciation account	15,290
Loss on coal	81
Supplying steam	1,559
Expenses of founders' shares	172

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	100,561	0	0	—
Meter rents, &c.	4,343	0	0	5·46d.
Supply of steam	2,392	0	0	—
Transfer fees	69	0	0	—
Total	£107,365	0	0	5·46d.

Total cost per unit (exclusive of depreciation and renewal accounts), 2·10d.; works' cost, 1·33d.

London Electrical Omnibus Company, Limited.

An extraordinary general meeting of this company was held last Friday at Winchester House, E.C., to receive the report of a committee which was appointed at the annual meeting of the company, held on December 30th, 1897. Major Flood Page presided, and called upon the chairman of the committee (Lieut.-Colonel Turnbull) to read the report of the committee, which was as follows:—

1. The committee have to report that they held a meeting on December 30th, 1897, and wrote on the following day to the board requesting the chairman to name a day for consultation. It was arranged that all joint meetings should be held at the office of the company, and the committee have received most courteous treatment from the chairman and members of the board, and information has been placed before the committee upon all questions raised.

2. At the first joint meeting a letter was submitted by the chairman of the board from Mr. Scrimgeour, intimating that as he would be out of London for some weeks, he would suggest that Mr. J. S. Thomson (who held his proxy) might be allowed to represent him on the committee. This was unanimously agreed to, and the committee hope the shareholders will endorse this decision.

The Present Position of the Company.

3. The first business discussed was the company's present unsatisfactory position, which, in the opinion of the committee, results from the following causes:—

(*a*) By the board having gone to allotment on too small a firmly-subscribed capital.

(*b*) By the payment to the vendors of £6,163 10s. in cash, when the company had such a very small available working capital.

(*c*) By the board having made an agreement on July 29th, 1896, with Mr. Marshall, one of the vendors, who was also a director of the company, that only one call of equal to 2s. per share should be made prior to July 31st, 1897. This agreement deprived the company of the power to raise the capital necessary to work the business.

(*d*) By the loss of capital—firstly, through the failure of Mr. Marshall and his associates ultimately to pay their calls, amounting to £9,737 10s., and secondly, to that of other shareholders, amounting to £5,696 19s., making a total deficiency of working capital of £15,434 9s.

(*e*) By the excessive expenditure upon general charges, as shown in the annual report; a portion of this may, however, have been indispensable in the establishing of this new industry.

(*f*) By the large expenditure in connection with the development of the Sola accumulator.

4. The above are the reasons why this company has not succeeded as it ought; but, with an increased working capital of not less than £15,000, and under economical and careful management, expending said capital in building and properly equipping omnibuses, the committee are satisfied the company has a splendid future before it, with a large earning capacity. Provided the above capital is secured to work the Ward system and Schanschieff Sola accumulator agreements, which are both valuable, the position of the company is much better than was represented to the public previous to the annual general meeting.

5. Mr. Ward has agreed with the board and committee to extend his licenses to the whole of the United Kingdom; he to be paid 10 per cent. in cash or shares on any gross amount the company may receive from the sale of the same in the United Kingdom outside of England; the company already possessing the licenses for England; the company also to have the benefit of any and all improvements Mr. Ward may make in relation to electric accumulator traction in omnibuses, cabs, stage coaches, and other public vehicles other than vehicles used on tramways.

6. Mr. Schanschieff's agreement conveys the exclusive right to use his patents for accumulators for omnibuses and cabs for London, with the additional privilege of granting sub-licenses for all public carriages, excepting tramways, for all England, and a right to use any improvements and discoveries that may be secured by the patentee, provided the company pays cost of securing the patents. Also, the patentee undertakes to supply accumulators for 300 omnibuses at actual cost, and, should the company decide not to manufacture accumulators, to supply all future orders at a royalty to be fixed by arbitration, the price not to exceed what is usually paid to other accumulator companies. Further arrangements can be made with the patentee to mutual advantage.

7. Mr. Spagnoletti attended one of the meetings, and expressed his opinion that the "Sola accumulator was most suitable for street traction, because it was lighter and cheaper than the average accumulator, and more economical to manufacture and work."

8. The committee requested the board to make a practical test of the running of the omnibus, resulting in a trial made on the 5th inst. The entire arrangements for this test were made under the direction of the board, who requested Mr. Spagnoletti and Mr. Schanschieff to take observations, and Mr. Ward to act as engineer. The omnibus carried 17 passengers, and ran out to Hammersmith Broadway from Trafalgar Square and back to Whitehall, a distance of 14 miles, going and returning by circuitous routes. On the outward journey the route lay up Haymarket, one of the steepest grades in London, and the omnibus maintained a uniform rate of speed on this grade. The steering was perfect in every respect, and the control in starting and stopping was thoroughly successful, the omnibus threading its way through the crowded traffic with perfect facility. Mr. Spagnoletti concludes his report thus:—

"The result of this trial trip I consider most encouraging, and very satisfactory indeed."

9. The committee find a contract is in existence with the Electric Street Car Manufacturing Syndicate, Limited, of Wolverhampton, its main object being the building of suitable omnibuses in an expeditious manner for this company. Provided these are secured on advantageous terms, this contract should prove to be to the interests of the company.

10. The committee, having carefully examined the articles of association, are of opinion that these should be suitably amended.

11. *Ordinary Stock* (*unissued*).—The company has at present at its disposal 119,993 shares ordinary stock unissued.

12. This issue is 80,000 shares of £1 each; these were all given to the vendors. The committee recommend that, provided the consent of the holders of the ordinary stock is secured, some satisfactory arrangement should be made with the deferred shareholders which would have the effect of reducing the capital stock of the company very materially. This, in conjunction with the securing of the additional capital, would be an important factor in the future prosperity of the company.

13. In the meanwhile this company has secured a prominent lead in the great question of electric traction for omnibuses, &c., and the committee feel assured that within a very short space of time this company's method of accumulator traction will entirely supersede that of horse traction. The committee have gone into facts and figures and given careful consideration to the probable results from an investor's point of view, and are satisfied that if properly-equipped omnibuses are placed on good thoroughfares in London and elsewhere, with regular services, the returns will be satisfactory on money invested, and will bear out the figures, as to profits, given in the original prospectus.

14 A reduction of expenditure is necessary, and towards this it has been proposed, by the directors themselves, that they should be entitled to only two-thirds of the fees fixed in the articles of association until such time as the company has paid an annual dividend of 7 per cent.

15. Mr. Ward has voluntarily reduced his annual salary one-half until the company is able to pay a 7 per cent. annual dividend to its shareholders, when he may resume his former salary, provided the said dividend is arrived at within the limit of his agreement. Mr. Ward has also relinquished his seat at the board.

16. It has been unanimously decided by the board and committee jointly, that a sum of *at least* £15,000 working capital is required for the immediate development of the company's business. It is proposed to construct 12 omnibuses, and place them on a desirable route, or routes, to be decided. It is estimated that these omnibuses will cost, with complete equipment, the sum of about £9,000, leaving a balance for fixed charges, omnibus stabling, wages, &c., of about £6,000.

17. In the event of providing a station and electrical appliances, so that this company might supply its own electricity, it is estimated that a further sum of about £5,000 would be required. Though arrangements can at present be made to purchase electricity on fairly reasonable terms, it is thought advisable that this matter should be taken into consideration as soon as the necessary capital is available.

18. The immediate appointment of an assistant engineer is absolutely necessary; this will receive the board's attention.

19. The company has the right to dispose of the forfeited shares upon which 10s. has already been paid, or credited as paid. This should prove a valuable asset, and the committee recommend that these shares should be offered: (1) To the shareholders who have defaulted. If so taken up the company would receive the sum of over £15,000; and (2) To the present shareholders as fully-paid shares for the sum of 10s. each, which would yield the sum of £15,935; and (3) in block to any person or persons who would be willing to purchase at a price to be named, or who would advance a sum sufficient for the company's immediate requirements. Provided the amount required is realised from the forfeited shares, there will remain 119,993 unissued shares of ordinary stock, which the proposed development under the expenditure of the £15,000, should also become an asset of considerable value to the company.

20. The committee feel assured that the future prosperity of the company, carried out on the proposed lines, will lead to great financial success; and trust this policy will be heartily endorsed by the shareholders.

In proposing the adoption of the committee's report Col. Turnbull said there had been mistakes of judgment on the part of the board, but they had had great difficulties to contend with, on account of going to allotment on too small a capital, and by reason of shareholders not paying their calls. More money had been probably spent on the Sola accumulator than the shareholders might think ought to have been done, but it had been done with the best objects.

Mr. Condict, a member of the committee, seconded the report, and referred in terms of praise to the Sola accumulator.

The report of the committee was then accepted, and it was agreed to remunerate the services of the committee by 100 guineas.

The Hove Electric Lighting Company, Limited.

Col. Filgate presided at the annual meeting of this company, held at Cannon Street Hotel, on Monday, and congratulated the shareholders on the position the company had attained. The capital expenditure had increased from £62,022 at the end of 1896, to £66,896, at the close of 1897, or by £4,874. Of this increase, £3,764 had been expended on mains, and £887 on meters. The demand for the supply of electric current in new streets, necessitated increasing the section of copper in the mains and feeders, the construction of about 2½ miles of new mains from all of which they hoped to realise a fair return. The demand for new mains was a satisfactory feature in their business, and they had every reason to believe that this demand would continue. Since the close of the year they had sanctioned further additions to their system of about 1½ miles of mains. To cope with the increasing demand on the works for current, they ordered a new 350 H.P. Willans-Crompton set for delivery early in the Autumn, but owing to the engineering strike and other causes, this set had only recently been delivered. Owing to the non-delivery of the new set, they were somewhat anxious as to their capability of meeting the heavy load during December, but the plant worked satisfactorily, and met the demand without any hitch. With this new set the power of the plant would be increased from 750 H.P. to 1,100 H.P. To meet the expenditure they had to incur, they determined to ask the shareholders' approval to increase the share capital by 2,000 shares of £5 each. 1,000 of these they proposed to issue at an early date, and to offer them to the proprietors *pro rata* at a premium. As the shares stood well in the market, they had no doubt that the issue would be a success. They further took advantage of this opportunity to ask the shareholders to increase the borrowing powers from £25,000 to £50,000. The year's working showed a satisfactory result, and that notwithstanding the large reduction they had made in the prices charged to customers for current, amounting to about 20 per cent. That reduction has no doubt increased the number of customers and the consumption of current. The number of customers had grown from 270 at the end of 1895, to 314 at the end of 1896, and to 397 at the end of 1897. The number of lamps attached to the system at the same dates were the equivalent of 18,298, 21,914, and 27,777 respectively. The number of units delivered to customers in the three years was, in 1895, 162,428; in 1896, 200,562; and in 1897, 268,243. Those figures showed the healthy and progressive nature of their business. The gross revenue for 1897 amounted to £7,269, compared with £6,518 in 1896, an increase of £751, while the working expenses stand at £3,667, against £3,404 in the previous year, an increase of £263. Considering the large increase in units delivered to customers, which amounted to 34 per cent., they would agree with him that the work has been conducted economically, which he must attribute to the care bestowed on the business by Mr. C. B. Smith, the resident engineer, at Hove, to the good work done by Mr. Reeves, the secretary, at head-quarters, and to the thoroughly satisfactory machinery supplied by Messrs. Crompton and Co., Limited, which has worked in a highly satisfactory manner. After providing interest payable on debentures and loans for the year 1897, income-tax, and interim dividend, at the rate of 4 per cent. per annum paid last October, they had a balance left of £2,092 7s. 11d. to deal with. They proposed, in the first place, to write off £150 from the amount standing in the capital account under "preliminary expenses," reducing the balance under this head to £1,200; to set aside £600 to the credit of the reserve fund; to pay a final dividend for the half-year at the rate of 6 per cent. per annum on the capital of the company, making, with the interim dividend paid in October, 5 per cent. per annum for the year, and to carry forward the balance, £218 7s. 2d., to the current year. Speaking of their prospects, the units delivered to customers from January 1st, compared with last year, showed an increase of nearly 30 per cent. The Hove Commissioners had again taken up the question of increasing the light in the streets of Hove, but were apparently debating as to whether the increased light which the public was demanding should take the shape of the electric light or an increased consumption of gas. They had made the Commissioners numerous proposals during the last five years for the supply of current for public lighting, but none of them had found favour with the Commissioners. At their request, they made a further and very liberal offer some two months ago, but had as yet received no communication regarding it.

The accounts were then adopted.

The House-to-House Electric Light Supply Company, Limited.

The directors' report states that the revenue account shows a credit balance of £12,033 4s. 11d., which, with the balance of £43 12s. 6d. brought forward, and £177 6s. 8d. dividends and balance of interest received, makes a total of £12,254 4s. 1d. After deducting £2,250 for interest on debenture stock paid and accrued, and £1,403 19s. 2d. for interim dividend paid on the 7 per cent. cumulative preference shares, the directors recommend that the sum remaining, viz., £8,600 4s. 11d., be dealt with as follows:—

		£	s.	d.
To credit of depreciation account	...	3,000	0	0
To payment of the remainder of dividend to December 31st, 1897, on the 7 per cent. cumulative preference shares	...	1,750	0	0
In reduction of preliminary expenses account	...	1,391	4	8
To payment of a dividend on the ordinary shares for the year at 4 per cent.	...	2,232	14	5
And that the balance of ... ... be carried forward to the next account.	...	226	5	10
Total	...	£8,600	4	11

The sums of £11,926 received as premiums on the last issue of shares and of £1,097 6s., profit on sale of 300 Yorkshire House-to-House shares have been applied in extinction of the balance of preliminary expenses account and construction business development account.

The following Table shows the progress of the company's electric lighting business since 1890:—

Year.	Equivalent of 35 watt (8-C.P.) lamps connected.	Increase in 35 watt (8-C.P.) lamps.	No. of houses connected.	Gross receipts.			Expenditure.			Net receipts.		
				£	s.	d.	£	s.	d.	£	s.	d.
1890	18,665	9,145	248	5,010	9	2	4,624	6	5	386	2	9
1891	19,388	5,723	373	8,328	8	11	6,077	14	10	2,250	9	1
1892	23,700	4,312	471	10,688	18	6	7,851	19	6	2,836	19	0
1893	28,429	4,729	599	12,068	10	10	7,832	6	8	4,231	4	2
1894	35,[illegible]58	7,429	755	13,695	11	8	7,431	16	8	6,263	15	0
1895	44,162	8,304	982	15,394	16	11	8,554	0	10	6,840	16	1
1896	55,265	11,103	1,164	17,442	6	5	8,410	8	4	9,031	18	1
1897	66,364	11,099	1,416	20,810	10	1	8,777	5	2	12,033	4	11

The increase in the number of lights connected during 1897 was equivalent to 11,099 8-candle-power (35 watt) lamps. The revenue from electricity has increased by £3,200 12s. 6d., while the expenses have increased £366 16s. 10d.

Additions and alterations to the plant and mains have been made, at a cost of £24,326 16s., and the expenditure for 1898 is estimated at £28,000. This outlay will be provided by the proceeds of the ordinary and preference shares issued under the agreement with the holders of founders' shares.

The Leeds and London Electrical Engineering Company, Limited, having resolved upon voluntary liquidation, gave notice to determine the agreement with this company. The directors have decided, in view of the consequent unsatisfactory position of this asset, to write off the whole, as stated. The relations between the two companies are receiving the careful consideration of the board.

A portion of the capital expenditure in recent years having been incurred in superseding earlier and less efficient plant, it will be necessary to make proportionately larger annual contributions to depreciation account than hitherto, in order to preserve the capital intact at the expiry of the concession. On the other hand, the revenue account will, in future, be relieved by the extinction of preliminary expenses now effected. The agreement with the holders of the founders' shares, which was passed by the shareholders, having received the approval of the High Court, has now been carried out. During the year a further 1,661 ordinary and 3,332 7 per cent. preference shares have been issued.

Mr. H. R. Beeton and Mr. R. A. Germaine retire from the board by rotation, and, being eligible, offer themselves for re-election. Messrs. Miall, Wilkins, Randall & Co., the auditors of the company, offer themselves for re-election.

Kensington and Knightsbridge Electric Lighting Company, Limited.

Mr. Granville R. Ryder presided on Thursday last week over the eleventh ordinary general meeting of the above company, held at 1, Great George Street, Westminster.

In moving the adoption of the report, the Chairman said the shareholders would observe that the form of accounts adopted on the present occasion was different from what they had been used to hitherto. The form in which they were put that day was the one required by the Board of Trade, and up to the present they had had practically to prepare two sets of accounts—one in the old form they used to have, and one according to the Board of Trade. Personally, he must say that he preferred their old form of accounts, as it set out things more clearly before them than those voluminous and somewhat pedantic figures. However, the point was not how the accounts were set out, but what was in them. He thought it was very gratifying to them to be able to put before the shareholders so satisfactory a statement. During the year the number of houses and shops which had taken the light had increased by 295, against the preceding year, whereas in 1896 the increase was only 216, as against the year preceding that. That was very satisfactory. On the other hand, the actual increase of lamps for the year was not so great as it was the year before. In fact, last year it was only 18,000 lamps as against 25,000 in the year before. But there was ample evidence that the district as a whole was taking more electric light, because, as a matter of fact, the actual number of units of electricity which had been taken by the district during the year as compared with the year before showed an additional increase of nearly 100,000 units—that was an increase of 353,000 units as against 285,000 units. With regard to the capital account, they would observe that the amount of increased capital which had been issued during the year was £11,060 of 4 per cent. debenture stock and £10,000 of the 5 per cent. second preference shares, that had been issued at a premium which produced within the year £2,079. With regard to that premium, £558 of it had been used to wipe out the remainder of the cost of the conversion of the debenture stock two or three years ago. The rest—£1,521—had been written off against the Kensington Court purchase account, which did stand at £13,000, and was, therefore, now reduced to about £11,500. The next point was with regard to the renewal account. They would observe that the sum of £8,061 had been paid to that account after paying for the maintenance for the year of the plant of all kinds, including buildings and everything else, at a cost of £3,150. While the sum of £8,061 might possibly be thought to be rather too large a sum to put to that account in one year, yet the best men competent to advise us on the subject, considered the point was to make that particular fund a strong one, and so give to the company all the stability possible. When they came to consider how fragile and short-lived a good deal of the electrical plant was, and how necessary it was that they should be in a position to take advantage of all improvements in electrical science which came out, it was absolutely necessary that such a fund as that should always exist in the case of a company such as theirs. With regard to the number of units sold during the year, the figures were very satisfactory. In 1896 the number of units of electricity sold was 1,514,729, and in 1897 the number was 1,898,362, an increase in the year of 383,633 units. It was satisfactory to find that the increase had been earned at an increased cost of £18,019, but at the same time the profits had increased from £34,371 to £41,681, and, therefore, they had earned the additional amount of £7,309. That showed that when they increased their output they decreased the cost, and so he hoped it would always go on. It must go on until the time came when they would have to go in for extensive new works, or for large additions to the existing works. These were the principal points to which he had to call their attention. One item of expenditure they would notice was always increasing—rates had increased by about £1,000, and, as far as they could judge, there was little chance of any diminution under that head. At one time it used to be considered that premises should be rated according to the burden they were to the parish. Now that was altered, and it seemed to be the custom to take the profits and charge on that, and what it came to practically was paying another income-tax.

Sir Frederick Bramwell seconded the motion.

A Shareholder asked how it was that the shares were not quoted on the Stock Exchange.

The Chairman said it would be a great advantage if they could get a quotation, and they were gradually working up to that. It was, however, necessary to have a certain proportion of share capital to debentures before they could get a quotation. It was a matter which the board had always in view.

The Shareholder said the amount carried to renewal account was equal to a dividend of 3 per cent. The chairman had referred to the fact they could continue to produce electricity at a cheaper rate until they had to enlarge the works. He would like to know how much longer it would be before the plant would be fully employed and lighting would have to extend?

Mr. Crompton said the plant was now up to the capacity which it was originally expected the district would take, and in all probability it would be fully utilised at that time next year, and after that there would have to be a very considerable increase. The probability of having to extend was due to the fact that the district had proved much better and richer than it was ever anticipated it would be. There were now many small tenements coming down which were being replaced by large flats, in which there would be a demand for electricity. It was quite possible they would have to increase their plant the year after next.

The report was then adopted.

The Chairman moved the confirmation of the interim dividend at the rate of 8 per cent. for the year and the declaration of a dividend at the rate of 12 per cent. for the year.

Mr. Hopkinson seconded the motion, and it was carried.

The retiring directors and auditors were re-elected, and a vote of thanks was passed to the board and the employés.

The Birmingham Electric Supply Company, Limited.

The directors report that the amount of net profit, including the balance of £1,042 15s. 6d. brought forward from last year, is £13,656 1s. 7d. Out of this sum, after placing £4,460 8s. 6d. to the credit of the depreciation reserve fund, the directors recommend the payment of a dividend of 5 per cent., absorbing £8,206 9s. 4d., and carrying forward a balance of £989 3s. 9d. The premiums obtained on the issue of the remaining portion of the company's capital amounted to £5,475 8s. 1d. Out of this the directors have added the sum of £3,366 17s. to the special reserve against provisional orders; with this addition the cost of the provisional orders, amounting to £4,027 4s. 8d., is now fully provided for. The balance of the above premium, amounting to £2,108 11s. 1d., has been carried to the general reserve fund. On making the above appropriations, the total reserves and undivided profits will amount to £22,536 16s. 6d.

There has been a steady increase in the company's business during the past year, the total number of 16-C.P. lamps, or their equivalent on order, December 31st, 1896, was 25,876, and on the same date in 1897 the number was 39,232. The additions since the close of the financial year have brought the number up to 40,707. The expenditure on capital account during the past year has been £35,250 9s. 4d.

Included in the capital expenditure during the past year are the completion of the works in connection with the new boilers at the Dale End station. The extension at the company's Water Street depôt in equipment of steam plant was completed in time for the winter's supply. Extensions have been made in the underground main system in various parts of the company's Parliamentary area.

The reductions in the company's charges for current, introduced in the early part of the year, although slightly decreasing the revenue per unit, have been amply justified by the greatly increased demand for current.

The company during the year have carried out, through the wiring department, a considerable number of installations for consumers from the company's supply system. Included in this work has been the entire installation of the General Hospital. Hitherto the working of the department has resulted in a surplus to the company's funds; the result, however, of last year's work has been a loss amounting to £558 2s. 3d., which has been written off the profits for the year. The directors have always looked upon this portion of the business as a necessary feeder to the company's system, and as the loss in question has been entirely due to the tedious and expensive nature of the work carried out at the General Hospital, such a loss is not likely to recur.

A large number of motors have been added to the system during the year, and the economy and convenience of electricity as a source of power are now generally recognised. In view of the continued increased output, orders have been placed for further engines and boilers for the Water Street depôt for completion by the end of the summer.

The capital of the company is now subscribed, paid up, and expended. As certain capital outlay is necessary during the year, a resolution will be submitted to the meeting to authorise the increase of the capital by the creation of 20,000 additional shares of £5 each, to be issued at the discretion of the board when necessary.

W. T. Glover & Co., Limited.

The prospectus of this company, registration of which we announced in our issue of February 25th, has been issued this week. The capital is £200,000, £100,000 5 per cent. cumulative preference shares, and £100,000 ordinary shares.

The business has been well known in the electrical world for some years, as that of manufacturers of insulated wires and cables, and enjoys a high reputation in these respects. The profits, although showing a trifling falling off for the last six months of 1897, have averaged for the past four years, over £14,000 per year.

It would appear that the company will acquire:—

	£	s.	d.
Land plant and machinery (according to Messrs. Wheatley Kirk, Price & Goulty's valuation)	43,733	5	4
Stock in trade on basis approved by Messrs. Wheatley Kirk, Price & Goulty... ...	49,436	17	6
Book debts (guaranteed by the vendors) ...	41,049	11	10
Sundry investments	1,205	9	4

or £135,425 4s. plus the value of the patents, goodwill, trade marks, &c. On the other hand, it will have to discharge the liabilities, £76,513 16s. 3d., it will, therefore, be in this position: £135,425 4s., less £76,513 16s. 3d., *i.e.*, £58,912. The value of the patents, goodwill, trade marks, &c., must, therefore, stand at about £91,088. In other words, the £150,000 (in shares and cash) plus the liabilities undertaken by the company, £76,513, or say £226,513, less the other assets valued at £135,425 as above = £91,088 the assumed value of the remaining assets (patents, goodwill, &c., &c.).

There are portions of the document regarding assets, liabilities, and vendors' consideration, so curiously worded that it would seem well-nigh impossible to criticise, but as the vendors will take all the ordinary shares (besides about one-third of the preference shares), there is no doubt that the holders of the remaining preference shares will obtain their 5 per cent. thereon.

The success of the issue is, we understand, well assured, and the undertaking has our best wishes for its continued prosperity.

Stock Exchange Notices.—The Stock Exchange Committee has ordered the following to be quoted in the Official List:—Waterloo and City Railway Company—540,000 ordinary stock, in lieu of the shares now quoted; West Coast of America Telegraph Company, Limited—30,008 shares of £2 10s. each fully paid, Nos. 1 to 30,000 and 53,001 to 53,008, and £150,000 4 per cent. debentures, Nos. 1 to 1,500, in lieu of the shares and debentures of the old company of the same name now quoted.

Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to—Babcock & Wilcox, Limited—A further issue of 8,000 ordinary shares; British Electric Traction Company, Limited—10,000 6 per cent. cumulative preference shares; Buenos Ayres and Belgrano Electric Tramways Company, Limited—"A" 6 per cent. cumulative preference shares; "B" 6 per cent. cumulative preference shares; and fully and partly-paid provisional certificates for 5 per cent. debenture stock; City and South London Railway Company—22,500 ordinary shares; St. James's and Pall Mall Electric Light Company, Limited—Further issue of 12,000 ordinary shares, Nos. 40,081 to 52,080. The Committee has been asked to allow Waterloo and City Railway Company—£540,000 ordinary stock, in lieu of the shares now quoted, to be quoted in the Official List.

Chelsea Electricity Supply Company.—The report for the year 1897 shows a balance available for distribution of £11,344, after payment of debenture stock interest, and placing £2,000 to the renewals fund. Dividends are recommended of 6 per cent. for the year on the preference shares and on the ordinary shares, carrying forward £1,652. £20,851 is added to the reserve fund from premiums, making the total of the reserve fund £36,717. Lamps connected total 96,638, an increase of 16,178 during the year.

British Insulated Wire Company.—After writing off £2,222 for depreciation, and £1,770 off preliminary expenses, the net profits for the eight months ended December 31st, were £17,754. A dividend at the rate of 15 per cent. per annum for the eight months is declared on the ordinary shares, £1,500 is transferred to patents and goodwill, and £129 carried forward.

Commercial Cable Company.—The directors have declared a quarterly dividend of $1\frac{3}{4}$ per cent. on the capital stock, payable on April 1st. The transfer books will be closed from the 21st inst., to April 2nd.

TRAFFIC RECEIPTS.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending March 4th, 1898, were £2,322 7s. 9d.; corresponding period, 1897, £2,101 18s. 1d.; increase, £220 9s. 8d.

The City and South London Railway Company.—The receipts for the week ending March 6th, 1898, were £1,089; week ending March 7th, 1897, £1,062; increase, £27; total receipts for half-year, 1898, £10,719; corresponding period, 1897, £10,775; decrease, £56.

The Dover Corporation Electric Tramways.—The receipts for the week ending February 26th, 1898, £100 12s. 10d.; total receipts, February 26th, 1898, £848 10s. 9d. Week ending March 5th, 1898, £99 15s.; total receipts to March 5th, 1898, £948 5s. 9d.

The Dublin Southern District (Electric) Tramways Company.—The receipts for week ending Friday, March 4th, 1898, were £378 16s. 7d.; corresponding week last year, £436 15s. 7d.; decrease, £57 19s.; passengers carried, 65,343; corresponding week last year, 69,824; aggregate to date, £3,594 9s. 4d.; aggregate to date last year, £3,913 7s. 6d.; decrease to date, £318 18s. 2d.; mileage, 8 miles.

The Liverpool Overhead Railway Company.—The receipts for the week ending March 6th, 1898, amounted to £1,364; corresponding week last year, £1,315; increase, £49.

The Western and Brazilian Telegraph Company, Limited.—The receipts for the week ending March 4th, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £8,099.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, March 2nd.	Closing Quotation, March 9th.	Business done during week ended March 9th, 1898. Highest.	Lowest.
137,400*l*	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	...	...	100 104	100 —104	...	...
25,800	Amazon Telegraph, Limited, shares...	10	...	...	...	6½ — 7½	6½ — 7½	...	...
125,000	Do. do. 5% Debs. Red.	100	...	...	...	93 — 96	93 — 96	...	...
923,900*l*	Anglo-American Teleg., Ltd.	Stock	£2 9s.	£2 13s.	3 %	59 — 61	59 — 61	...	...
3,038,020*l*	Do. do. 6 % Pref.	Stock	£4 18s.	£5 6s.	6 %	107½ 108½	108½ 109½	109¼	107⅞
3,038,020*l*	Do. do. Defd.	Stock	...	...	...	11⅞ – 12¼	11⅞ — 12¼	12 1/16	...
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	...	...	16¾ — 17¼	16¾ — 17¼	17 3/16	16⅞
75,000*l*	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	...	...	112 —116	112 —116	...	...
44,000	Chili Teleph., Ltd., Nos. 1 to 44,000	5	4 %	4 %	...	3 — 3½	3 — 3½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	...	187 —192	187 —192	189	...
653,586*l*	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	106 —108	106 —108	107½	106⅝
224,850	Consolidated Teleg. Const. and Main., Ltd.	10/-	1½%	2 %	...	1/16 — 3/16	1/16 — 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	...	7 — 8 xd	6½ — 7½	7½	7
6,000	Do. 10 % Pref.	10	10 %	10 %	...	14½ — 15½xd	14½ — 15½	14⅝	14½
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	...	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	...	10 — 11	10 — 11	...	...
30,000*l*	Do. do. 4½ % Debs. Nos. 1 to 6,000	50	4½%	4½%	...	103 —106%	103 —106%	...	...
60,710	Direct United States Cable, Ltd.	20	2½%	2½%	...	10¾ – 11¼	10¾ — 11¼	11¼	11⅛
120,000	Direct West India Cable 4½% Reg. Deb	100	...	...	...	98 —101	98 —101	99¾	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	...	18 — 18½	17¾ — 18¼	18⅛	17⅞
70,000	Do. 6 % Cum. Pref.	10	6	6%	...	19 — 20	18½ — 19½	19¼	...
89,900*l*	Do. 5 % Debs., repay. August, 1899	100	5 %	5%	...	100 —103	100 —103	...	...
1,302,615*l*	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4%	...	131 —134	129 —132	...	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7%	...	18¾ — 19¼	18¾ — 19¼	19⅛	18⅞
25,200*l*	{ Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326 }	100	5 %	5%	...	99 —103	99 —103	...	...
100,500*l*	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5%	...	100 —103	100 —103	...	...
320,000*l*	Do. 4 % Deb. Stock	Stock	4 %	4%	...	130 —133	130 —133	...	...
51,100*l*	{ Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343 }	100	5 %	5%	...	99 — 103	99 —103	100½	...
69,200*l*	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5%	...	100 —103	100 —103	...	...
300,000*l*	{ Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909 }	100	4 %	4%	...	102 —105	102 —105	...	...
200,000*l*	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4%	...	108 – 111 %	108 —111%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	...	12 — 12½	11¾ — 12¼	12½	11⅞
180,042	Do. do. 6 % Pref.	10	6 %	6%	...	17¾ — 18½	17¾ — 18¼	18¼	17¾
150,000	Great Northern Teleg. Company of Copenhagen	10	10 %	10%	...	28½ — 29½	29 — 30	29¼	28⅞
160,000*l*	Do. do. do. 5 % Debs.	100	5 %	5%	...	100 —103 xd	100 —103	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10%	...	52 — 55	52 — 55	54½	53½
100,000*l*	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6%	...	106 —109 xd	106 – 109	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	...	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5½%	5½%	6 %	6⅝ — 6⅞xd	6½ — 6¾	6 3/16	6⅝
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 18 xd	16 — 18	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	15⅝	15⅜
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5¾ — 6¼xd	5¾ — 6¼	6 1/16	5 15/16
329,471*l*	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	104 —109	104 —109	105½	105⅜
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	⅝ — ¾	⅝ – ¾	...	...
100,000*l*	Pacific and European Tel., Ltd., 4 % Guar Debs, 1 to 1,000	100	4 %	4 %	...	105 —108	105 —108	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	8 — 9	8 — 9	8⅝	...
3,381	Submarine Cables Trust	Cert.	...	...	...	139 – 144	139 – 144	141	...
58,000	United River Plate Teleph., Ltd.	5	4 %	...	...	4 — 4½	4 — 4½	...	...
146,733*l*	Do. do. 5 % Debs.	Stock	5 %	...	...	103 —107	106 —109	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	nil	...	4½ — 4⅝	4 5	...	...
213,400*l*	Do. do. do. 5 % Debs.	100	5 %	5 %	...	101 104 xd	101 104	...	...
64,268	Western and Brazilian Teleg., Ltd.	15	1 %	2 %	...	11½ 12	11¼ 11¾	11⅞	11 5/16
33,129	Do. do. do. 5 % Pref. Ord. .	7½	5 %	5 %	...	7½ – 8	7½ 8	7¾	7⅝
33,129	Do. do. do. Def. Ord	7½	1 %	...	...	4 — 4½	3½ – 3¾	4⅜	3⅞
382,230	Do. do. do. 4 % Deb. Stock Red....	Stock	...	...	...	106 —108	106 —109	108	107
88,321	West India and Panama Teleg., Ltd.	10	⅞%	1 %	...	½ — ⅝	½ — ⅝	⅝	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	8 — 8½	8 — 8½	8	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	5 — 7	5 — 7	...	...
80,000*l*	Do. do. 5 % Debs. No. 1 to 1,600 ...	100	5 %	5 %	...	105 – 108	105 - 108	...	...
163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ..	$1000	7 %	7%	...	105 —110	105 —110	...	...
160,100*l*	Do. do. 6 % Ster. Bonds.	100	6 %	6%	...	100 —105 xd	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	1895.	1896.	1897.	Closing Quotation, March 2nd.	Closing Quotation, March 9th.	Highest.	Lowest.
30,000	Charing Cross and Strand Electy. Supply	5	5 %	6 %	7 %	14 — 15	13½ - 14½	14⅜	13⅞
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	6 7/16	6 1/16
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	...	11½ — 12	11½ — 12	11⅞	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	4½%	4½%	...	115 —117	115 —117	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	7 %	10 %	28½ 29½	28 – 29	29½	28
10,000	Do. do. Prov. Certs.	5	...	...	10 %	28 — 29	27½ — 28½	28¼	27⅝
10,000	Do. do. Nos. 90,001 to 100,000 £2 pd.	10	...	...	...	14 — 15	13½ — 14½	14⅜	14
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17½ — 18½	17½ – 18½	18¼	18
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	129 – 134	129 —134	132½	131½
30,000	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—30,000	10	nil	nil	nil	15½ — 16	14¾ — 15¼	15⅝	15¼
20,000	Do. do. do. 6% Pref., 40,001—60,000 ...	10	6 %	6 %	6 %	15¾ — 16¼	15¾ — 16¼	16 3/16	15⅞
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5	...	..	...	11 — 12	11 — 12	11⅞	11⅜
10,000	Do. do. 7 % Cum. Pref. ...	5	...	...	...	11½ — 12	11¾ — 12¼	12¼	12⅛
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	4 %	5 %	...	20 — 21	20½ — 21½	21⅜	20⅝
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem. ...	10	...	...	...	19½ — 20½	20 — 21	20½	...
220,000*l*	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	117 —121	117 — 121	119	118
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	2 %	4 %	6 %	19 — 20	20 — 21	20½	20⅛
19,980†	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,000	5	7½%	10½%	14½%	18½ — 19½	18½ — 19½	19¼	18⅞
20,000	Do. do. 7 % Pref., 20,001 to 40,000	5	7 %	7 %	7 %	10 — 11	10 — 11	11	10½
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	4 %	107 —110	107 —110	...	...
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2¾ — 3¼	2¾ — 3	3	2⅞
79,900	Westminster Electric Supply Corp., Ord., 101 to 80,000	5	7 %	9 %	12 %	17½ — 18½xd	17½ — 18½	18	17½

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation March 2nd.	Closing Quotation. March 9th.	Business done during week ended Mar. 9th, 1898. Highest.	Lowest.
30,000	British Electric Traction	10	...	...	...	16½—17	16¾—17¼	16 15/16	16⅝
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	...	...	...	2—2¼	1⅞—2⅜	2 1/16	1 13/16
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	...	...	2¼—2½	2¼—2½	2⅜	2¼
125,000*l*	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	...	...	...	110—114 xd	110—114	...	...
50,000	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	102—105	102—105	...	...
19,126	Central London Railway, Ord. Shares	10	...	...	...	10½—11	10½—11	10 15/16	10 11/16
143,106	Do. do. do. £6 paid	10	...	...	...	6½—7	6½—7	6⅞	6⅝
58,830	Do. do. Pref half-shares £1 pd. ...	...	...	...	...	1½—2	1½—2	1¾	...
61,777	Do. do. Def. do. £5 pd. ...	...	...	...	...	4⅞—5⅛	4¾—5	5	4⅞
630,000*l*	City and South London Railway	Stock	1 3/16%	1 9/16%	1⅞%	67—69	67—69	68½	67⅝
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	...	...	2¼—2¾	2¼—2¾	2½	2⅜
99,261	{ Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 99,261	} 5	5 %	5½%	...	2½—3	2½—3	2⅝	...
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5½%	...	4—5	4—5	4⅛	...
194,023	Do. do. do. 4% Deb. stock Red. ...	100	...	...	...	103—105	103—105	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	5 %	6 %	...	2⅝—2⅞	2⅝—2⅞	...	...
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 ...	2	7 %	7 %	...	3⅛—3⅜	3⅛—3⅜	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	...	...	...	½—¾	½—¾	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	...	...	...	⅜—⅝	⅜—⅝	...	...
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	10½%	...	...	9—11	9—11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	8 %	10 %	12 %	23—24	23—24	22¼	21¾
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	19—20	19—20	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½%	110—115 xd	110—115	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	21½—22½xd	21½—22½	...	...
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	104—108	104—108	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	2⅞%	2⅞%	3¼%	10¾—10⅞	10 11/16—10 13/16	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15¾—16¼	15¾—16¼	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	15 %	15 %	39—41	37—40	40	39
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102—105	102—105	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	...	...	13¾—14¼	136—139	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7%; 1890—8%.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

* Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7¾, £5 (fully paid) 10⅜.

Electric Construction Corporation, 6 % Debentures, 106—108.

House-to-House Company, 4½% Debentures of £100, 106—109.

Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 16½—17½xd; 1st Preference Cumulative 6 %, £5 (fully paid), 8½—9. Dividend, 1896, on Ordinary Shares 7 %.

London Electric Supply Corporation, £5 Ordinary, 4½—4⅝.

* T. Parker, Ltd., £10 (fully paid), 14.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8—8½xd. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount 3 per cent. (October 14th, 1897).

INSTITUTION OF ELECTRICAL ENGINEERS.

On the Manufacture of Lamps and other Apparatus for 200-Volt Circuits. By G. Binswanger Byng, Member. (Paper read February 24th, 1897.)

(*Concluded from page* 311.)

The possible current through four lamps on 200 volts, allowing 40 volts across each arc, is five times the normal; with five lamps on 230 volts, 7·5 times the normal; while with four lamps on 230 volts it is only 3·3 times the normal. Therefore, when 5-ampere lamps are used upon a 230-volt circuit, it is better to run four with steady long arcs than five with unsteady short arcs.

It is probable that the enclosed arc lamp will be brought into prominence in this direction, offering certainly many advantages; but I would point out that in practice the current cannot be largely increased, because of the frangibility of the enclosing envelope under an accession of temperature. If the cooling surface be increased so that the temperature of the gases surrounding the arc remain about the same, the efficiency of the lamp is considerably reduced.

Adverting to the manufacture and installing arc lamps, to meet the contingencies of the high voltage, we have to consider that, if the carbons run short, or the slides stick in one lamp, the other lamps close together, and the full voltage of the circuit is maintained across the shunt coil of that particular lamp. The possible troubles are that the shunt coil is burnt up, and that the carbon holders are damaged with the excessive flaring of the arc before it breaks.

It would hardly be practical to make magnets to stand such overload. Of course we can instal a cut-out and equivalent resistance to each lamp. But this expedient is very costly, and presents the further difficulties of finding suitable room near the lamp, or making it self-contained with the lamp, and of teaching the consumer that the full current can be used, although the lamps are not alight.

Some sort of cut-outs must be installed, and I am of opinion that there is a field for inventors in this direction. I will indicate how I have endeavoured to meet these difficulties.

If, as is generally the case, one pair of carbons burn at a greater rate than the others, the slide in that lamp will touch the stop first, and the stumps will burn away until the gap is wide enough to break the arc. I append a table showing the results of five trials.

Four 10-Ampere Lamps on 200-Volt Circuit.

+ *carbon* 18 *mm. cored*, − 11 *mm. solid*.

(1)	Arc flared and was extinguished at	...	1½ inches gap.
(2)	" " "	...	1 3/16 "
(3)	" " "	...	1 "
(4)	" " "	...	1¼ "
(5)	Current switched off when arc was at		2¼ "

In the first four trials the arc broke while flaring; that is to say, it travelled up the side of the carbon and ignited the loose dust, taking a spiral course, this course being continued until the length is too great for the voltage. The arc only leaves the point of the carbon when there is sufficient dust to maintain it, and counteract its increasing length; thus, when the supply of dust fails, the arc is extinguished before it can return to the points.

During Trial No. 5 the carbon became pointed, and the temperature rose to the extent of freeing the surface from dust, hence the arc did not leave the crater.

We may deduce from this the desirability of maintaining a considerable gap between the carbon-holders, exceeding even 3 inches. For absolute safety it is better to extinguish the arc automatically. Now an automatic switch is useless, because it is necessarily controlled by the potential across the lamp, and could not discriminate between the increased voltage caused by the carbons burning short and that caused by the extinction of a flare; and, since this may happen at any time, the arc could not be re-formed even when the carbons came together. The circuit, in fact, would be inert, and the arc would have to be re-established by hand.

An efficient cut-out must extinguish the arc, and simultaneously cut the shunt coil out of the circuit, the mechanism of the lamp also being free that the carbons may travel together. The shunt must on no account be cut out whilst the brake is on, since it could not then compensate the series coil and draw the carbons together.

For the protection of the shunt coil I have used a temperature fuse, made of an alloy with a melting point of 210° Fahr., and having sufficient sectional area to be independent of the amount of current likely to traverse it. The carbons could be held apart several minutes before fusion took place. Although a decided advantage was gained over a plain lead fuse, and the shunt coil was efficiently protected, the carbon-holders were not protected, and the fuse required renewing each time it became ruptured.

The chief difficulty in constructing an automatic "cut-in" and "cut-out" lies in the necessity for a rapid make or break, to save vibration and sparking. My system may be briefly explained, in that the arc is first short circuited through a shunt path, and so put out by reducing the voltage across the terminals. This short is then broken by a quick break switch, the same action reversing the shunt switch simultaneously, ready to fall upon its normal contact when the carbons touch, or are replenished. The mechanism is actuated by the main armature of the lamp, and the movements take place while the armature is below the feeding point, so as not to interfere with the working of the lamp.

You can see the actual working of this novel "cut-out" on the lamp which I show here.

Heating and Motors.

The effect of the increased pressure upon such applications of the house current as heating, cooking, &c., does not entail a sufficient alteration structurally or electrically to need an exhaustive description.

The resistances forming or causing the heating surfaces must be arranged to conform to the higher E.M.F. at the terminals, and it is mostly preferable to increase the length rather than decrease the diameter of the resistance wires; but this fact presents some difficulty in such articles where the space available is small. If the space is too limited, such apparatus can only be used in series, or in connection with an external resistance.

With motors, the greatest difficulty also lies in adopting the smaller sizes, say from $\frac{1}{12}$th H.P. to $\frac{1}{4}$th H.P., to suit the altered conditions of higher pressure. A certain structural alteration is doubtless necessary to arrange a new winding to produce the same efficiency as heretofore on a 100-volt circuit. In the larger sizes I am, in order to facilitate keeping stock, using a double or differential winding, which, when coupled in parallel, conforms to 100 volts pressure, and with the same winding in series, gives an equal efficiency on a normal load at the 200-volt pressure.

In reviewing the subject of higher voltage generally from a standpoint of *cost*, I am of opinion that sufficient time and experience, naturally resulting from an increased demand, will place the cost of most fittings for 200 volts within the margin of those of the lower voltage—except, perhaps, a few cases, among which I may instance incandescent lamps. These will necessarily always be more expensive, owing to increased cost in mounting of larger bulbs and extra supports, and also through increased time of exhaustion and percentage breakage.

But we must not overlook the fact that in the matter of wiring there must be a decided saving. The smaller sectional area of conductor per lamp employed, without the necessity of increased insulation, as also in a minor degree smaller connectors and contacts will, in all probability, compensate some other apparent disadvantages, and may bring the balance of cost in favour of the high voltage system.

I do not wish to bring the subject of cables and wires or wiring systems within the scope of my present paper; but I will only mention that, in my opinion, such matters as the establishment of revised wiring tables, the use of twin wires, the smallest gauge allowable for single lamps, the best and cheapest system of wiring for high-voltage supply, would be subjects well worthy of the immediate consideration of, and an interchange of opinion between, engineers and manufacturers.

TEST OF THE CHICAGO STORAGE BATTERY ROAD.*

(*Continued from page* 313.)

The coal had a theoretical evaporative power of 10·5 lbs. of water from and at 212° Fahr., and actually evaporated 6·6 lbs., giving for the efficiency of the furnace and boiler 62 86 per cent. This low efficiency is to be expected because of the boiler being 26 per cent. underloaded. The equivalent evaporation per pound of combustible was 8·22, so that the efficiency of the boiler alone is 78·3 per cent. The boiler then loses by radiation, convection, and through escaping gases 21·7 per cent. of the original heat units, while the furnace is to be charged with 15·44 per cent. of the lost heat, and 62·86 per cent. appears in the steam.

The economiser did not give satisfactory results on the tests shown. This is not the fault of the economiser, however, but is due rather to the unfavourable conditions under which it was installed and is operated. Several large cracks in the brickwork flue leading from the uptakes of the boilers to the economiser on the outside of the power house allow air to infiltrate to such an extent, that the flue gases are cooled fully 100° before reaching the economiser. In spite of this fact, however, the economiser, upon some of the other tests, effected an economy of 7 per cent., as figured from the gain in temperature of the feed-water. A graphical log of the boiler test made November 5th indicated a rise of 75 7° F. in the feed-water, due to the action of the economiser. This log also shows the amount of coal required for banking the fires over night. Upon this test, however, a larger amount of coal was burned in the boilers, and thus a greater amount of flue gases passed about the economiser pipes. During the latter part of the test on November 26th, the economiser was cut out of service.

The pumps used 14·36 per cent of the water evaporated by the boilers. The feed-water, however, was heated by the pump exhaust from a temperature of 97·4° F. to a temperature of 202° F., resulting in a gain of 9·25 per cent. The fuel, then, to be charged against the pumps is only 14 36 per cent., less 9·25 per cent., or 5·11 per cent. of the total fuel burned.

The test shows that the engines used 18 lbs. of steam per indicated horse-power. The conditions of the test were not favourable to either an accurate engine test, or to the most economical operation of the engines. The steam pressure was lower than it should have been, while the vacuum was but 24·25 inches. The engines were also overloaded during the entire run, and were operated at 363 instead of 380

* *Street Railway Review.*

Results of Boiler Tests.

Items.	Units.	Determinations.
Number of trial	...	3
Date of trial, 1897	...	Nov. 26th.
Duration of trial	hours	9
Number boilers in operation	...	1
State of weather	...	Rainy.
Dimensions.		
Kind of boiler	...	Heine horizontal tubular.
Dimension of shell, diameter and length	feet	48″ × 19′9½″
Number and diameter of tubes	...	87-3½″
Grate surface 84 inches wide, 78 inches long, area	sq. ft.	45·5
Water-heating surface	sq. ft.	1,407
Ratio of water-heating surface to grate surface ...	sq. ft.	30·9
Average Pressure.		
Steam pressure in boiler, by gauge	lbs.	168 3
Absolute steam pressure	lbs.	183 0
Force of draught in inches of water at stack ...	ins.	·58
Force of draught in inches of water at boiler ...	ins.	·52
Average Temperatures.		
External air	deg.	30·0
Fire room	deg.	45·3
Steam	deg.	374 2
Feed-water	deg.	192 0
Fuel.		
Kind of coal	...	Fairmount, W. Va.
Total amount of coal consumed	lbs.	7,000
Moisture in coal	%	6·32
Dry coal consumed	lbs.	6,558
Total refuse, dry	%	13·14
Total combustible (dry weight of coal less refuse)	lbs.	5,638
Dry coal consumed per hour	lbs.	728 6
Combustible consumed per hour	lbs.	626 4
Calorific power by calorimeter, B.T.U.	per lb	10,145
Theoretical evaporative power from and at 212° Fahr. in pounds water per pound coal ...	...	10 51
Results of Calorimetric Tests.		
Quality of steam, dry steam being taken as unity	%	935
Percentage of moisture in steam	%	5
Water.		
Total weight of water pumped into boiler and apparently evaporated	lbs.	43,440
Water actually evaporated, corrected for quality of steam	lbs.	43,323
Factor of evaporation	...	1 07
Equivalent water evaporated into dry steam from and at 212° Fahr.	...	46,356
Equivalent water evaporated into dry steam from and at 212° Fahr. per hour.	lbs.	5,150·6
Economic Evaporation.		
Water actually evaporated per pound of dry coal from actual pressure and temperature ...	lbs.	6 60
Equivalent water evaporated per pound of dry coal from and at 212° Fahr.	lbs.	7·06
Equivalent water evaporated per pound of combustible from and at 212° Fahr.	lbs.	8 22
Commercial Evaporation.		
Equivalent water evaporation per pound dry coal with $\frac{1}{6}$th refuse at 70 lbs. gauge pressure, from 100° Fahr.	lbs.	5 96
Rate of Combustion.		
Coal square feet grate surface per hour	lbs.	16 0
Consumption of dry coal per hour, coal assumed at $\frac{1}{6}$th refuse—		
Per square foot grate surface	lbs.	16 74
Per square foot water heating surface	lbs.	·534

RESULTS OF BOILER TESTS—(*continued*).

Items.	Units.	Determinations.
Rate of Evaporation.		
Water evaporated from and at 212° Fahr. per square foot heating surface per hour	lbs.	3 66
Water evaporated per hour from 100° Fahr. into steam of 70 lbs. gauge pressure—		
Per square foot grate surface	lbs.	98·46
Per square foot water heating surface ...	lbs.	3·18
Commercial Horse-power		
On basis of 30 lbs. water per hour evaporated from 100° Fahr. into steam of 70 lbs. gauge pressure (equals 34½ lbs. from and at 212°) ...	H.P.	149
Horse-power, builders' rating at 7 square feet of heating surface per horse-power	...	200
Per cent. developed below rating	%	26·5
Efficiency.		
Percentage of total calorific power utilised ...	%	62·86

RESULTS OF TESTS ON ENGINES, GENERATORS AND AUXILIARIES.

Items.	Units.	Determinations.
Number of test	...	3
Date of test	...	Nov. 26th.
Duration of test	hours.	9
Water.		
Total water handled by pumps	lbs.	43,440
Water used by economiser engine	lbs.	350
Water used by stoker engine	lbs.	532
Water used by air and feed pumps	lbs.	6,240
Water used by calorimeters	lbs.	90
Water escaping through leaks, estimated liberally 2 per cent. total	lbs.	868
Water not used by engine	lbs	7,880
Per cent. total water not used by engine	%	18·12
Per cent. total water used by pumps	%	14·36
Total water used by engine...	lbs.	35,560
Per cent. moisture in steam at engine	%	1·20
Total dry steam used by engine corrected for moisture	lbs.	35,133
Average dry steam used by engine per hour ...	lbs.	3,903
Engines.		
Average speed of engine	...	363
Average vacuum	...	24·25
Average gauge pressure	...	171.3
Average indicated horse-power	...	217
Maximum indicated horse-power	...	246
Minimum indicated horse-power	...	202
Total indicated horse-power-hours...	...	1,951·8
Pounds dry steam per indicated horse-power-hour	...	18
Dynamo No. 4.		
Average volts...	...	176·5
Average amperes	...	727·0
Average kilowatts	...	128·3
Per cent. of full load	...	67·5
Total kilowatt-hours output	...	1,154·7
Average kilowatt output of all dynamos	...	128·3
Total kilowatt-hour output of all dynamos ...	...	1,154 7
Total electrical horse-power-hours	...	1,547·8
Maximum kilowatt output	...	156·48
Load factor (average watts divided by maximum watts)	...	·82
Watts used by cooling tower motor	...	7,568
Kilowatt-hours used by cooling tower motor ...	...	68·1
Net kilowatt-hours output	...	1,086·6
Efficiencies.		
Average efficiency E.H.P. divided by I.H.P. ...	...	79·3
Pounds water evaporated per indicated horse-power-hour...	...	32·25
Pounds coal burned per indicated horse-power-hour	...	3·58
Pounds water evaporated per net kilowatt-hour ...	...	40 6
Pounds coal burned per net kilowatt-hour ...	...	6·44
Indicated horse-power-hour per pound coal ...	...	·298
Watt-hours per pound coal...	...	155·2
Costs.		
Coal per ton	...	$1·90
Total cost of coal burned	...	6 65
Cost of coal per net kilowatt-hour	...	00611

revolutions per minute. The difference in the power developed by the two lines of cylinders is due to an improper adjustment of the cut-off on the north line. With a few changes there is no doubt but that a material improvement can be made in the duty of the engines.

The indicator cards taken with one engine operating one generator, running on open circuit, show a friction load of 32·26 I H.P. This is but 14·86 per cent. of the average, and is a very satisfactory figure.

The average efficiency between the horse-power developed in the cylinders and the electrical power delivered on the switchboard is shown to be 79·27 per cent., which is also satisfactory.

The commercial efficiency of the generator (including the leads to the switchboard) at this load is 78·27 ÷ 85·14, or 93·1 per cent., which is all that can be expected of a generator running 32 per cent. below its rated capacity.

The total station efficiency from coal pile to switchboard is 5·58 per cent. It may be of interest to compare this result with some other modern station. The Chicago Edison Company, in its Harrison Street station, produces electrical energy of ·3 of a cent per kilowatt-hour burning coal containing 13,000 British thermal units per pound, and costing delivered $1.05 per ton. The efficiency of that station, therefore, is (1·05 × 1,000 × 3 43 × 100) ÷ (·003 × 2,000 × 13,000), or 4·61 per cent. This indicates that the net efficiency of the plant tested is 20 per cent. better than that of the Edison station. The Edison station has an output of over 3,000 H.P., while the Englewood station has a maximum capacity of 500 H.P., which makes the comparison more striking.

The cost of fuel for a net kilowatt-hour on the switchboard is shown to be ·611 cent. This high price is to be explained, then, not by the inefficiency of the station, but by the fact that a high price is paid for a poor coal. With a more advantageous arrangement in the purchase of coal, there is no reason why this station should not develop a kilowatt-hour for less than ·3 cent.

(*To be continued.*)

THE KELVIN QUADRANT ELECTROMETER AS A WATTMETER AND VOLTMETER.

BY ERNEST WILSON.

Communicated by Dr. J. HOPKINSON, F.R.S., to the Royal Society Received January 11th—Read January 27th, 1898.

(*Concluded from page* 309.)

Experimental Results.

In making a thorough test of the electrometer as an alternate current wattmeter we have the following variables to deal with:—

1. The frequency of the alternate current.
2. The phase difference between current and potential, that is, between C and A or B.
3. The amplitude of C and A or B.
4. The shape or wave form of the curve of potential and current.

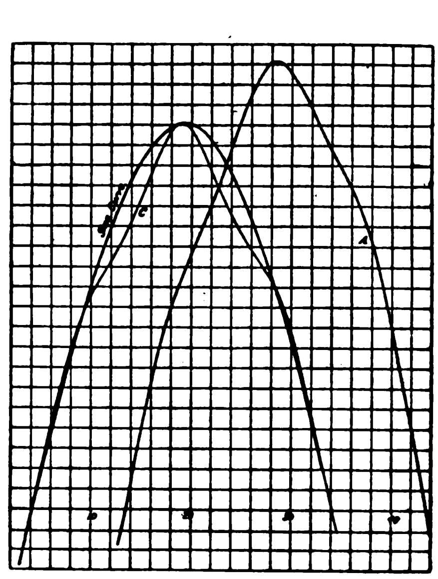


FIG. 3.

The results obtained are tabulated in Table II., and are divided into three groups (*a*) (*b*) (*c*). In group (*a*) two frequencies are given namely, 41 6 and 83 complete periods per second. The potential on the needle is constant at about 100 volts ($\sqrt{\text{mean}^2}$). The phase difference between potential and current and the current itself are each varied. When the phase difference is zero, it is only necessary to take the product of the $\sqrt{\text{mean}^2}$ values to deduce the watts,

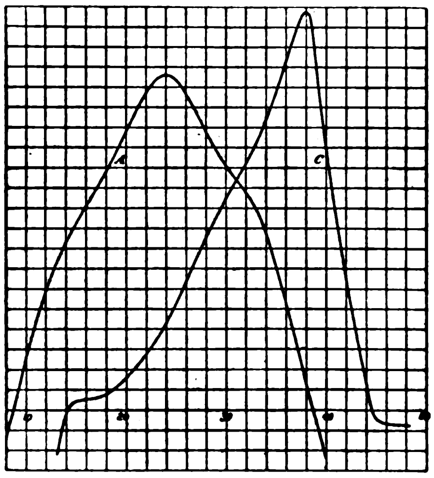


Fig. 4.

although in section (*b*) three instances are given in which for phase difference zero, the watts are deduced by both methods. The average watts per division given by section (*a*) are 17·00 for all angles of phase, leaving out the two values deduced by aid of the cosine law for angles of 30° and 60°. It will be seen that under the conditions

curve in fig. 1, that for high potentials on the needle the watts, per division of the scale, would diminish. This is found to be the case when the potential, C, is raised to 1,860 volts ($\sqrt{\text{mean}^2}$) for frequencies of 75 and 43. In section (*c*) the wave form is very much distorted. The curves of potential and current are plotted in fig. 4. The distortion of the potential curve, C, was brought about by placing a considerable non-inductive resistance in series with a choking coil, and taking potentials across the choking coil. The instrument under these conditions gives trustworthy results. The phase difference on one or two occasions was such that the curves indicated no work, the deflection under these conditions was zero.

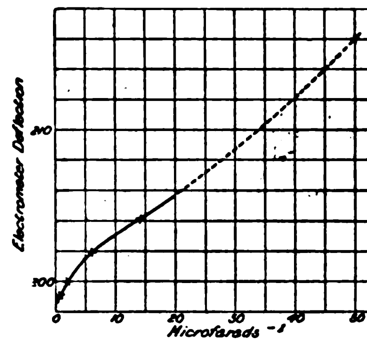


Fig. 5.

The maximum angle of deflection of the needle from its normal position was 7·8°, and tests were made from time to time, especially with the large potentials on the needle, to see if the instrument was in proper adjustment, by placing both pairs of quadrants in connection with the case, and noting the agreement between its then

Table II.

Frequency.	Phase difference in degrees. 360° = 1 period.	Potential of needle C in $\sqrt{\text{mean}^2}$ volts.	Current in amperes $\sqrt{\text{mean}^2}$.	Watts.		Watts per division of scale.		Date of experiment, 1897.
				From product of volts and amperes.	Given by curves.	From product of volts and amperes.	Given by curves.	
(*a*)								
41·6	0·0	100·35	39·65	3,979·0	...	16·79	...	November 24th
41·6	0·3	99·85	17·11	1,709·0	...	16·75	...	" 24th
41·6	0·0	100·4	39·8	3,996·0	...	16·79	...	" 25th
41·6	29·7	100·3	39·85	3,996·0	3,371·0	...	16·85	" 23rd
41·5	31·5	99·66	16·85	...	1,457·0	...	17·30	" 23rd
41·6	30·0	100·0	39·6	...	...	17·23*	...	" 25th
41·6	59·4	100·0	39·7	...	...	18·54*	...	" 25th
83·0	0·0	99·3	39·24	3,897·0	...	16·87	...	" 30th
83·0	0·0	100·0	29·91	2,991·0	...	16·85	...	December 1st
83·0	0·0	101·7	9·64	980·6	...	16·90	...	" 1st
83·0	0·0	101·5	9·70	984·5	...	17·27	...	" 2nd
83·0	0·0	99·5	39·45	3,925·0	...	16·85	...	" 2nd
83·0	0·0	101·0	73·98	7,472·0	...	16·68	...	" 2nd
83·0	61·9	99·6	19·76	1,968·0	892·3	...	17·5	" 1st
83·0	39·3	99·4	40·15	...	3,191·0	...	17·34	" 1st
83·0	63·9	100·0	39·9	...	1,622·0	...	17·07	November 30th
83·0	60·0	101·7	74·15	...	4,097·0	...	17·29	December 4th
(*b*)								
82·0	1·2	563·0	11·89	6,689·0	6,736·0	15·67	15·77	December 4th
83·0	60·0	553·0	11·83	...	3,142·0	...	15·25	" 4th
83·2	0·8	630·0	10·86	6,842·0	6,892·0	16·25	16·37	" 11th
83·0	65·4	623·0	10·3	...	2,433·0	...	15·7	" 11th
75·0	0·0	1,860·0	2·33	4,330·0	...	10·93	...	" 18th
75·0	0·0	1,860·0	1·25	2,320·0	...	11·40	...	" 18th
53·6	0·0	438·0	16·03	7,020·0	7,162·0	16·52	16·85	" 9th
53·7	64·8	436·0	15·01	...	2,868·0	...	16·49	" 9th
43·0	0·0	1,840·0	2·39	4,400·0	...	11·21	...	" 17th
43·0	0·0	1,840·0	1·30	2,390·0	...	11·60	...	" 17th
(*c*)								
50·4	6·0	117·2	45·0	5,275·0	5,350·0	16·91	17·15	December 15th
50·4	36·0	117·8	45·0	...	2,741·0	...	16·82	" 15th

* Watts deduced by Cosine Law.

of section (*a*) the wattmeter may be said to verify within the limits of accuracy attainable by the method of test. The wave form of the unloaded alternator is given in fig. 3 and marked C; this is the wave form of potential applied to the needle in all experiments in sections (*a*) and (*b*). A sine curve having the same maximum ordinate is superposed for the purpose of comparison. The current curve has different wave form according to the load on the alternator. For small currents it approximates to C in fig. 3. The curve, A, fig. 3, is the wave form for current 74 amperes, which is the maximum we have employed.

The experiments in section (*b*), Table II., are intended to demonstrate the reliability of the instrument when the potential of the needle, C, is varied through wide limits. One would expect from the

zero and the zero when quadrants and needle were put to the case, that is when the instrument was totally discharged. To test the effect of dismounting the instrument the needle was taken off the suspension and the instrument moved to another room and used for another purpose, on December 10th, 1897. On continuing the experiments it was set up by the level only, and found to be in proper adjustment. The results of experiment before and after this removal are given in Table II.

Seeing from fig. 3 how great was the deviation from the sine law, it would have been necessary to analyse each curve by Fourier's theorem, if the subject was to have been treated mathematically the phase difference being given. The current curve was continually changing its form with different loads, and this would have necessitated observing the curve in each case, so that nothing was to be gained by this method of treatment. The potential curve, c, fig. 3, has, however, been analysed,* and can be expressed by the equation—

$$c = B_1 \sin \frac{2 \pi t}{T} + B_3 \sin \frac{6 \pi t}{T} + \ldots .$$

The first five coefficients are as follows:

B_1	B_3	B_5	B_7	B_9
540 1	1·9	31 5	—6 5	1·3

We see that B_5 is important, being about 6 per cent. of B_1; so that from the analysis the cosine law could not be expected to hold. In section (*a*), Table II., the cosine law is applied in two instances for the purpose of illustration. It gives 18·54 as against 17·0 for the watts, per division of scale, for 60°; and 17 2 as against 17 for 36°. For small angles the error does not appear to be so great.

The conclusions arrived at from these experiments are that the Kelvin quadrant electrometer can be used with accuracy as a wattmeter in the case of alternate currents having any phase relation, and that, as pointed out by Dr. J. Hopkinson,† it is necessary to see that within the range of potentials applied, Maxwell's formula is verified. This is, perhaps, best done by applying steady potential differences to the needle and quadrants, and measuring these by Poggendorff's method, employing Clark's standard cell as the unit of comparison. It could also be tested by applying known alternating potentials to the needle and quadrants, the curves being in phase. If it is required to use alternating potentials of high value, such, for instance, as 2,000 volts or more, a suitable transformer could be employed to reduce the potential on the needle. Such unloaded transformer could have the primary and secondary electromotive forces in phase, and of the same wave form,‡ so that no error would be thereby introduced.

The Revolving Contact Maker.

The revolving contact maker, M, fig. 2, exhibits a peculiarity worth noting. It is in itself the seat of an electromotive force, as is demonstrated by placing it across the electrometer, Q_2, and running the machines without excitation. A deflection of 68 scale divisions, corresponding to 0·45 volt, is given if the electrometer has no capacity across its terminals, that is, if G is zero. A copper brush gives the same effect as a steel one. As soon as G is given a substantial value as compared with the electrometer itself, this deflection disappears.

When actually observing potentials in the usual way, let the value of G be varied. For a given position of the contact maker the deflection varied, as shown in fig. 5, in which the ordinates are observed deflections, and the abscissæ the reciprocals of the capacity of G in microfarads. We see that when G has 1 microfarad capacity, the deflection is practically what it would be if G were ∞, and with 1 microfarad the results verify with the true value. Such inductive effect is certainly rendered negligible by sufficient capacity, and it is therefore wise to examine this effect when working with a given contact maker, since each one may have its own peculiarities.

The manganin strip, r_3, r_4, fig. 2, is in lengths of 5 feet, brased together. This material has altered its resistance, as shown in Table III.

TABLE III.

Date.	Resistance at atmospheric temperature in ohms.
November 1st, 1897	0 4625
„ 3rd „	0 4590
„ 13th „	0·4592
„ 20th „	0·4589
„ „ „	r_3 = 0·2269
„ „ „	r_4 = 0 2270
January 4th, 1898	r_3 = 0 2275
„ „ „	r_4 = 0·2277

The strip was mounted on November 1st, 1897, and submitted to currents varying from 100 amperes downwards. On November 20th, 1897, it was adjusted for r_3, r_4. The results show that there is an initial diminution of resistance, and that then the resistance remains practically constant. This is worth noting, as this material is largely used at the present time on account of its low temperature coefficient. The manganin strip is unvarnished and exposed to the atmosphere of the engine room. The conditions are therefore not the best to secure constancy of resistance, but in all probability the initial diminution is due to the brazing.

Messrs. C. J. Evans and H. H. Hodd have given me valuable assistance, not only in the experimental part of this paper, but also in the working out of the results. Messrs. Simpson, Greenbank, and Davey, the present Student Demonstrators in the Siemens Laboratory, have also helped me. I wish to acknowledge this, and to tender my thanks to these gentlemen.

* *Electrician*, August 31st, 1894, p. 517.
† *Philosophical Magazine*, April, 1885.
‡ *Electrician*, February 15th, 1895, p. 463.

THE INSTITUTION OF CIVIL ENGINEERS.

At the ordinary meeting on Tuesday, February 22nd, Sir John Wolfe Barry, K.C.B., F.R.S., the president, in the chair, two papers, "The Theory, Design, and Working of Alternate Current Motors," by Mr. Llewelyn B. Atkinson, Assoc.M.Inst.C.E., and "Dublin Electric Tramway," by Mr. H. Parshall, M.Inst.C.E.

The first paper was principally devoted to consideration of asynchronous motors, which, although the subject had on two previous occasions been referred to in the *Proceedings of the Institution* (in 1883 and 1889), had not hitherto been discussed. The principles of alternating currents, so far as necessary for their use in alternate current motor design, were first dealt with, and the method of graphically making the necessary calculations was illustrated. After showing the principles on which the continuous current motor was based, and that it consisted of two parts, a field magnet and an armature, the author pointed out that a similar construction (a magnetic field being made of laminated iron) enabled motive power to be derived from alternating currents, provided that means were taken to ensure the phase of the magnetic field, and of the current in the armature being the same. This gave rise to the first class in the classification adopted by the author, that was to say, motors in which the energy was conveyed to armature through brushes, and which were therefore called "conductive motors," which might be series wound, shut wound, or separately excited; in the latter case, the phase of the E.M.F. producing the exciting current differed by a quarter period from that producing the armature current, thus forming an example of the application of multiphase currents to alternate current motors.

The transformation of energy from one circuit to another by electro-magnetic induction, instead of by conduction, was next considered, and by diagrams and curves the working of transformers, both with magnetic leakage and without magnetic leakage between the primary and secondary windings, was illustrated. This gave rise to a class of motors in which the energy was supplied to the armature not through the brushes, but through the air gap; these motors in the simplest form having, however, a commutator for short circuiting the coils so as to produce a proper distribution of current in the armature. The author classed these motors as "inductive motors with brushes, having one inductive electric axis and one magnetic axis."

A modification of this class furnished a third class, "inductive motors with brushes," in which there were "two reciprocal inductive electric and magnetic axes."

The brushes might then be dispensed with, giving rise to a class of "inductive motors without brushes, having short circuited coils and two reciprocal inductive electric and magnetic axes," the modern induction motor. The author proceeded to examine in detail the theory of such motors, and showed how, by means of a diagram, its properties might be determined. It was then pointed out how, in such a motor when running, the supply on one phase might be eliminated, and the motor would remain self-exciting, furnishing itself a magnetising current in phase with the supply current, thus forming the modern monophase induction motor.

The supply might be on any number of phases, to the same number of magnetic systems, provided that a proper relation existed between the two.

The use of asynchronous motors as generators was next touched upon, and the author showed that the various motors explained might be used as motor generators, in which case not only the pressure, but the phase of the current, might be changed. All these machines might be used as generators, and the various combinations of motors and generators of this class were illustrated.

In a second part of the paper, the author dealt with the design of alternate current motors, and showed the necessary conditions to produce the proper distribution of currents in the armature and of the magnetic field, and further, gave a formula for determining the proper loading of the armatures, and from this showed how all the other dimensions of a machine for any given power might be derived. The wave form and frequency, as affecting alternate current motors, were discussed, and examples were given showing to what extent the necessary conditions were realised in practice.

In the third part the author dealt with the practical construction and working of asynchronous motors, and taking each class described, illustrated them by examples so far as they existed, and tests where these were available. This part was illustrated by curves and data relating to a large number of different classes of motors. Curves were also given showing the relative weight of continuous current motors, single-phase motors, two-phase motors, and three-phase motors.

The second paper embodied an account of the Dublin Southern Tramways, which was to some extent peculiar, in that the installation, as originally designed, would not conform with the Board of Trade regulations in the matter of the fall of potential in the earth return. The machinery had been ordered and the work proceeded with before the author had been called in to advise in the matter. The problem became, therefore, to utilise as much of the machinery ordered as possible, and to instal such other machinery as would be necessary to distribute the electricity under the Board of Trade regulations. The high-tension alternate-current method of transmission was considered most suitable. It was necessary to make use of the sites owned by the Tramway Company, and to execute the work as cheaply as was consistent with safe operation. The three-phase machines and switchboards were specially designed for the installation, which was the first one of its kind established in the British Isles. The installation had been in operation for nearly two years, and had been found entirely satisfactory. The operation of the sub-stations had been found to be very simple, so simple, in fact, that only a boy was employed in each station to work the machinery. Owing to the low frequency the motors were very easily synchronised, and even though they were thrown in considerably out of phase, they quickly fell into step. Since the opening of the road the load had been greatly increased by a considerable number of additional cars and trailer-cars, yet the machines had never given trouble, nor had the synchronous motors fallen out of step, even in the case of the most severe loads. The requirements of the Board of Trade had been satisfactorily met, and owing to the number of points of distribution it was possible to work some 60 cars on the line instead of 20, as originally designed to comply with the Board of Trade regulations. As originally designed, the fall of potential in the earth return would have been some 18 volts to 20 volts, whereas in the present installation it was found to be 3½ volts.

The installation was, perhaps, most interesting from a commercial rather than from an engineering standpoint, in that it illustrated how traffic might be developed by an improved service. Formerly the traffic was worked by three disjointed horse lines, none of which were profitable. They were finally sold for about £14,000, whereas the value of the present property was estimated at £300,000, and the revenues were consistent with this figure.

At the time the installation was designed the total number of cars contemplated was 20; since that time it had been found profitable to work as many as 50 cars on the line, even though the line had been subjected to the disadvantage of not having a through connection to the centre of Dublin. Owing, therefore, to the largely increased load, the capacity of the power house at Ballsbridge had been greatly added to by a large direct-connected unit which was more suited for heavy traction loans. Likewise the sub-station at Blackrock had been re-designed, and in the place of the 60-kilowatt motor-generator sets originally installed there were two 200-kilowatt rotary converters, with the necessary static transformers, and an improved switchboard for manipulating it.

The principal point of importance was the ease and reliability with which such a system was shown to be operated. The efficiency of the system was shown by the working cost to be satisfactory, although, as might be gathered from the paper, the efficiency of the machines in the sub-stations was not so high as would be the case with larger machines and larger rotary converters. For a small tramway installation, however, the sureness of operation and the minimum of labour were of vastly greater importance than any small gain in efficiency.

SOME AMERICAN METHODS.

II.

The Gray planer shops in Cincinnati are another sample of that rapidly growing practice of a firm confining itself to the manufacture of one article. In England we have been too diffuse, not merely in mechanics but in all subjects, too diffuse that is for modern success. The diffuseness of English practice is never more markedly shown than when some successful Westminster engineer is called in to advise perhaps on sewage disposal, because he has made a name on a canal or a bridge. In matters of everyday life we don't call in our solicitor to cure us of a fever because he has won a case for us at law; but we do just such things when it comes to questions of engineering, and the sight is familiar of expenditures of thousands of pounds under the advice of a noted engineer when a few hundreds would have secured a better result. This same habit is carried out in mechanical engineering. A tool-maker makes planers, lathes, drills, and the whole range of machine tools. We hear that Smith's lathes are the best, and Jones's planers are the best, but Smith still makes planers and Jones gaily carries on his trade in lathes. A friendly understanding, honourably carried out between them, would result in each man making one only of these machines, leaving the other to his rival.

In America they practice this concentration very largely, and in the Gray shops they stick to planers. This company scrape neither beds nor tables to fit, except just to remove loose particles of iron.

Accurate tools and "know how" eliminate scraping. One sample of "know how" is the use of two tools to plane the V's of the bed. The tools balance each other as to cutting pressure, and do accurate work by relieving the bed of so much stress, leaving the finishing tool with very light work to perform.

In the Bickford drill and tool shops the same idea prevails, and a total of 23,000 square feet of surface of floor is devoted solely to drilling machines. It is obvious that the process of selection will tend to secure for each of the shops just named, the best available talent at planers and drill presses respectively. Unite the two shops, and one of the two men would be the stronger, and would impress his inferior ability upon the better weaker man, and either the planer or the drill would be inferior for lack of the specialisation. In the Fay and Egan wood-working machine shops, they were estimating for machinery to turn out 300 freight cars daily in a Russian works, contemplated to be, therefore, six times the output capacity of the largest American car works, and no doubt Russia will be a large field for machinery, which our own works ought to look into now they have the prospect of working on better lines.

In the shops of the Laidlaw-Dunn Gordon Company everything is carried out with a view to economy of operation. Thus, if a man wants a tool, he presses a button and rings up a number in the tool room, a boy answers the call and takes the man what he requires; and no doubt a few boys must save the time of many men going to and fro for tools.

The new shop of this company is 665 feet long and 113 feet wide, with overhead traveller and side lights above the traveller. All the heavy tools are placed on one side and light tools opposite, the castings passing across the shop and so reducing handling. The large traveller is 15 tons capacity, electrically worked, and there are numerous air hoists suspended from jib cranes. In the Lodge and Shipley shops, the speed pulleys of lathes, which are the sole product of the company, are crowned at one operation by a full width tool. Some of these tools are 4 inches wide.

A custom in the tool shops of this locality is that of making all small parts of machinery from samples. After a new machine has been set up and tested, it is taken apart and its pieces used as samples, being placed in the sample room and all subsequent parts are made to these samples. The last named company carry the idea into their purchase department, which contains samples of all they require in the way of supplies, as sand and emery papers, drills, screws, wrenches, in fact, one of every standard article they purchase, numbered and catalogued.

In the shops of the American Laundry Machine Company there is a board about 30 inches × 38 inches, carrying two pins for every size of machine of every style they make. On these pins are hung different coloured poker chips. These show the number of machines in stock. Thus, when an order for 12 machines is sent into the shop there are, say, 12 red chips hung on the upper of the two pins proper to that machine. As each machine is completed one chip is removed from the upper to the lower pin. Blue chips represent orders from outside, and a blue chip is removed as each machine is shipped. The system is a great aid in showing progress of orders, &c. Other boards fulfilling similar ends are used in these shops, one, for example, with the days of the month, carries hooks and clips containing the orders to be filled on the different days. These boards are always at hand showing when work is to be shipped.

There is also a telephone system whereby a call is made in every department for the man wanted at head quarters by means of a push button and bell. On hearing his call the foreman wanted goes to the telephone and replies. The bell in the Superintendent's office rings in unison with the rest. The telephone itself is simply the old speaking tube system. The calling only is electrical, as the old tubes required so much lung power to sound them.

In an engine shop was found an old lathe, dating back authentically to 1832, and known to be older by several years. It is used for facing columns, and is holding its own to-day, though its shears are bolted to stout wooden beams, and the carriage is operated by a crowbar. If this tool were seen by a travelling American in an English shop, it would be published and illustrated as a standard sample of the ways of the Britisher. We do not doubt that though old it may be quite equal to anything for the work it is doing, but as it calls forth the daily eulogiums of the manager, we think it might pay to put in a less interesting specimen, if only to save the time of the manager. However, it is satisfactory to know that even in America age does not necessarily condemn.

JAPANESE COPYING.

Some good articles on "Engineering in Japan" have been recently appearing in the *Engineer*. Referring to the charge that the Japanese copy European and American designs, as though such were a rascally thing to do, our contemporary hints that did they not do so the Japanese would be a trifle idiotic. All round originality in the design of a machine can scarcely be possible to-day. Should they elect to build a locomotive, they could not get far away from European or American types, and even so original a people as the Americans, have only been able to elaborate the old English locomotive on lines from which the English themselves departed more widely than the Americans, who, however, every day are more nearly approaching European forms as their country approximates more nearly to Europe in its settled areas. We have often thought that much valuable time is wasted in the endeavour to make new departures without sufficient reason. Did the Japanese contrive their products widely different from the existing examples before them—the outcome of a century of trial, error and endeavour, it would be looked on as a proof of overweening conceit. Sudden and wide departures from the plan and system of a steam engine, a gas engine, or a spinning frame, are not possible. All existing types of spinning frames to-day, are obviously only developed from the small machines of Crompton and Arkwright, and it is only during the past few months that the first departure has been made in the loom for several thousand years, and the departure now made is not a matter of a difference in the machine, but the discovery of a novel principle in weaving. Before the Japanese or anyone else can make departures in design, they must invent new principles of action. To-day we are as Watt left us with the steam engine, and use the same designs where we follow the piston principle. But if we abandon the principle, we easily get a new design in the steam turbine. The gas and oil engine are almost identical in principle with the steam engine, and they follow its mechanical lines very closely.

In this charge of copying it is therefore very unfair to charge bad faith upon copyers. Originality is well in the proper place, and may be evidence of good judgment and correct taste, but it is as often a sign of weakness. A weak man will re-design a machine because he has not the courage to confess that some other man's design is better than he can do himself. If all engineers aimed at being original in place of being good managers, there would be an immense amount of waste. It is in too much striving after originality at others' expense that engineers so often waste money. It should be our aim to see that English models come into Japanese hands so as to lead them in the direction of English systems and ideas. We surely cannot find fault with a people only just at the beginning of their engineering life for utilising Western experience of a hundred years.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1898.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents*, 322, *High Holborn, London, W.C., to whom all inquiries should be addressed.*]

4,267. "Improvements in or relating to enclosed globe electric lamps." C. Oliver. Dated February 21st.

4,278. "Improvements in or relating to electrical signalling apparatus." J. A. Busher. Dated February 21st.

4,282. "Improvements in automatic cut-outs for arc electric lamps." G. Byng and A. E. Angold. Dated February 21st.

4,287. "Improved electric arc lamp." H. V. James. Dated February 21st. (*Complete.*)

4,306. "Improvements in electrodes for secondary batteries." P. W. Northey. Dated February 21st.

4,371. "Improvements in electric meters applicable also to instruments for testing the magnetic properties of iron." J. Finlayson. Dated February 22nd.

4,398. "Improvements in electric railway systems." J. M. Murphy. Dated February 22nd. (*Complete.*)

4,409. "Improvements in third-rail underground electric railway system." W. H. Wheatley. (L. E. Walkins and G. M. Jewett, United States.) Dated February 22nd. (*Complete*)

4,414. "Improvements in lamp globes or apparatus for distributing and modifying the light of oil, gas, and electric lamps or burners." W. H. Witham. Dated February 22nd.

4,416. "Improvements in or relating to electricity meters." R. F. S. Venner and Chamberlain & Hookham, Limited. Dated February 22nd.

4,435. "Improvements in electric signalling apparatus for use on railways." C. S. Davy. Dated February 22nd.

4,441. "Improvements in or relating to electric motors." H. O. Duncan. Dated February 22nd, (Date applied for under Patents, &c., Act, 1883, Sec. 103, January 14th, 1898, being date of application in France.)

4,455. "Electric railways." F. C. Esmond. Dated February 22nd.

4,468. "Improvements in conduits for wires carrying electric current." F. G. Howard and A. W. Scalter. Dated February 23rd.

4,471. "Wareham's electric clock or time recorder." E. Wareham. Dated February 23rd.

4,508. "Apparatus for metering electrical current." W. A. Price. Dated February 23rd.

4,516. "Improvements in holders for the brushes or collectors of dynamo-electric generators and motors, and other revolving electric machines." J. Matthews and G. B. Cruickshank. Dated February 23rd.

4,549. "Apparatus for electrically controlling the hoisting mechanism of elevators or any other type of machinery." H. H. Leigh. (F. J. Sprague, United States.) Dated February 23rd.

4,550. "Improvements in telephone signal systems." E. Edwards. (W. Stillwell and A. Barneck, United States.) Dated February 23rd.

4,588. "An improved method of, and means for, holding the bases of electrical fittings within boxes, or upon other surfaces." F. Bathurst. Dated February 24th.

4,621. "Improvements in electric arc lamps." A. F. Spooner. (P. Vassia, France.) Dated February 24th.

4,635. "Improvements in apparatus for travelling through pipes or conduits, more especially intended for use in threading through electric conductors." H. Edmunds and A. H. Howard. Dated February 24th.

4,646. "Improvements in apparatus for magnetic testing." J. A. Ewing. Dated February 25th.

4,678. "Improvements in insulation of wire for electrical purposes." C. E. Hearson. Dated February 25th.

4,683. "Improvements in electric accumulator grids." A. Schanschieff. Dated February 25th.

4,742. "Improvements in devices for lighting lamps by electricity." C. M. White. (H. M. Brigham and S. M. Meyer, United States.) Dated February 25th. (*Complete*)

4,746. "Method of, and means for, measuring the work performed in a rotary phase current system." Siemens Bros. & Co., Limited. (Siemens & Halske Aktien-Gesellschaft, Germany.) Dated February 25th.

4,747. "Improved means for counterbalancing the frictional resistance in alternating current motor-meters." Siemens Bros. and Co., Limited. (Siemens & Halske Aktien-Gesellschaft, Germany.) Dated February 25th.

4,761. "Improvements in electric controlling and regulating apparatus." W. Emmott. Dated February 26th.

4,764. "Improved process and apparatus for tanning by the aid of electricity." N. P. Andersen, J. Westergaard and H. Zerener. Dated February 26th.

4,791. "Improvements in connection with the mechanism of electrically illuminated devices." W. H. Clegg, J. S. Richardson and S. Jevons. Dated February 26th.

4,812. "Improvements in or connected with alternating current electric motors." A. Heyland. Dated February 26th.

4,819. "A method of electrically heating materials in closed chambers and apparatus for that purpose." Electric Reduction Company, Ltd. (W. T. Gibbs, Canada.) Dated February 26th.

4,820. "Improvements in electric arc lamps." Siemens Bros. and Co., Ltd., and F. Booker. Dated February 26th. (*Complete.*)

4,825. "Improvements in or relating to electric accumulators." C. Junge. (R. Knoschke, Germany.) Dated February 26th. (*Complete.*)

4,828. "Improvements in electro-magnetic couplings for shafts, pulleys, and the like." H. H. Lake. (W. Dierman & Co., Belgium.) Dated February 26th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free,* 9d. (*in stamps*).]

1897.

13,971. "Improvements in and relating to controllers for electric motor circuits." The British Thomson-Houston Company, Limited. (E. D. Priest.) Dated June 8th, 1897. Relates to various improvements in controllers operated by fluid under pressure, and consists of employing a number of pistons to vary the resistance of the circuit by cutting out the resistance or change the motor connections from series to parallel or *vice versâ*. Arcing is prevented by blow-out magnets, and the coils are protected against injury by a piece of refractory material, a similar protection being afforded to the pole-pieces. The valve mechanism for operating the parts is divided into two parts, one valve for the resistance contacts, and the other for changing the combinations of the motors; both valves are operated by a single handle by means of gear wheels. 31 claims.

17,144. "Improvements in flexibly insulated conductors." J. H. Kelman. Dated July 20th, 1897. Relates to a method of insulating conductors, and consists in coating the conductors with a thin coating of boiled linseed oil, and hardening by oxidation. Various methods are devised whereby the wire may be coated and hardened. 11 claims.

18,095. "Improvements in method and means for operating and alternating current motors." The British Thomson-Houston Company, Limited. (C. P. Steinmetz.) Dated August 3rd, 1897. Relates to a method of enabling an alternating current motor to be run at full efficiency and at different speeds, or at full efficiency when fed with currents of a periodicity much higher than would be permissible were the motors connected directly to the line in the usual manner, and also to obtain the same good results in regulating the power and speed of a number of alternating current motors as are obtained by the use of the "series parallel" method of control used with continuous current motors. 21 claims.

13,977. "Improvements in three-phase alternating current induction meters." The British Thomson-Houston Company, Limited. (C. P. Steinmetz.) Dated June 8th, 1897. Relates to a three-phase induction watt meter, and consists of a closed-circuit armature and magnetising coils, comprising current coils in two of the main lines, and two potential coils in circuit with electromotive forces which are in quadrature with the electromotive forces between the third main and the two mains carrying current coils. 6 claims.

6,243. "Improvements in and relating to the protection and support of underground electric conductors, principally applicable for electric railways and tramways." H. S. Cowx. Dated March 10th, 1897. Relates to conduits composed of lengths of a trough-like section placed end to end to form a channel, and if necessarily, supported at the centre of its length. At the ends where each length joins the next length a chair is provided supported on a sleeper. The chair is of similar section to the trough and fits closely. Between the ends of lengths of the conduit and the chair which supports it is placed a waterproof slip. Upon each side of the chair is placed a metal plate secured by set screws and firmly holds the waterproof slip and thus protects the ends of the circuits. A series of plates form a partial covering for the channel and is filled in with the ordinary road material, spaces left at the sides allow the collector to pass in. 6 claims.

1,887. "Improvements in or connected with incandescent electric lamps." The British Incandescent Electric Lamp Company, Limited, and H. E. Maul. Dated January 23rd, 1897. Relates to a method of connecting the cap to the neck of the electric bulb of an incandescent lamp without the use of cement. A groove is formed in the neck of the bulb by blowing, and the cap is secured to the bulb by a wire secured to the cap and entering the groove in the neck of the bulb which the said wire should fit sufficiently truly to hold the bulb firmly in position. 2 claims.

6,695. "Improvements relating to electric tramways and railways on the sectional conductor system." H. H. Lake. (R. Arno and A. Caramagna.) Dated March 13th, 1897. Relates to electric tramways and railways on the sectional conductor system, and consists of fixing to an armature an arm of a conducting and dia-magnetic part and of an iron portion. On the armature being attracted the iron portion of the arm dips into the mercury electrically connected with the branch of the cable, and contained in the cup floats a small spherical carbon block. The lower cavity is also filled with mercury. Other modifications are shown. 4 claims.

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BRADFORD CORPORATION AND THE ELECTRIC TRAMWAYS.

THE *Railway World* exposes what to us seems a very questionable procedure on the part of the Bradford Corporation in respect of the electric tramways.

The particular and most glaring offence seems to be that, in calling for tenders, the Corporation has specified certain particular articles only purchaseable from particular firms; for instance, rail bonds of a special type, trucks made by a designated manufacturer, car motors of the General Electric Company's make.

Our contemporary has no fault or otherwise to find with the special articles desired and specified, but says, why ask for tenders when certain makers must be dealt with? For our own part, we do not think so much of this as does our contemporary. An individual who would build a tramway for himself would probably select what he wanted, and buy it as he pleased; but corporate bodies are supposed to have less liberty, and often this obligation to call tenders publicly results in cutting prices and bad work. But the Bradford Corporation has not stopped at this point. On the obligatory specification put forward, there were four tenders, ranging from £15,067 to £16,460—a remarkable closeness, the highest three being within a £200 range. Probably to show to the Corporation the error of their ways, one of the tendering firms—the Westinghouse Company—put in an alternative tender for £14,814, on the basis for their own apparatus in place of that specified. None of the firms had permission to put in alternative tenders, or doubtless would have been glad to do so. The one firm that did had its tender accepted. Now, this was manifestly unfair to the rest. The Corporation asked tenders for a certain thing, yet accepted something else from a firm which went outside the specification. Obviously, when the Corporation threw their preconceived notions to the winds and decided to tear up their stringent specification, it would only have been an act of common honesty to say so, and to call for open tenders. If Dick, Kerr & Co. could underbid Westinghouse by £1,200 on the close tender, the inference is they would have sent in a tender on their own lines for probably not over £14,000, and beaten the Westinghouse Company. The glories of self-government are apt to be dimmed somewhat when one has had much experience of municipal work. When there is anything more than usually technical in hand, committees seem to act without their engineer or surveyor, and, as a rule, if contractors appear before them, an *ex parte* statement may win the order.

We have not seen the specifications which were got up by the surveyor, Mr. Cox, and by the electric light engineer, Mr. Gibbings, neither of whom, in our contemporary's opinion, however good in their own special line, can be considered likely to be *au courant* in traction work. The complaint is made that the specification is full of unnecessary details, while the two Corporation engineers are to be sole adjudicators of sufficiency and quality in respect of work in which their very position in other and different lines implies they are not specialists. The specification gives conditions and tests, and, as stated above, in certain cases makes certain goods obligatory. In specifying the trucks by a given maker, the details of the trucks are elaborated. Why this unnecessary elaboration? This supererogation?

It seems to have occurred to the Bradford Corporation when they discussed the tenders, that the method of procedure which had been followed by their engineers was likely to prove costly, and that there was a chance of saving nearly £2,000 by taking a more liberal stand, and no doubt they were, so far, perfectly in the right. But they were evidently so overwhelmed with the idea of saving the amount, that they stood not upon the order of their saving, but saved at once by accepting the Westinghouse tender forthwith, never seeming to grasp the idea that other firms if free to enter in by a side door might have done still better.

It is quite possible that no member of the meeting had any idea of the basis on which the four first tenders were made. Probably they did not know just what the Westinghouse second tender was alternative to. We have no information as to what the engineers did in the matter. Their duty was to tell the Corporation the facts, and that they could not honestly accept the alternative tender. Of all this we are uninformed. We do know, however, that where there are obstinate men on a committee, the position of the surveyor or engineer is often not a happy one. Half the members of a vestry have a particular crank of their own, and are a perpetual thorn in the side of the poor engineer. If every shareholder of a railway were allowed to inflict himself upon the engineers in the way that members of corporate bodies inflict themselves on their surveyors and engineers, the working of a railway would become impossible.

The Bradford affair differs from what was known as the West Ham scandal of a year ago. At West Ham the tenders accepted amounted to about 50 per cent. in excess of the lowest tenders, had these been summed up. The explanation offered was that, in the engineer's opinion, it would be to the advantage of the public that the accepted tenders should be taken. There was a complaint from an unsuccessful firm, who were lower than the tenders accepted. They argued that as they were a company of repute, and the work had to be done to the satisfaction of the West Ham engineer, why, therefore, should thirty shillings in the pound be paid for work ostensibly in the power of the engineer to insist upon being to his liking.

The question of accepting the lowest tender is a very vexed one. Work is put out to public competition with a view to cheapness, and apparently the lowest tender of any reputable firm should be the one accepted. Even when a tender is put in at less than will pay for a good job, this is no reason to doubt the good job being secured. There may be half a dozen good reasons for tendering below cost—reasons of finance, of advertisement, and of keeping the works going. It is sometimes cheaper to work for nothing than it is to succumb to temporary slackness by discharging old hands and spoiling one's character for being a steady shop. Shops which discharge their men freely and frequently never secure more good men than they have permanent jobs for. Public tendering generally implies, then, the acceptance of the lowest tender, and this they failed to do at West Ham. At Bradford, on the other hand, they did accept the lowest tender, but it was a tender for something with which they had particularly requested not to be supplied, and most of the firms tendering had acquiesced, and tendered for what was required. One firm only tendered for entirely different goods of its own make, and, therefore, presumably cheaper, and got the order. Hence the trouble. There was a doubt at West Ham, but it was not shown that there had been any wrong doing. The Bradford affair, on the face of it, is distinctly discreditable, and though an explanation is generally thought should be forthcoming, we fail ourselves to see how the matter is to be explained, other than by boldly admitting sheer thoughtlessness, or a spirit of don't care.

Moses G. Farmer.

It is very difficult for the mere men of the crowd to contemplate with other than wonder, or perhaps curiosity, the mental attitude of a man like Moses G. Farmer, who pursued science without a thought of the solid personal benefits to be derived from it. To-day most of us, as soon as we have discovered some new fact or discerned some new bearing of an already ascertained fact, hasten to publish it, in order to obtain for ourselves priority. Indeed, in some countries, notably in France, there is an elaborate system of sealing papers, whereby a man may state in general terms something into which, perhaps, he has obtained some insight, and then when someone else comes forward at a later date, he can produce from the archives of the Academy of Paris his hidden statement, which guarantees him that much coveted priority. Vanity is doubtless at the root of this curious practice. This quality, for it is a quality, and a good one if it is properly balanced, is the last which we could possibly ascribe to Moses G. Farmer. In him the world had a clever, industrious worker, who observed, deduced, and noted down facts, which, had they been published at the time, would have covered him with honour and renown. We can quite sympathise with this modesty, but to-day can see the pity of it, for had those notebooks been given to the world, applied electricity would, without doubt, have come more rapidly into prominence in the industries of mankind than it has done. It may be said that the new science has come on quite fast enough, but useful progress in the application and acquirement of knowledge cannot proceed too rapidly. To-day our American contemporaries are recognising that Moses G. Farmer was a great inventor. In an address before the American Institute of Electrical Engineers, Dr. George F. Barker has pronounced a well merited eulogium on the man and his work. It would be a good thing for the rising generation of electrical engineers if a biography of Farmer could be placed in their hands. It would prove not only interesting and encouraging, but inspiring. In Farmer's work there was no cheap clap-trap, no striving after effects which would dazzle the multitude, no dashing about in order haply to light upon the fact of which he was in search, no rule-of-thumbism. He proceeded slowly and steadily, measuring his paces and calculating his distances, until he was able to gain the end he had in view. Nothing is so characteristic of this than a little incident which took place in 1860, when, on the celebrations in connection with that American Saints' day, July 4th, an exhibition of the electric light was arranged to take place on the Boston State House. Prof. William B. Rogers had charge of the exhibition, and a very large battery was placed in the dome, and wires were led up, and this light was shown at the same time with the fireworks on Boston Common. There was somebody else up there beside Prof. Rogers and his assistants, and that man was Mr. Farmer. They wanted to make a display; they wanted to show an electric light larger than any that had been seen up to that time. Mr. Farmer had no such idea. He wanted to do what had not been done in the world before, and what has not been done, possibly with one exception, since. He wanted to determine how much power, how much horse-power it required to produce that light, and out of the data which he obtained in those experiments in the dome of the Boston State House on that night of July 4th, 1860, was the mechanical equivalent of light, and he gave us the fact that to support the light, not the heat, but the light of one candle required the expenditure of 13·1 foot-pounds per minute. Some time after that Prof. Thomson, of Copenhagen, undertook from similar data to get a result, and the results were very closely accordant. It is sincerely to be hoped that Mr. Farmer's note books will be edited and published. Their contents are believed by those who have inspected them to consist of matter which was new science at that time. He was a great inventor, and deserves that certain discoveries which figure in those note books should be credited to him. The work of Farmer has passed unconsciously into the work of others, but had his individualism been more energetic, he would have been recognised during his life as one of the greatest leaders in the application of electricity.

SOME NOTES ON SINGLE-PHASE MOTORS.

By A. C. EBORALL.

(*Continued from page* 277.)

At first sight it might appear that it would be more economical and cheaper to put the starting resistance in series with the *stator* for the purpose of reducing the starting current. This is, however, not possible, as the output of an induction motor is practically proportional to the square of the supply pressure, and hence the reduction of this at starting would, in the case of single-phasers, prevent the motor starting at all. Hence this is never done in practice.

It may be remarked here that the fact of the output of an induction motor being very approximately proportional to the square of the impressed pressure, makes it essential that the regulation of any motor circuit should be fairly good, because should the tension on the line suddenly decrease from any cause, such as might be produced by starting up a large motor too quickly, or without its resistance, any heavily loaded motors on the circuits at the time might pull up; for a motor that would carry considerable overload at its normal tension, would barely take its full load with a reduction of 25 per cent. in the line pressure. As, however, single-phasers are only used in conjunction with lighting systems, it follows that the amount of overload such a motor will take will practically depend on the quality of the design.

The above is the only way in which the pressure on the stator affects the speed regulation of an induction motor—whatever the number of phases.

The effect of frequency on the running performance of a single-phase induction motor is not very greatly felt between 30 and 60 ~ in a given design, although it may make considerable difference to its starting powers. Theoretically it should make no difference at all, and would not do so except for the fact of the motor poles increasing directly with the frequency for a given speed. That is, in large motors, the poles become very numerous as the frequency is increased, because the speed of such motors must not be too high. The effect of increasing the poles in any given type of machine is to increase the magnetising current and also the leakage. It is this last factor that counts the most, and so in high frequency motors the power factor is not so good, and the starting rendered more difficult than in those working at the same speed on a circuit of moderate frequency.

The whole question of the design of induction motors really resolves itself into this question of leakage, which takes into account nearly all the quantities involved, such as dimensions of air-gap, induction density in it and in the stator, depth of winding in stator, and distribution and form of winding in rotor and stator. The induction motor with least leakage will always start best, have highest power factor, least slip, and hence be better all round.

Having now considered the broad principles underlying the construction and running of single-phasers, it may prove of interest to describe the different starting devices actually used by the various makers, and to briefly discuss the results attained.

(*A*) *Messrs. Brown, Boveri & Co.*—This firm was the first in the field with a commercial single-phase motor, and many hundreds have now been sold, in units ranging from $\frac{1}{10}$th to 70—80 H.P. The table given below shows the weights, efficiencies, &c., of stock sizes of their motors, arranged for running on circuits of 30 to 60 ~, and 100 to 500 volts.

TABLE I.

Reference number.	1	2	3	4	5	6	7	8	9	10	11	12	13
Horse-power	0·1	0·3	1·0	2	3·5	6	9	13	20	35	45	65	90
Approximate weight (in pounds)...	40	60	140	240	400	620	1,000	1,400	1,700	3,100	4,000	5,200	6,800
Full load efficiency (per cent.) ...	50	60	65	70	73	76	80	84	88	90	90	90	91
Apparent watts per H.P.	2,260	1,750	1,570	1,420	1,330	1,240	1,150	1,080	1,020	1,000	1,000	1,000	990

The weights given include starting apparatus and rotor resistance when this is used. The larger motors (from about No. 10 upwards) can be arranged for any tension up to 5,000 volts, this being transformed down for the starting winding.

Motors up to No. 5, inclusive, have simple short-circuited bar rotors, and must start on a loose pulley. The starting current is about equal to the full load current. From No. 7 to No. 13, the rotors are all wound with three slip-rings on the shaft for the insertion of a resistance, as before described. If they start on a loose pulley, the starting current is somewhat less than the full load current, but they will all start against some load if enough current is allowed them. No. 6 can either have a plain or wound rotor, depending on the frequency. For higher frequencies than 60 ~ the wound rotors commence at either No. 4 or No. 5.

The different starting arrangements used with these motors are as follows:—

For motors up to and including ½ H.P., the device shown in fig. 11A is used. At starting, the working and starting windings are put in series, the latter being shunted by a non-inductive resistance. The current will, therefore, lag more in the working than in the starting winding, and hence, as

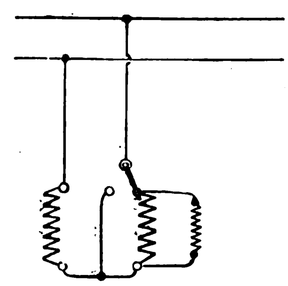


FIG. 11A.

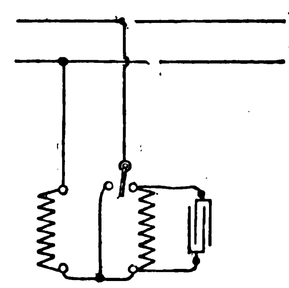


FIG. 11B.

the two windings are displaced 90° from one another, an imitation rotary field will be produced, causing the rotor to very quickly run up to speed, when the starting coils and resistance are cut out, and the working coils put direct on the line.

Fig. 11B shows the arrangements for motors above ½ H.P., and up to 6 H.P., when a starting resistance in the rotor is not used. The arrangements are exactly the same as in the first case, only the resistance shunting the starting coils is replaced by a liquid condenser. The leading current in the starting coils acts in just the same way as in the other case, causing the rotor to very quickly run up. The liquid condensers employed are very simple. They consist of a number of thin iron plates, separated by thin fibre strips, and arranged in an enamelled iron vessel containing soda solution. The manner in which the plates are connected (*i.e.*, in series or parallel), and the density of the soda solution employed, is determined for each individual motor, the solution, &c., being adjusted in the test-room until the best effect is obtained, the whole adjustment occupying but a very few minutes. It is necessary to treat each case separately, as minute differences in the air-gap, and differences in the windings for varying voltages and frequencies, prevent the condenser arrangements being exactly standardised.

These liquid condensers are practically indestructable, and never get out of order if properly made and used. A little water must be added occasionally to make up for evaporation. To give an approximate idea of the size of one of these condensers, it may be stated that the overall dimensions of one for a 4-H.P. motor would be about 9½ inches long by 6¼ inches wide by 8½ inches deep.

Fig. 12A gives the starting arrangements used for all Brown motors where a rotor resistance is employed. The resistance having its maximum value, the line current is switched directly on the working winding, the starting

D

winding, in series with a liquid condenser, being in parallel with it. The artificial rotating field produced causes the rotor to run up. As it runs up the rotor resistance is gradually reduced, the condenser and starting coils being cut out at about two-thirds of the normal speed.

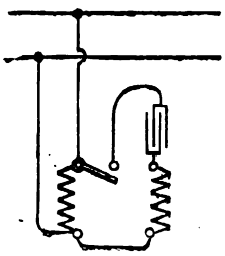


Fig. 12a.

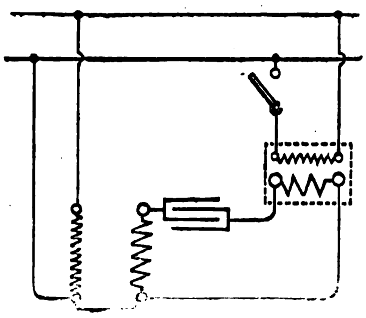


Fig. 12b.

The last arrangement described is somewhat modified in the case of large high-tension motors. Thus fig 12b shows the starting arrangements used with some 70 H.P. Brown motors at Frankfort. They are worked direct from the primary network at 2,800 volts. The working winding is straight on the mains as in the last case, but the starting winding and condenser are connected to the mains through a small transformer, which reduces the pressure to a lower value more suited to the condenser. When at about two-thirds of the normal speed, the transformer, &c., would be switched off.

Fig. 13 gives a view of a Brown starting resistance and condenser. The resistance is a star-connected non-inductive nickeline wire resistance, it being enclosed in a cast-iron box filled with oil. This arrangement allows the use of a high current density in the wires, owing to the excellent cooling afforded by the oil. The contacts, giving five degrees of variation up to the short circuit position, are arranged on the marble cover, and the whole forms a very compact and efficient arrangement. The external appearance of the condenser is well shown in the photograph.

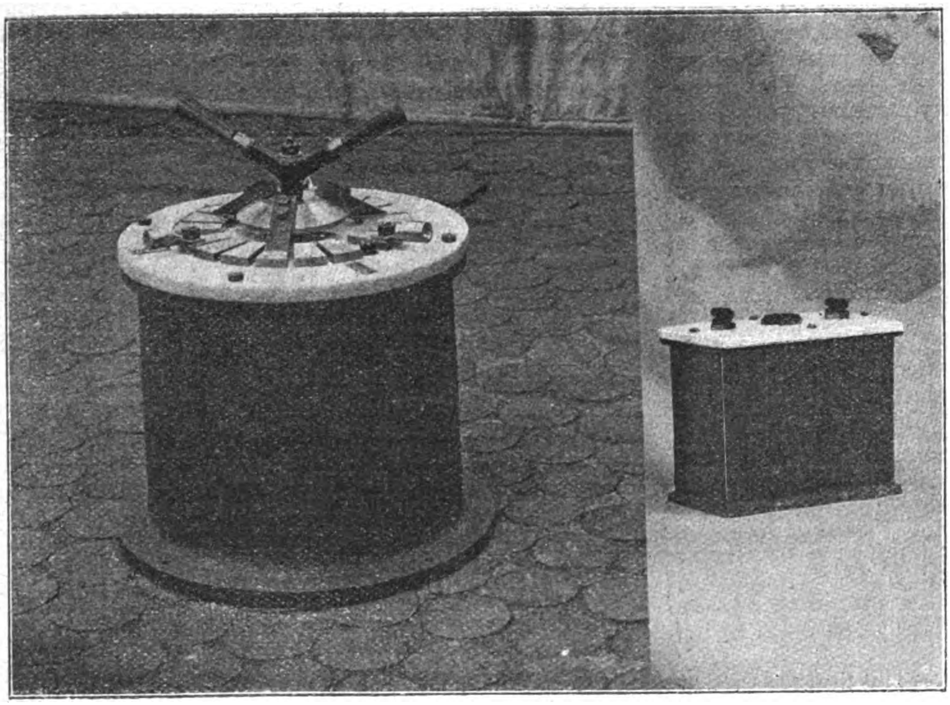


Fig. 13.

(*To be continued.*)

Electric Police Lanterns.—It is stated that the authorities at Scotland Yard are now engaged in subjecting a police electric lamp to practical tests, to ascertain if it will stand the necessary wear and tear of the service.

SERIOUS BREAKDOWNS FROM PRIMING.

Yarmouth was reported last week to have been in a state of darkness, the whole of the electric lights being suddenly extinguished. To make a long story short, we learn that three Willans engines and one of another make were suddenly wrecked by what is generally held to have been a sudden and excessive priming of one or more boilers, but whether caused by overfeeding or otherwise we suppose may never be known. An exceedingly funny report appears in a Norwich paper—evidently of non-technical origin. As usual with such, things seem to have been *hurled* about, and *ponderous* masses of iron so hurled have done a lot of *rebounding*. In fact, the description of hissing steam and roaring water seems to point to a sort of Niagara let loose in—the paper calls it Pandemonium, which seems about seven letters too long. Unless the water be very dirty, boilers which do not prime as a rule, do not suddenly give large volumes of priming, but if the water level has been allowed to get too high, the rush of steam over its surface might set it in motion, and finally gather it up in a vortex and produce the damage recorded. The idea of priming being the cause seems to be borne out by the simultaneous damage of four engines at once. The boilers are, we understand, of the water tube variety, and we believe there were no water separators on the steam pipe. A water separator is a fairly efficient instrument for producing dry steam, *i.e.*, steam free from a serious amount of water in a mass. The steam may remain misty but this will not damage engines. The main steam pipe from boilers to engine ought to bend at an absolutely square bend, the pipe from the boiler being continued a few feet past the branch to the engines, and terminating in a fair sized vessel drained by a good trap.

The engine branch may best be taken off square from the top of the steam main. Another suitable water-trap is to carry the steam pipe into the side of a fairly capacious vessel, the pipe turning down inside and discharging its steam and water towards the bottom of this vessel, which should be of some depth. The outlet should be from the top, and the cross-section of the vessel should be quite four times that of the steam pipe, so that the upflow of steam may be slow. A vessel like this in the length of the steam pipe would deal with sudden masses of priming, but it is obvious that it should be of some considerable depth and size so as to deal with the largest probable bulk of water. Of course, the sudden priming of a few gallons or even quarts might wreck several engines. A thimble full in a cylinder beyond what will fill the clearance space will wreck an engine. Even where relief valves are fitted these are never more than sufficient to discharge just the small amount of ordinary wetness which may accumulate in the cylinder, and is discharged when the piston is moving at its slowest just at or near the dead point. A large mass of water filling a greater length of the cylinder cannot be dealt with by relief valves, because the piston motion is so much more rapid at the time the relief valves are called on to act and the water cannot escape fast enough to prevent a breakage. Some years ago when relief valves of the short-weighted lever type were tried they acted, but they only acted once. The call to act was so sudden that the valves lifted and let out the water, but the weights did not lift. They remained stationary, or nearly so, and the levers bent under the sudden pressure of the valves.

Experience seems to have shown that water tends to find and travel along the lower side of a pipe, and water being heavy and devoid of any potentiality of movement in itself, it follows that law of motion which tells us that a body in motion tends to keep in motion in a straight line if unacted upon by any external force. Steam can of itself turn a sudden corner. Hence in a square bend pipe the water rushes forward past the bend and may be caught.

In a pair of engines supplied from one steam pipe it is common knowledge that the first engine has fairly dry steam, while the second only a few feet further gets all the water. This is but the action of the above law, and the fact that steam pipes are generally fixed so as to provide that the water shall travel all the way with the steam, is a proof of the little grasp of laws which the system of teaching mechanics gives to our engineering students. In the fixing of exhaust injectors better working is always secured when the pipe to the injector springs squarely from the exhaust pipe, for thereby it snatches dry steam, and the water and also the oily particles rush onward.

The danger of carrying the water at too high a level in a boiler is not perhaps so dangerous in boilers of large water surface area as in the small steam drums of water tube boilers in which probably it is easier to set the water in motion. Some safeguard is desirable against too high a water level, but this alone will not protect engines. The only safeguard is a sufficient separator, and as dry steam is always so much more economical than wet steam, the expense of a separator will very soon be returned.

ON SOME RECENT INVESTIGATIONS IN CONNECTION WITH THE ELECTRO-DEPOSITION OF METALS.*

By J. C. GRAHAM.

(*Continued from page* 320.)

Now, going back to the Diagram D, the first vertical column on the left hand under the fig. 1 shows the behaviour of an anode the same size as the cathode, when connected to one cell, two cells, three cells, &c., up to six cells. The second vertical column under the fig. 2 shows the behaviour of an anode double the size of the cathode, and so on.

The observations for each square were during 10 minutes, and were made every 15 seconds.

It will be noted that although the amperes which passed just at the moment when the current was switched on were pretty nearly in proportion to the electromotive force, the amperes which were passing after an interval of 10 minutes did not follow this proportion even approximately:—For example, the terminal amperes with one cell were about $1\frac{1}{4}$, and with six cells they were only about $2\frac{1}{8}$, with an anode the same size as the cathode.

It will also be seen from Diagram D that as the anodes became larger, the difference between the initial and the terminal amperes decreased, but with an anode eight times the size of the cathode the terminal amperes when working with six cells were only 80 per cent. of the initial amperes; that is to say, there was a drop of 20 per cent.

Although no gases appeared to be formed on either the anode or the cathode, it seemed possible that they were formed on the anode, but escaped observation, and that the fall in the current density might be due to this cause.

In order to test this hypothesis, lead anodes were substituted for copper ones, because it could be predicted with certainty that gas would be formed on them, and if the shape of the curves was due in any way to the formation of gas, it might be expected that the curves with lead anodes would exhibit all the peculiarities of the curves with copper anodes, but in a more marked degree. This, however, turned out not to be the case. This is shown in Diagram D_1, where the red line shows the current passing through a lead anode of the same size and shape as the copper anode which produced the black line. Clouds of gas came off the anode during this experiment. The broken lines in the columns 1 and 3 of Diagram D show the currents produced when lead anodes were substituted for copper ones at various voltages.

* Communicated to the Royal Society.

On looking at the broken lines where one cell was used, it will be seen that the current passing through the lead anode is less than that which passed through the copper one, the reason no doubt being that the lead produced a back electromotive force which was a large proportion of the electromotive force of one cell; but if the current passing through the lead anode when six cells were used be contrasted with that which passed through the copper anode, it will be noticed that the lead anode, notwithstanding the back electromotive force, allowed nearly three times the number of amperes to pass. This is clearly shown by Diagram D_1. And in all cases the current passing through the lead anode remains tolerably constant, and never shows the tendency to decrease which is apparent when copper anodes are used.

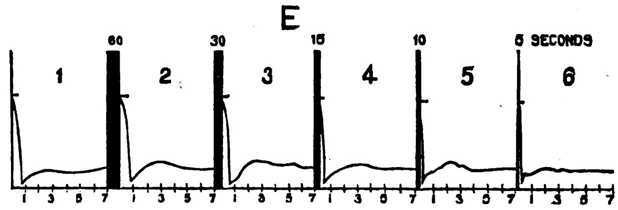
The drop in the current in the latter case can hardly be accounted for by polarisation, as this ambiguous phrase is ordinarily understood, for the drop is almost absent where the polarisation is the most perfect. In some experiments, which will be referred to later on, this drop disappeared where the anode was well washed by a rapid flow of the electrolyte. This rather points to the conclusion that it is due to the formation of sulphate of copper, which may take some time to dissolve.

It should be stated here that the curves shown on Diagram D_1, merely show the curves obtained in these particular experiments. These curves would probably change in form with any change in the shape of the anode, or in the distance of the anode from the cathode, the density of the solution, &c., but would maintain their characteristic peculiarities, viz., a sudden drop, followed by a rapid partial recovery.

The copper anodes show a tendency to blacken when small currents are passing, and become perfectly bright when dense currents are passed through them. Repeated experiments, however, showed that this had very little, if any, effect on the shape of the curves. Dense currents were passed through anodes which had become quite black, and small currents through anodes which had been made bright, and the curves were, practically speaking, the same, whatever the condition of the anode was at the commencement of the experiment.

The copper anodes also exhibited a capacity for rapid recovery. If the current, after it had come to its ultimate density, was switched off for a short interval, and then switched on again, the initial amperes were found to be almost the same as they were at first. This is shown in Diagram E. The experiments are numbered successively

E



1, 2, 3, &c. The anode area was double that of the cathode, and in all of them six cells were used. The current passing in each experiment is shown by the black curved lines. The operation was as follows:—The current was switched on and allowed to flow for seven minutes, giving curve No. 1. It was then switched off for 60 seconds, and again switched on and allowed to flow for seven minutes, giving curve No. 2. It was then switched off but for 30 seconds and allowed to flow for seven minutes. It was then switched off for 15 seconds, and so on.

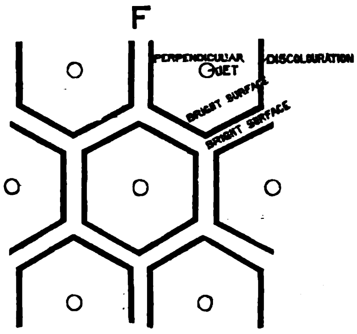
The initial amperes are nearly the same throughout, but the fall is more rapid as the time given for recovery is made smaller.

As the conditions necessary for getting fairly accurate results appeared to have been ascertained, a number of experiments were made at various current densities. It was found that with the apparatus shown in Diagram C copper could be thrown down at as high a current density as 2,000 amperes to the square metre, over a period of one hour, at the end of which time little round nodules had begun to appear.

The copper which is deposited at these high current densities does not appear to be either much harder or less ductile than that deposited at 150 to 300 amperes to the square metre. If it is deposited in the sheet form it can be doubled and opened without cracking, and if deposited in the wire form it can be drawn to any practicable fineness.

These experiments were made with a saturated solution of sulphate of copper; further experiments showed that the rate at which copper can be deposited appears to be approximately proportionate to the amount in solution. With double the

F



amount in solution the copper can be thrown down at double the rate; but accurate determinations are not possible, as there is no definite means of comparing the deposits.

Experiments were also made with a number of small jets substituted for one large one. Such jets, however, produce discoloration on the cathode along the lines where the currents meet, as shown in Diagram F, the dark lines showing the discoloured places.

(*To be continued.*)

THE "OPEN ARC" GROOVED CARBON.

The "open arc" carbon is the name which has been given to a new and interesting form of arc carbon recently brought out, and for which a number of valuable qualities are claimed, not met with in the ordinary form of solid carbons.

The distinguishing feature of this new type of carbon is a longitudinal groove running from one end to the other parallel with the length of the carbon, as shown in the accompanying figures, which we reproduce from the New York *Electrical Engineer*.

By the use of this carbon it is claimed, first, that the vortex action of the current is checked by the groove, and the crater of the carbon is held stationary at the apex of the pencil; and what is still more important, is that the size of

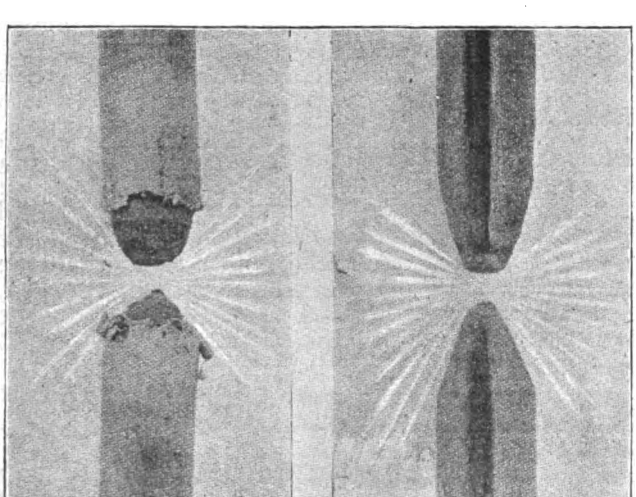


Fig. 1. Fig. 2.

the white light crater is nearly double that of any other carbon. This is explained by the inventor thus: With the solid or cored carbon that part of the white light crater is only visible which is on the apex of the carbon; with the grooved carbon, however, the crater appears as well on the sides of the segment cut out of the carbon as on the end, almost doubling its light rays.

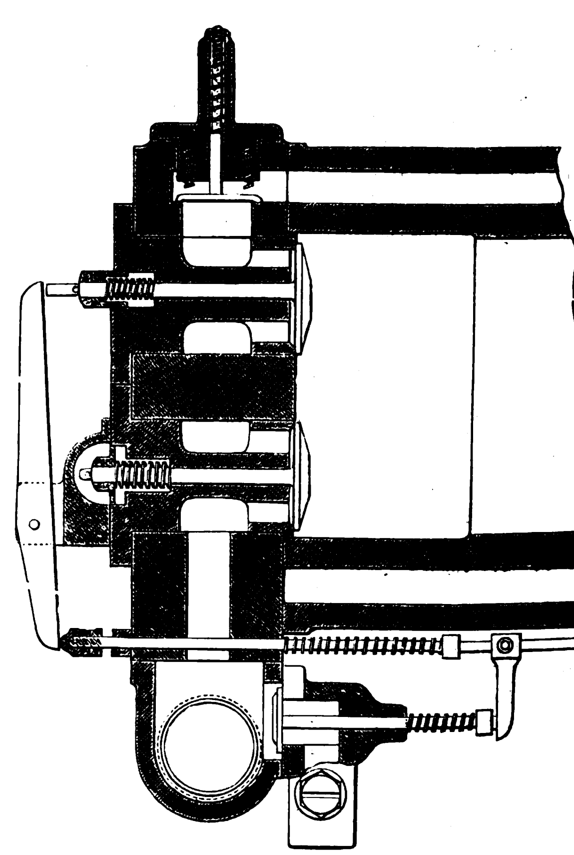
It is also claimed that with a solid or cored carbon, the maximum heat point is the centre of the carbon, hence, the centre of both carbons disintegrates too rapidly, leaving walls on either side which, a large portion of the time, obscure the crater, and build up on the lower carbon to a point that shuts off the rays from travelling downward. With the "open arc" carbon, it is claimed that the grooves cut the material from the centre, leaving nothing there, and throwing the maximum heat point to the sides of the pencil, thus giving the lower stick a cone-like form, and allowing all the rays to travel downward.

The accompanying figure illustrates this action, and was made from photographs taken from two sets of carbons burning side by side in high tension lamps, both sets of carbon being coppered. Another point made, is that a ⅝-inch carbon, solid or cored, while desirable for a long run, is a poor light developer; but with the "open arc" carbon, this result, for the reasons before given, does not obtain.

This new form of carbon is said to increase the illuminating power of the arc from 30 to 40 per cent., without any increase in current consumption, and if this be so it unquestionably has claims to recognition. We may add that the new product is being introduced by the Open Arc Carbon Company, of 108, Fulton Street, New York, and that a number of prominent electrical men are interested in the company, among them Mr. Charles A. Lieb and Mr. Caleb H. Jackson.

THE WHITE AND MIDDLETON GAS ENGINE.

This engine is of American make, and can be seen at 29, Queen Victoria Street, the size of this special engine being 6½ inches × 15 inches, to develop 13·6 I.H.P. and 12 B.H.P.

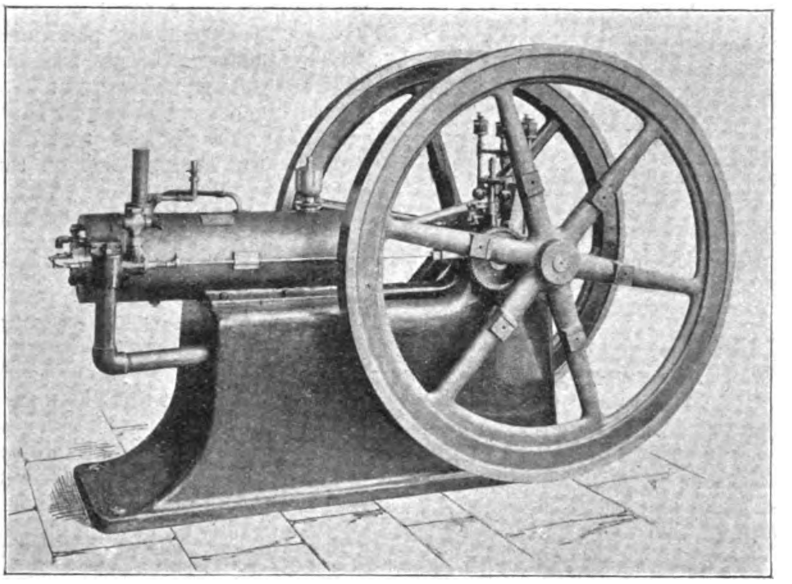


Like most engines of to-day, it is worked on the Otto cycle, but it is modified from most engines by the possession of an exhaust port at the forward end of the cylinder, which is uncovered by the piston on its extreme outward stroke, and thereby the ordinary exhaust valve is made much smaller and exposed to much less wear, only about a tenth of the exhaust escaping this way. The ordinary trunk piston is used, but has no rings. Ignition is by incandescent tube.

The valve gear is driven by small spur gears from the crank shaft. It consists of a revolving cam which drives a push rod through the medium of a friction wheel swung into contact with the cams by the governor. When the wheel comes against the cams the gas valve is opened.

When seen by us running light, the engine only required one explosion to run it on an average fully 15 revolutions. Indeed, the running was remarkably good and easy, and the engine is well made and neat in design.

Tests reported in the maker's catalogue show a consumption of only 16 feet of New York gas per brake horse-power-hour. The floor space occupied by the 12-H.P. engine is 7 feet × 2 feet 9 inches, and the fly-wheels, of which there are two, are 4 feet 8½ inches diameter. The belt pulleys are arranged to be screwed against the side of the fly-wheels, thus avoiding extra length of shaft, and avoiding stress on the fly-wheel keys to some extent.



White & Middleton Gas Engine.

The engine is readily convertible into a gasolene engine by removing the gas inlet, and substituting a small oil pump with electrical ignition in place of the ignition tube. The exceedingly neat and simple external appearance of the engine, and the absence of gearing and projections generally, give to it a very pleasing appearance. It gives a good indicator diagram, and is altogether a very good and well made machine. The forward exhaust port is, we think, an item that might be adopted with advantage in other engines.

KINGSLAND'S SURFACE CONTACT SYSTEM OF ELECTRIC TRACTION.

There appears to be a feeling at the present time among tramway experts, that the "surface contact" system is likely, under some circumstances, to come into limited use. It is noticeable that in America, which is greatly ahead of this country in tramway work, there is a disposition to adopt in some places a form of conduit system.

In many towns in this country where the "overhead" has been adopted it has been so because it was felt to be, so far, the only system which had proved an undoubted commercial success; but in most cases a reliable underground system, had such been available, and inexpensive in first cost, would have been welcomed.

The "open conduit" or "slot" system has not proved itself to be a serious competitor to the "overhead"; its disadvantages are many and its expense great. There remains the "closed conduit," or "surface contact," system; in which the whole of the conductors and other electrical apparatus is put underground, and the current is collected by the car from a number of surface contacts or studs placed at intervals along the track, their distance from each other being approximately the length of a car. These studs must be cut in and cut out of circuit as the car advances from one to another, and there must be no chance of any one stud being left "alive" after the car has passed it.

What may be called the intrinsic disabilities of the "overhead" and the "slot" systems respectively, do not pertain to the "surface contact" system; and there is in reality only one qualification to be demanded from it, and that is its reliability. The question is, can the automatic switches which are required to cut in and cut out the various sections or surface studs be relied upon to fulfil their functions with a minimum chance of failure?

The various patented devices for these automatic switches are very numerous, but the invention of Mr. Wm. Kingsland is claimed to possess some novel and interesting features which have not been hit upon by previous inventors, and which are stated to give the system some decided advantages which will readily be appreciated from the following description of the apparatus and method of working.

Fig. 1 is a diagram showing the main principle which is followed in the arrangement of the conductors and switches. M M is the main conductor, R R the rails, and S R^1, S R^2, S R^3, S R^4 are the sectional rails, or surface contacts, from which the current is collected by the car, and which may be simply studs instead of rails, as shown in the diagram. S^1, S^2, S^3, are three switches, each of which consists simply of a lever, *l*, which operates a sliding contact bar, the function of the bar being to connect the two contact springs, *a* and *b*, or the two similar contacts, *c* and *d*. It will be seen that when the levers are all in one direction, connecting, let us say, the contacts, *a* and *b*, of each switch, there is no electrical connection between the main, M, and any one of the surface contacts, S R^1, S R^2, &c. But if the lever, *l*, be moved to the right so as to separate *a b* and join *c d*, then there will be an electrical connection between the main and the surface stud, S R^2. Now let us suppose a car to be on

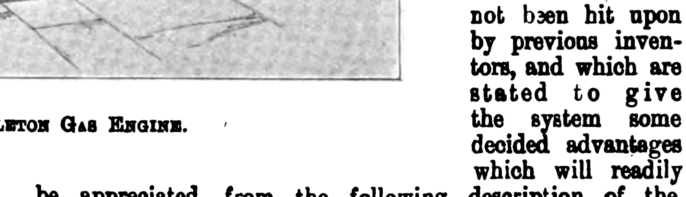


Fig. 1.

S R^2 and moving towards S R^3. When it reaches the lever, l^2, it will carry it over to the right, thereby opening *a b* and closing *c d*. The opening of *a b* disconnects the surface stud, S R^2, and the closing of *c d* connects the following one, S R^3. An advantage is said to be gained by this arrangement because it is only necessary to operate each switch once; that is to say, that after a car has left a switch, the switch has not to be operated again in order to break the circuit, as that is done by the action of the succeeding switch. In this way one-half of the difficulty of making a reliable switch is overcome, as the switch does not require to be held in position by any force, electrical or mechanical; it has simply to be moved to one position or another and left there.

A simple system of lever switches, however, will not be available for ordinary street work, and it becomes necessary to devise some means whereby the switches shall be operated electrically and automatically. This is accomplished by the action of a cylindrical commutator, which is partially rotated, or rocked, by means of an electro-magnet.

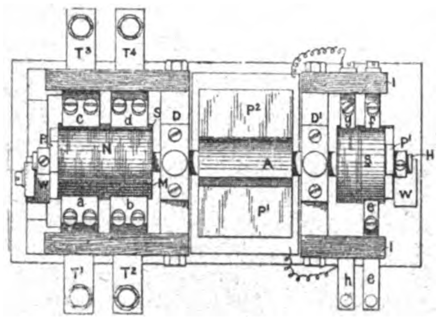


Fig. 2.

Fig. 2 is a plan of the apparatus. P^1 P^2 are the pole-pieces, and A is the armature of an electro-magnet, which is shown in elevation in fig. 3. N is a cylinder of insulating material, revolving loosely on the same spindle that carries the armature A. On part of the surface of this insulating cylinder are two metal plates, one of which serves to connect the contact springs *a* and *b* on one side, while the other will connect the contacts *c* and *d* on the other side. When *a*

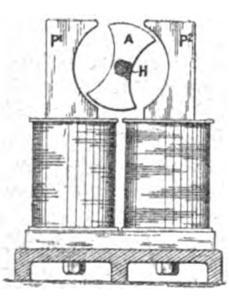


Fig. 3.

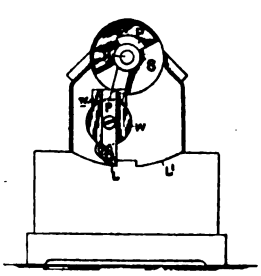


Fig. 4.

and *b* are connected by reason of the movement of the cylinder, *c* and *d* are disconnected, and *vice versa*, but the one pair cannot be disconnected until the other pair are connected, and thus there cannot be any sparking whatever at these contacts.

When the electro-magnet is energised, the armature will be turned to a horizontal position, and in turning will turn the commutator, N. This is effected in the following way. The spindle H, fig. 4, has attached to it the counterweight, W. The spindle is rigidly attached to the armature, A, fig. 3, but as already stated, the commutator, S, is free to revolve upon it. Part of the insulating cylinder, S, is cut away, and a quadrant projection, P, is fixed to the spindle, H. When, therefore, the armature of the electro-magnet is moved from a vertical to a horizontal position it will be able, on the one side, to move the commutator through a quarter turn, but on the other side, it will not do so, because of the half which is cut away. This cut away portion, however, permits of the armature returning to its normal vertical position as soon as the current in the electro-magnet ceases. If the armature were allowed to come to rest exactly in a vertical position, it would be attracted neither to one side or another when the magnet is energised, but it is prevented from doing this by means of a catch, L, at the end of the counterweight, W. The momentum of the counterweight carries it a little past the vertical position, and it is prevented from returning by the action of the catch on the raised portion of the plate, L^1. The result of this is, also, that the next time the magnet is energised the armature is certain to be attracted in the opposite direction, and thus an alternate motion from side to side is ensured.

The action of the electro-magnet is controlled by means of a small commutator, S, fig. 2, placed at the other end of the spindle, H, and working in exactly the same manner as the large commutator. The contact springs on the small commutator are so arranged that the electro-magnet can only be energised if the switch is set in the opposite direction to that which may be required for any particular surface stud.

The circuit through the electro-magnet is a shunt one, on the main conductors, one end of the coil being connected with a surface stud through the small commutator, and the other end to earth. The car, in passing along the track, makes contact with one surface stud before it leaves another. As soon, therefore, as it makes a contact with a stud in advance the current can pass down from that stud, through the electro-magnet of the corresponding switch, which will thus be operated, and will cut in the new surface stud and cut out the one which the car has just left.

It will now be seen that the system is fairly simple, both in the arrangement of the conductors and in the mechanism of the switch. The action of the switch is a simple rocking movement on one spindle, and there is no force required to keep the switch in position, as it is a simple change movement, and not a make and break. Moreover, the pressure of the contact brushes on the commutator is always the same, and is not affected in any way by the action of the switch. Another immense advantage lies in the fact that there are no working springs whatever, in fact it is difficult to see what there is in the switch which can possibly get out of order.

The switches are made to go into a cast-iron box 8 inches × 10 inches, with watertight covers. The cable connections pass in through watertight glands, and are so arranged that they can readily be disconnected, and the switch lifted out

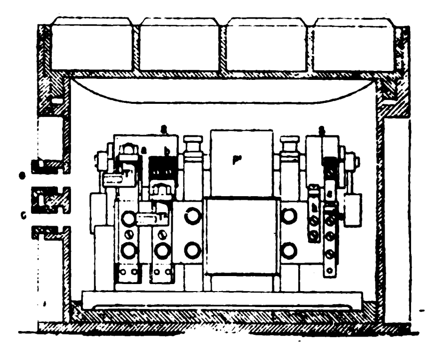


Fig. 5.

for inspection. Fig. 5 is a view of the apparatus in its box.

We suppose that it is impossible to make any apparatus which shall absolutely never fail. In this system, if a switch should happen to fail, the car could not proceed, and therefore the failure would be immediately discovered. It would be the work of a few minutes only to open the box and rectify or change the switch.

With this system the car is not required to carry any equipment in the way of electro-magnets or storage cells with which to operate the switches, and therefore it offers facilities in working the same cars on the overhead as well as on this system, as, for instance, where an underground system is required in a town, working in conjunction with an overhead in the suburbs.

The British and foreign patents for this invention are owned by Messrs. Kingsland & Edwards, of Manchester and Llandudno; and those who are interested in the matter may see the apparatus, which is now on exhibit at the Electrical Standardising, Testing, and Training Institution, Faraday House, Charing Cross Road, by written appointment to that address.

THE EMPIRE AND TELEGRAPH CABLES.

(*Concluded from page* 289.)

We have dealt with some of the more prominent of the objections which are now being revived against a cable through the Pacific. The "enormous depths" of this ocean, it will be seen, are now discounted, and we even find it put forward, with an austere assumption of impartiality, that the great depth of water through which the Cape cable must pass would obviate the serious danger of interruption to which the existing lines to Australia are exposed in the shallow Java Sea. We quite agree with the opinion expressed that the present cables which pass through the Mediterranean would probably be rendered useless in case of warlike complications, as this did actually happen during the Egyptian war; but we would go still further, and point out that the same objection applies with equal force to several sections along the proposed Cape route, which, in places, would necessarily have to lie in very shallow water, and where they could be easily cut by the enemy. Take, for example, the section which would pass off Brest, where, for more than 150 miles, all the existing lines to Africa and the East are in water of less depth than 100 fathoms; and through this dangerous belt it is now seriously proposed to lay a strategic cable! In the case of the Pacific scheme any such danger is quite avoided.

To turn to another aspect of the new "supplementary" scheme, we find that to carry it out, some 13,700 miles of cable would be necessary, to which should be added 1,000 miles of landline from Cape Town to Natal. We also find that the cable would be landed in no less than 11 different places—almost all points of weakness—the last being the town of Perth in Western Australia. As opposed to this, we find, in the Pacific, that the length would only be 7,500 miles, and the landing places only five in number, lying in a part of the ocean little frequented by foreign vessels of war, the cable terminating between the towns of Sydney and Brisbane on the east coast of Australia. Should the cable bifurcate from Norfolk Island to New Zealand, an additional length of 450 miles will be necessary, and an additional landing place will be created. In continuation of this comparison, it should be borne in mind that the two existing cable routes to Australia converge at Java, and bifurcating thence, end; one at Port Darwin in the north of Australia, the other at Roebuck Bay, in the north-west of Western Australia. Thus we find that, to reach the centres of the greatest population, which lie in the east and south-east of the continent, telegrams have to travel over very great lengths of landlines. In the case of the Roebuck Bay cable there is a distance of about 3,300 miles to be traversed from that point before even Melbourne is reached, and more than 4,200 miles (about half the length of the Pacific cable!) before Brisbane is reached. Again, a telegram *viâ* Roebuck Bay, destined for the town of Burketown, in Queensland, has to travel over a length of landline which is greater than the distance between London and Calcutta, or several hundreds of miles more than the distance intervening between London and Vancouver. The land wire from the Port Darwin cable station is not so long, giving about 2,400 miles to Melbourne and 3,300 miles to Brisbane. It is now, we are told, proposed to land the "Cape" cable at Perth, the capital of Western Australia, which is more than 2,000 miles by landline from Melbourne, and over 3,000 miles from Brisbane. On the other hand, in the case of a cable landing on the Pacific coast of Australia, the main centres of population and commerce are within easy reach, Melbourne being only about 450 miles south of Sydney by landline, while Brisbane is about 520 miles to the north. The great importance of these figures will be at once evident, when we realise that the long landlines from Port Darwin and Roebuck Bay, the only means by which telegrams from Europe can be forwarded at present, have been interrupted on no less than 15 occasions during the last six months, the duration of each of these interruptions varying from a few hours to several days. In speaking recently of the Roebuck Bay landline, Sir Charles Todd, the Postmaster-General of South Australia, says, it "is acknowledged to be the worst line in Australia, the many fogs on the coast rendering it very hard to get signals through." It is thus clear that a Pacific cable would offer advantages which cannot reasonably be looked for, neither in the case of the existing cables, nor in that of the proposed cable from the Cape. The landlines in the compact group of colonies, Victoria, New South Wales, and Queensland, are numerous, and here reliance has not to be placed on long single wires, as in the cases above referred to. Duplicate communication with New Zealand can be easily assured by a short branch cable from Norfolk Island. The advantages above indicated are obvious, if we consider that the population in the south and east of Australia is about 4,200,000, who carry on a total export and import trade equal to about £120,000,000 annually, employing for this purpose some 17,000,000 tons of shipping. It would, therefore, seem beyond dispute that a cable landing right in the heart of this busy district is much more to be desired, and is much more worthy of support than one which would terminate in Western Australia; in which vast area (11 times the size of Great Britain) the total population, although increasing, is less than that of the town of Cardiff, and the trade and shipping correspondingly small, the exports and imports for 1896 being valued together at something over £8,000,000.

We propose to touch but lightly on the financial side of the question. We were informed through the press that the cable to be laid, *via* the Cape, is to be carried out in return for "certain privileges." Some light has recently been thrown on the nature of these privileges; one of which seems to be the payment of £25,000 per annum by the Cape Government for 20 years; another being the prolongation of the annual subsidy of £32,400 which has been paid by the Australian Governments to the Eastern Extension Telegraph Company since 1879, and which, if not renewed, will lapse in July, 1900. There may be other concessions which have not yet come to light.

It is a question whether the limits of modesty are not being overstepped, when we remember that one of the companies concerned, *i.e.*, the Eastern Extension Telegraph Company, has already received from Australasia, subsidies amounting to over £750,000; and that in the 10 years ending December, 1896, the annual receipts of this company, which are now about £640,000 (including subsidies), have increased by £187,459, and this notwithstanding a reduction in rates of about 50 per cent., which was only brought about under great pressure. An allied company, the Eastern and South African Telegraph Company, of which almost the entire capital is held by the Eastern Telegraph Company, has received in subsidies from various governments a total of considerably over £1,000,000.* It is not, perhaps, a cause of wonder that even a far-fetched attempt should be made to secure the continuance of similar "privileges," but we do not think that it is at all in the interests of the Colonies, or of England, to assist in the consolidation of any such monopoly.

We have dealt at this length with the subject, as it seemed only fitting and just that, however useful a cable to Australasia, *via* the Cape, may be, the claims to superior utility, both strategic and commercial, of a cable *via* Canada to Australasia should not be undermined by the circulation of misleading information.

CORRESPONDENCE.

Accumulator Testing.

Although your article on "Comparing Results of Tests on Accumulators" contains several hints to those engaged in testing accumulators, the writer seems to have omitted many equally important considerations.

If the accumulator is intended for lighting purposes, where constancy of voltage is imperative, it should in all cases of comparison be stated how thick was the acid space, or the distance between the plates.

Your contributor will find a marked increase in the steadiness of the pressure line with every fraction of an inch increase in the distance of the plates up to a limit ascertainable only by test for each kind and thickness of plate.

This is true of all lead storage batteries, but is, of course, most marked in those of the pasted type.

If the accumulator be intended for traction purposes, the acid space may be small, because a fall in pressure merely means a reduction in the speed of about the same percentage as is the fall in pressure.

One other point out of those named is the incorrectness

* The Aden-Zanzibar cable belonging to this company was interrupted all last week, thus completely cutting off the Cape from communication with Europe by the East Coast of Africa route.

of the assumption that the result from one positive can be used, all other things being equal, for accurately ascertaining the capacity, &c., of a complete battery.

Let your correspondent take three positive and five negatives of similar type and make them up into two cells of one positive and two negatives and two positives and three negatives respectively, and he will, after a few trials, see fit to modify his statement.

Even so far, however, as your correspondent goes, his article contains much that may be carefully followed by inventors and experts when testing batteries, and it may ultimately come to be understood that no two kinds, or even arrangements of the same kind of plate, will give results which can be tabulated on one basis, either of total weight, weight of single plates, weight of acid, or weight of so-called active material.

Appak.

Crowdus Storage Battery.

Referring to your article in the last ELECTRICAL REVIEW, I consider practical work of far greater value than academical figures. Some of these cells are now on the way here, and I shall be pleased to allow you, or your engineer, to make your own tests. Meanwhile, a perusal of the enclosed detailed description may be interesting to you. By letter just received from Mr. Crowdus, he states:—

"It seems almost incredulous, but these waggons have been going six days a week through the severe snows of the past two months, and in blizzards that severely crippled all kinds of traffic."

The waggon referred to is on page 16 of enclosed catalogue, which please return.

John T. Bowden.

[The figures called academical are unfortunately Mr. Crowdus's own figures. We also prefer practical work, and nothing can be more practical than careful, accurate, tests of a battery by a competent engineer. There are doubtless many professional experts to be found ready to test and report on this battery, and if the claims made for it can be supported by any one or more of these gentlemen, we shall be the first to congratulate Mr. Bowden. We publish on p. 381 the description referred to, from which it may be gathered that the cell is just what we all know as a pasted plate cell. The use of sulphate of zinc in the solution, and aluminium for the negative support, are doubtful improvements; at any rate, they require investigation by independent experts before being accepted as such. There is nothing surprising in driving waggons by electricity; it is easy enough if we put in plenty of cells of large enough capacity; but what we took exception to was Mr. Bowden's "academical figures," that waggons were driven 50 miles by a $3\frac{1}{2}$ horse-power motor, with 44 cells of 100 ampere (hours) capacity; such an incredulous claim requires more support than the bare statements of the inventor. Mr. Bowden has put nothing before us of the slightest value in support of the extravagant claims made for his battery.—EDS. ELEC. REV.]

Parabolic Reflectors—An Anticipation.

I notice under the heading "The Institution of Electrical Engineers," an abstract of a paper entitled, "An Electrolytic Process for the Manufacture of Parabolic Reflectors," by Sherard Cowper-Coles.

I was quite interested in the account given, inasmuch as I practised substantially the same method of producing metal mirrors a number of years ago, and have the specimens of work now in my possession. My method was the same as that described in the paper referred to, viz., to take a glass surface, highly finished, and of the form of the reflector required, deposit upon it a silver coating, by any of the well-known silvering processes, such as are used for glass specula; follow this deposit by a heavy coating of copper, electrically made; separate the glass from the deposited metal; and, when needed, coat the face of the mirror with nickel or other metal resisting oxidisation or tarnish.

My object in developing the process was to replace the glass mirrors of searchlights, which are very easily fractured, but the process is undoubtedly a good one for making any accurate metallic mirrors.

I have had the silver coating leave the glass in such a high state of finish as to present the appearance of a vitreous surface. The least blemish or scratch in the glass surface is reproduced in the silver coating with absolute fidelity. I found that an easy way of separating the metal from the glass was by warming; the metal being more expansible than the glass readily separated when the warmth was sufficient. The deposited silver coating must be as free from pores as possible, otherwise there is a tendency for the copper-plating fluid to insert itself between the glass and the silver and blister.

Elihu Thomson.

March 2nd, 1898.

Sparking Coils.

Apparatus of various kinds for producing very long sparks have been lately described in your columns. I notice that in every case, while the length of spark is carefully stated, no measurement of the quantity of electricity yielded seem to have been made. The outputs were apparently guessed at. I designed some two years ago a simple instrument for measuring the quantity of electricity yielded by spark coils and similar apparatus.

In its simplest form it consists of a sensitive thermometer, on the bulb of which a small bobbin of thin insulated platinoid wire is mounted. The current from the secondary is passed through the bobbin for a known length of time, and the rise in temperature is noted. The heating effect may be taken to be proportional to the square of the current multiplied by the length of time the current has been passing. The instrument can be calibrated by passing a known current from a battery through the bobbin.

I have found that this instrument throws much light on the actions which take place in the various parts of the secondary winding.

G. Bowron.

March 14th, 1898.

"The Burning Question."

An original dissertation in the pages of the ELECTRICAL REVIEW, on the treatment of sewage sludge, could not fail to make very interesting reading, and I am sure you will not take offence if I add that the article on this subject, under the above heading in your issue of the 25th ult., is not merely interesting, but very amusing also. I hail the appearance of the article with great satisfaction. When the ELECTRICAL REVIEW voluntarily devotes so large a portion of its valuable space to a careful, even if utterly erroneous, investigation into problems connected with the disposal of refuse, and sewage sludge of all things, I feel convinced the time is not distant when the refuse destructor, which has hitherto, as you will allow, often received rough, and even disdainful, handling in the electrical press, will frequently find an honoured place in your pages. I do not mind even if your present article appears adverse in any way to a particular type of destructor with which I happen to be associated, when used for a particular purpose. It is sufficient for me that you are really investigating. Soon you will "discover" the refuse destructor, and we shall all be happy.

Meanwhile, you will recollect a description of a group of individuals who, if I remember rightly, "sat apart upon a hill retired," pursuing certain abstruse speculations, and became "involved in wandering mazes lost," and I greatly fear you also have become a little involved in your investigations in connection with sewage sludge. I am consumed by a desire to put you in the right path, therefore I beg to ask your reconsideration of the following proposition which occurs early in your article. The italics are mine. "The cost of burning is 1s. $6\frac{1}{2}$d. per ton of pressed sludge. *Assuming that one-third of the weight of wet sludge has been removed by pressing*, this would amount to, say, 1s. per ton of wet sludge." This assumption is so delightfully naïve, that one hesitates to disturb it; but stern logic compels. I am obliged to inform you, therefore, that every ton of *pressed* sludge at Leyton represents eight tons of wet sludge; and instead of the "weight removed by pressing" being "one-third," as you artlessly assume, it is more than 87 per cent; instead of being only *one-half* that of the pressed sludge, it is seven times as much. There is no mystery about it. The moisture in the *pressed* sludge is 60 per cent., in the wet 95 per cent. One of your young men would check the calculation. Consequently the cost of burning, when expressed in terms of the weight of the wet sludge, instead of being 1s., as you have estimated, is a fraction over 2½d.

You will easily see the absurdity of attempting to express the cost of any such process as the burning of pressed sludge, in terms of the wet sludge, if you consider that the moisture in the latter may vary immensely without making any appreciable difference to the cost of pressing, and none at all to the cost of burning. Thus, in the figures that you quote from Sir Alexander Binnie's report, the moisture in the wet sludge at Barking and Crossness averages about 91·00 per cent. Now, if this sludge were pressed as at Leyton, every ton of the pressed material would represent rather more than 4½ tons of the wet; the weight removed by pressing would be 77 per cent., or three and a half times as much as the weight of the pressed residue; and the cost of burning would be 4d., or 60 per cent. more than at Leyton, *expressed in terms of the wet sludge. The real cost of burning the material actually put into furnaces would be the same in both cases.* Of course, the impressive fabric which you have built upon your "assumption" must now come down.

"London," if she wished to press and burn her sewage sludge, would not require to expend anything approaching the extraordinary sum at which you have arrived. As a matter of fact, I do not know that anyone is seriously proposing that "London" should press and burn her sewage sludge. If at the time the present system was adopted by the late Sir Joseph Bazalgette, after a most complete series of experiments upon the pressing of the sewage sludge, one of which was adopted at my suggestion and superintended by myself on behalf of an eminent firm of Scotch engineers —if at that time there had been a destructor furnace whose capabilities in regard to the burning of sludge cake had been demonstrated like those of the Leyton furnaces have now been demonstrated; if also the question of destroying house refuse had attained the importance it has now acquired, then the problem of getting rid of the house refuse of London, or more particularly of the river districts, by using that refuse in that way to destroy the sewage sludge, thus getting rid of two huge nuisances at one stroke, would have been well worth the consideration of the authorities of that time. Even as it is, the possibility of such a combination is probably still worth the consideration of Sir Alexander Binnie. Leyton saves over £300 a year in coal in operations in connection with her sewage. The same rate would not apply to Barking and Crossness. If it did, over £18,000 per annum might be saved there; but, anyway, Sir Alexander Binnie could get all his mechanical operations at the Outfall Works done for a mere fraction of his present expenditure on coal, and have something considerable to spare. The idea is not new; Mr. Jones, of Ealing, I believe, proposed it at one time. But "it were well 't were done quickly." London refuse is rising in value. Soon none will be available for burning sewage sludge; it will all be in demand for producing electric light and power.

There are other texts in your article upon which I would have liked to descant, but I fear I have trespassed too much. I would, however, as you have referred to Mr. Jones, of Ealing, like to express my personal regret that there should have been the appearance, in connection with the recent celebration at Leyton, of a deliberate ignoring of Mr. Jones's claims in connection with the burning of sewage sludge. However crude one may consider the process at Ealing to be, it is unquestionable that to Mr. Jones belongs the credit of having first destroyed sewage sludge by burning upon a practical scale, and this acknowledgement is no more than the merest justice to him.

A. J. Liversedge.

March 3rd, 1898.

P.S.—The above was written before the appearance of Mr. Hetherington's letter in your issue of the 4th inst. Mr. Hetherington has put you right in reference to the "weight removed by pressing sewage sludge," but seems to have fallen into a remarkable misapprehension, to judge from his delightful account of what he imagines to take place at Ealing. He is not apparently aware that whilst the wet sludge is not "pressed" at Ealing as it is at Leyton, it is *drained* through house refuse—Mr. Jones devotes a certain proportion of his refuse to that purpose. What is the exact proportion of water so removed has not, I think, been stated. It will not, of course, be so much as the amount removed by pressing; but it is sufficient to bring down the process from the realms of the alchemist, where Mr. Hetherington appears to think it properly belongs—well, something after the prosaic style of Leyton.—A. J. L.

Rubber Cables.

The manager of the Burton-upon-Trent Gas and Electric Light Works a few weeks ago issued a circular to his colleagues of other towns. In this circular he stated that India-rubber covered cables of our manufacture had given him considerable trouble. As a letter of this description was likely to prejudice this company in the eyes of many, if dealt with as a confidential document, we had the circular reprinted and distributed, asking the recipients if they would take the trouble to furnish us with any replies they may have made to the original document. We have to thank a number of these gentlemen for their courtesy in replying. In answering, many informed us that they had not received the circular in question, others either had not replied to it, or were not users of our cables. Among the replies received from the users of our cables, six stated that they had some trouble either with the small or with the arc lighting cables, and in the majority of these cases the trouble was only temporary. Two wrote that they had no trouble whatever of a serious character, and the remaining 10 wrote that they had absolutely no trouble at all.

From the number of definite replies, we are well aware that these do not include reports from all the users of our cables for high tension distribution, as in some cases, where there was no cause of complaint, no replies were made, and, in other cases, where there has been, or may have been, trouble, we were not favoured with a copy of the report, if any, which was sent to Burton.

We hold that the statement reported to have been made by Mr. Alderman Lowe, of Burton-upon-Trent, and referred to in your issue of the 18th ult., must be incorrect, as the answers received to our circular show that, out of a total of 18, in 12 cases the cost of maintenance has been practically *nil;* and, as to the others, we understand the cost of maintenance has in no case been large.

We trouble you with this letter as the matter certainly is of importance to ourselves, and we believe it to be of interest to electrical engineers.

Wm. Gray,

Electric Light Department, The India-Rubber, Gutta-Percha, and Telegraph Works Company, Limited.

Knots.

Having read Mr. Little's letter carefully I fail to see that the expressions "60 knots in length" and "12 knots per hour" are "inexact and wholly unscientific," and beg to differ when he says a *knot is a speed.* A knot is a measurement arrived at as follows: The circumference of the earth, 131,385,465 feet, is divided into 360 degrees, each degree being again divided into 60 parts or knots, consequently

$$\frac{131,385,465}{360 \times 60} = 6,082{\cdot}66 \text{ feet} = 1 \text{ knot},$$

6,080 feet being the length of the Admiralty knot.

A knot per hour is a speed expression in the same way as the expressions miles and miles per hour denote distances and rates of speed travelled by trains or other vehicles on land.

Mr. Little says the "word knot is used to denote an interval (length) between one or more marks on the log line." A log line being a length of line divided by knots spaced at intervals of about 50 feet, this spacing being chosen when the sand glass (used in taking speed measurements by this method) runs for 30 seconds, 50 feet bearing the same ratio to the length of a knot as 30 seconds does to an hour, viz., $\frac{1}{120}$th part (50·68 feet would be correct) but the fractional part is not considered as it is allowed for the wash of the wake of the vessel. Thus the log line is a measurer of distance, as when in use the log ship (a triangular piece of wood weighted to keep it in a vertical position) remains stationary and the line is allowed to run out freely, the operator counting the knots in the line as they run through his fingers or over the rail, the number of knots which are counted being the number which have run out whilst the sand has been running through the glass for 30 seconds. This, of course, gives the distance which has been traversed by the vessel from the place where the log ship was thrown overboard in that period of 30 seconds. The log line, therefore, merely acts as a convenient scale for measuring a short distance travelled over in a given period of time, by which the speed per hour can be determined at once.

The whole question appears to be a quibble, as Mr. Little admits the use of the word knot to denote the interval between two particular marks on a log line, but will not permit it to be used to denote a distance which has been used for scores of years by naval officers and others, including misguided cable engineers.

Another Cable Engineer.

Testing Secondary Batteries.

In the communication on "Comparing Results of Tests on Accumulators," published in your issue of last week, I notice the following statement:—

"That constant rate of watts is the correct method is undoubted, for if we use a battery for power or traction, it may be called upon to work at the same rate at the end of 6 or 8 hours as at the beginning of the run."

Now, it would be interesting if your correspondent would let us know how a battery can be used in this manner. It probably could be done by some series-parallel arrangement of the cells, but surely the ordinary way of working in nearly all practical cases is to keep the *current* constant by switching in regulating cells or by cutting out resistance coils? Thus, although the watts *given to the motor* are constant, the watts *given out by the battery* are by no means so. To test a cell at constant current, therefore, seems the best method for present day practical purposes.

Albert Campbell.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

At the last meeting of the Institution of Electrical Engineers, held at the Institution of Civil Engineers on Thursday the 10th inst., the discussion on Mr. Binswanger Byng's paper dealing with 200-volt lamps and fittings was continued and concluded. It was not concluded, however, without repeated requests on the part of the president to speakers to be brief, while many desirous of throwing the light of their experience on the subject were relegated to the sending in of written communications to be printed in the *Journal*, and even then the hour of 10 had struck and gone ere an adjournment to the less formal, but equally interesting, discussion over tea and cake, was effected.

Prior to the re-opening of the discussion, the president, Mr. J. W. Swan, announced the preparation of a testimonial to M. Gramme, that a circular asking for subscriptions thereto was in hand, and that the inventor whose work in connection with the dynamo, everyone is aware of, and acknowledges, is to be banquetted at Brussels shortly. Strange to English ears, was the promise that donors of the smallest current gold coin would receive a bronze, and givers of a larger sum, a silver medal to commemorate the event, and, we suppose, reward those who assist the subscription list.

Mr. Stearn was the first speaker on the question before the meeting, and he gave his views at length. He had little to add, and nothing to retract from what he said in the discussion on Mr. Addenbrooke's paper,* as to the principles of high voltage lamp construction, and to show the exact position he held, and holds still, he quoted largely from his remarks in the *Journal of the Institution.* He considered the double filament is the most convenient as a transitional form, but that the zig-zag filament lamp met most requirements. Considering the material of the filament, he believed it has been shown that the change in candle-power is slower with low specific resistance; with high specific resistance a shorter filament can be obtained, which has the drawback of a rapid change in candle-power. But low specific resistance filaments can be used where some means of anchoring is adopted. He still considered that the type of high voltage lamp was best for a time, which suited most closely the conditions of the transitional period. Timidity in the use of high voltage supply was, however, dying out, and opposition to the change being gradually overcome. Lamps should be durable in the first place; reliable, so that there should not be premature breakages, while they should absorb the same amount of energy that one is accustomed to with the older and better known types. That the candle-power should be the same is merely desirable, and not at first essential; but small units, such as 5 and 8-candle-power lamps, should be forthcoming.

At the time when the high voltage was mooted, we were informed that fatal accidents and fires would be likely to occur at this tremendous pressure; but confidence is slowly giving place to suspicion. The lamps and fittings to-day do not meet every possible objection; but one must walk, if not yet able to run, and it is for this reason that at the time of the introduction of 200-volt lamps, the untreated filament seemed to meet the then requirements. The light curve is not everything. Carbon of an earlier period than that of the present day was rough, cindery and fragile, and the duration of use very short indeed. Treating was adopted to patch up irregularities, and fit the carbons for commercial use. About 1881 a number of lamps were made up, half with treated and half with untreated filaments, and tested by Mr. Crompton. None of the treated filaments were readily broken, but the untreated gave way rapidly. The process, devised by Mr. Swan, of projecting a jet of cellulose into a setting solution is now generally used for the manufacture of filaments, and lamps can be made of any reasonable efficiency. Those made in this way are better and more reliable than if treated. Equal diameters and very nearly equal resistances can be depended upon. When the treating process has once been begun one is liable to variations in specific resistance, diameter and emissivity, or the radiating qualities of the surface, and changes occur from any difference in the temperature, pressure, or kind of hydro-carbon used, and many other things.

A treated filament for a high voltage lamp may be from 14 to 15 inches long, and it cannot be safely used unless some special mode of disposing of it be provided, as it really is a very flexible pendulum. But if some such disposition be not adopted, Mr. Stearn would prefer to use the untreated filaments. The fears of the public have now passed away, but they prefer lamps of long life. The factor of convenience is often overlooked. Suppose the life curve does fall, the user has the option of replacing lamps as he pleases. Mr. Stearn was surprised to hear that one lamp in a dozen was expected to short circuit at once, but this may not represent the general conception of what such lamps do. There are two causes of short circuiting: a fertile cause is the entanglement of the double filament in transit, and if this defect be not noted trouble must ensue. Another is an accidental crack in the bulb. Externally the short circuits may be due to bad capping or carelessness in using soldering fluids, or in frosting with chemicals. Internal shorts are more attributable to careless exhaustion. This should be utterly impossible. When the change was made from 50 to 100 volts, it was thought that the space between the terminals should be doubled, but later experience showed this to be quite uncalled for, and the distance between them is amply sufficient for much higher pressures if the vacuum is properly made and permanent. Mr. Stearn has not been able to discover any reason for making any difference in exhaustion or the mode of doing it. The gas to be removed is not from the filament alone, but comes, also, from the soldered ends and from the platinum.

A rise in candle-power is entirely in the hands of the lamp maker, and at one time it was thought best to do away

* "High Voltage Lamps and their influence on Central Station Practice," Mr. C. H. Stearn's remarks in discussion, p. 271, No. 122, Vol. 25, *Journal Institute Electrical Engineers*, March 12th, 1896, also *Proceedings Municipal Electrical Association*, parts of 1896 issue.

with it entirely. But rise can be kept at from 16 to 17 or 17½ C.P. in 300 hours, made to expend the excess during the useful life of the lamps. By this means a better average is obtained from the lamp during its life. Accuracy in classification, rather than cheapness in the lamps, and the maintenance of an average standard efficiency for all voltages were, the speaker believed, highly desirable. Until that accuracy is reached, lamp making cannot be an exact science.

Mr. Stearn did not see why stations should not go up to the highest pressure permitted by the Board of Trade, and even calmly spoke of 500-volt lamps for street lighting. On the question of alternating and continuous current, he suggested that if the vacuum was not absolutely perfect, lamps may last longer with alternating current. Some figures were given showing that the breaking strain for treated was less than for untreated filaments.

Mr. Crompton stated he laid out Harrow for 200-volt supply three years ago. The lamps were wholly satisfactory, and he had found no difficulties, as he had proceeded on Mr. Stearn's lines and advice. The users seemed to be as well satisfied as any 100-volt consumers, while the extreme ease of regulation and every other advantage of high voltage has been obtained. He had made tests of switches for the Council of the Institution, and at first hoped to be able to prepare a table of lengths of break for different pressures and currents, but the results proved unsatisfactory, as very short breaks on a particular form of switch gave better results than longer breaks on other patterns. He is decidedly of opinion, however, that larger covers are wanted. With fuses the perforations in the cover minimise the arcing effect. It is a very excellent idea to use plaster of Paris round the wire as Mr. Binswanger Byng does. In prescribing a twin wire one can get no further than the tests and specification given in the Institution wiring rules. It is, therefore, unnecessary for that matter to be gone into further.

Mr. Swinburne had found that one might put an N.B. into text books of chemistry to the effect that "the real chemistry may be quite different." He amused the audience by a most interesting and crisp contribution to the discussion in his best form, and our only regret is that so much is lost in attempting to convey in cold type what is so well worth listening to. He reminded those present that Ferranti had in 1885 proposed to use 500 volts, and as the representative of the Hammond Company he supposed he would have had to make the lamps had they been required. After a few remarks as to carbon, he mentioned that certain carbonised animal fibres give nearly the same resistance hot as cold. We believe we are correct in saying * that Mr. Swinburne holds the opinion that efficiency and temperature go together in lamp making. In the classical trial, Edison-Swan *v.* Holland, he was in a minority of one in this opinion, being considered as on the one hand a biassed witness, and on the other a lunatic!

Mr. Wordingham gave the results of his Manchester experience, thought small arc lamp users must not be overlooked, had received no complaints, reminded the profession of his warning that 100-volt fittings would not be safe on 200 volts, and described his tests for fuses and switches of overloading them by 50 per cent. both on current and pressure factors.

Mr. Rawlings delivered a most amusing speech on his relations with 200-volt consumers. It was painful to meet those who had gone over from lower pressures to higher, but quite a pleasure to see those who knew no better than 200 volts. Some houses have no less than four separate voltages to meet piano lamps in series, &c., and many were the troubles Mary Jane, his clients, self, and supply company had to meet. Lamps he found certainly unsatisfactory. The next speaker went into lamp manufacture in detail, and was followed by Mr. Swinton, who pictured the cathode ray lamp without a filament. He adduced the fact, not known to all, that in a high vacuum the nearer two conductors are together the greater the resistance. Even 20,000-volt lamps for street lighting, with a separate transformer to each might come.

* Mr. Swinburne later in the evening protested against a statement that he had said that efficiency depended only on temperature, which is by no means the idea he conveyed by his speech.

Mr. H. W. Miller told an unvarnished tale of certain complaints as to lack of light with high-volt lamps and the deterioration that occurs. He disagreed with the author as to the action on the blowing of a fuse, and thought that when a fuse melted the hot air and metallic vapour rushes out of the holes in a pattern such as described in the paper. Mr. Robertson stated that the advantages of carbon were so many that lamp manufacture must remain where it is until some substance other than this is found for filaments. He dealt with the controversy, treated *v.* untreated filaments, and methods of manufacture at some length.

Mr. Geipel, Prof. S. P. Thompson, Mr. Grimshaw, Mr. Addenbrooke, and the president proceeded with the debate, and then Mr. Byng rose to reply in brief. These speakers reiterated and enlarged upon the questions which had already been treated by others in part, and although what was said was extremely interesting, we think the accounts of the proceedings in the forthcoming *Journal* will be sufficient to satisfy all our readers that ample justice was done to an excellent paper.

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending March 17th, 1897.	£	s.
Alexandria	50	0
Amsterdam	200	0
Antwerp	21	0
„ Elec. fuses ...	307	0
Baltimore. Teleph. mat.	50	0
Bombay	24	0
Bushill. Teleg. mat. ...	33	0
Calcutta...	88	0
Cape Town	335	0
Christiana. Teleg. wire	45	0
Colombo	10	0
Copenhagen. Teleg. wire	20	0
Durban	793	0
East London	279	0
Genoa	160	0
Gothenburg. Teleg. wire	310	0
Hong Kong	14	0
Jersey. Teleg. poles ...	14	0
Lisbon. Teleg. mat. ...	12	0
Melbourne	45	0
Ostend	33	0
Paris	10	0
Rangoon. Teleph. mat.	48	0
Shanghai	63	0
Singapore	75	0
Stockholm. Teleg. mat.	125	0
Sydney	1,638	0
Wellington	337	0
Yokohama	2,000	0
Total ...	£7,142	0

Week Ending March 17th, 1898.	£	s.
Adelaide	10	0
Albany	43	0
Alexandria. Teleph. mat.	49	0
Amsterdam	300	0
Bangkok	89	0
Bombay	50	0
„ Teleg. cable ...	670	0
Boulogne	24	0
Buenos Ayres	81	0
„ Teleg. mat.	310	0
Cape Town	820	0
Colombo	78	0
Delagoa Bay. Teleg. mat.	3,710	0
Demerara	58	0
Durban	714	0
Flushing	14	0
Fremantle	30	0
Gibraltar	121	0
Gothenburg	171	0
Hong Kong	10	0
Key West. Teleg. cable	1,400	0
Launceston	11	0
Lisbon	425	0
Madras	107	0
Malaga	334	0
Malta	16	0
Melbourne	59	0
New York. Teleg. mat.	525	0
Ostend	65	0
Port Elizabeth... ...	51	0
Stockholm. Teleg. cable	60	0
Sydney	186	0
Wellington	445	0
Total ...	£11,036	0

Application for Extension of Patent.—On March 30th, at 10.30 a.m., the Judicial Committee of the Privy Council will hear the petition of the Hon. C. A. Parsons for an extension of the term of the letters patent granted to him on April 23rd, 1884 (No. 6,735), for "an invention of improvements in rotary motors actuated by elastic fluid pressure, and applicable also as pumps."

Australian Electrical Work.—From a Sydney engineering exchange we learn that the Brush Company is busy in that part of the world. The company is supplying an electric pumping plant for a Lithgow (N.S.W.) colliery company, and is now erecting electric light plant for the Sydney electric light station.

Bankruptcy Proceedings.—An application was made last Friday to Mr. Registrar Brougham, at the London Bankruptcy Court, for an order of discharge on behalf of John Orme, scientific apparatus manufacturer, Cross Street, Finsbury. The bankrupt, in 1893, promoted Orme's Electric Signal Company, Limited, to take over his patent electric fog signal. As vendor he received £6,000 in shares, which, however, proved valueless, as the company went into liquidation in 1895. He failed in November last with liabilities, £1,769, and a dividend of about a 1s. in the £ will be paid to the creditors. The failure was partly attributed to the loss and liabilities incurred in connection with the fog signal company. Three offences were reported by the Official Receiver, and the learned Registrar imposed a suspension of two years and a half.

Bankruptcy Proceedings.—Under the failure of Trehearne Son & Crump, electrical engineers and contractors, 155, Fenchurch Street, E.C., the first meeting of the creditors was held on Wednesday, at the London Bankruptcy Court before Mr. Wildy, official receiver. The accounts show liabilities £1,066, and assets, £413. The business was started by Mr. Trehearne in June, 1895, and in May, 1897, Mr. Crump became a partner, introducing a capital of £750. Disputes arose between the partners as to the position of the firm, resulting in the present proceedings. In January last an electrical engineering company was formed by Mr. Trehearne and his friends, which took over the firm's offices, and appointed him (Trehearne) as managing director with a commission on the profits. When the firm stopped there were some contracts on hand, but they were abandoned. The failure was attributed by Mr. Trehearne to losses by betting, heavy expenses incurred in getting business, loss on trading and bad debts. Mr. Crump, on the other hand, attributes it to the failure of his partner to carry out his guarantees relating to the liabilities of the business when the partnership was formed. No offer was made to the creditors, and Mr. B. T. Norton (Pratt and Norton), accountant, Old Jewry, E.C., was appointed as trustee to wind up the estate in bankruptcy, assisted by a committee of inspection.

Business Announcement.—Messrs. J. C. Lyell & Co., of 55, Victoria Street, announce that increased business has compelled them to take *all* the offices at the above address, which is now occupied solely by them. They are shortly about to open several new departments.

Catalogues.—Mr. A. P. Lundberg, of Bradbury Street, Kingsland, has brought out a catalogue which is a credit to both printer and compiler. The setting out of the cover is very neatly done, and it is printed in green and gold. In the 28 pages of letterpress and illustrations, Mr. Lundberg lays before his customers and the trade generally particulars of his numerous types of switches, wall connections, wall plugs, distributing fuseboards, cut-outs, ceiling roses, &c. Many of these fittings have already been described in our columns, and are well known to the electrical trade. Mr. Lundberg has given a good deal of attention to high voltage fittings, and has introduced some new patterns embodying high voltage requirements.

A list has been issued by Messrs. W. O. Rooper & Robins, electric light engineers, of 3, Newgate Street, Chester and Stafford, in which they give a list of electric lighting and power contracts carried out by them in various public works, country houses, business establishments, residential premises, &c., in the provinces.

Messrs. Schischkar & Co., of 67, Stafford Street, Birmingham, and Nottingham, who are sole agents for the L. W. Pond Machine Company, of America, send us an illustrated list of the English and American machinery and tools they have in stock in this country. The list shows lathes, drilling machines, chucks, also milling, emery grinding, and shaping machines, as well as various other engineers' tools.

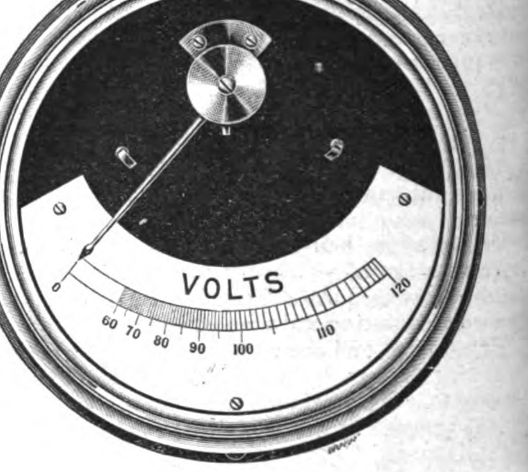
Change of Address.—Mr. S. Harrison, late of Ellesmere Works, Newtown, and 697, Ormskirk Road, Pemberton, near Wigan, announces that he has taken over new showrooms, offices and works, at 73, Wallgate, Wigan, where he will carry on business in electrical accessories, switchboards, incandescent lamps, arc lamps, fittings, &c. Mr. Harrison has been appointed sole agent for the North of England for the Crescent arc lamp and the Hard incandescent lamps. All letters should be sent to the new address.

Change of Name.—The business formerly carried on at Maritzburg by the Excelsior Electrical and General Engineering Company is now being conducted under the name of Messrs. Brady and Wyles, electrical engineers, at 192, Church Street, Maritzburg. The firm has recently carried out some important electrical contracts in that city, including three private plants—one for the Government Laboratory at Allerton, and two other Government contracts.

Coke v. Richardson.—In the Westminster County Court on Tuesday his Honour Judge Lumley-Smith, Q.C., tried the case of Coke *v.* Richardson, which was a claim for £20 odd for work done by a gasfitter and plumber of Whitcombe Street, W., against the defendant, an electrical engineer, of Southport. Evidence was given that defendant was fitting an electrical installation at the Clarence Hotel, Charing Cross, and a gas engine was to be used. Other work was required, and plaintiff did it. The defence was that part of the work had been done upon the order of Mr. Buxton, the owner of the hotel, and that plaintiff had rendered an account to him, and that all that was due to the plaintiff had been paid to him. His Honour found that the question of the work was really between Buxton and Richardson, and that the latter was liable to the plaintiff. There would be judgment for the plaintiff for the amount claimed with costs.

Commutator Bars.—The Forest City Electric Company, of Cleveland, O., has issued an 1898 railway catalogue of roll drop and drop forged commutator bars. The list contains details of bars for Westinghouse, General Electric, Edison, Walker, and other railway motors.

McWhirter's Patent Shielded Instruments.—It is interesting to notice the tendency among instrument makers and users to revert to the permanent magnet in the manufacture of ammeters and voltmeters and other electrical measuring instruments. The causes underlying this change are twofold: Firstly, there is no doubt that the production of finely made instruments constructed on the D'Arsonval principle has tended to bring permanent magnets into favour, not because they are any better or more reliable than they were 10 years ago, but because instruments of this class possess so many good qualities that the main objection, viz., the unreliability of the test of magnets, has been lost sight of, and on all hands we hear of engineers using such instruments as standards, regardless of the fact that they are only fit for secondary standards. As such, instruments of the D'Arsonval type are admirable, but it should never be forgotten that occasional comparison with an absolute standard is essential. The second, and, perhaps, the main reason for this reversion is the failure of electro-magnetic instruments to meet the demands of electrical engineers. The need for accurate measuring instruments is ever increasing, and electro-magnetic instruments, in spite of the paramount advantage of permanence, fail in many respects to meet this great want. The engineer expects his instruments to give accurate results under all conditions of temperature and in stray magnetic fields of great and ever-varying strength, and as the field of the average electro-magnetic instrument is comparatively weak, the stray field due to leads carrying, say, 200 amperes and upwards has a very substantial effect; also, in cases where the switchboard has to be close to the dynamo, there may also be a very serious disturbance. In some cases these troubles can be avoided by careful design, but in most cases this is impossible. The instruments which are described below lead us to hope that the electro-magnetic instrument is beginning to move faster towards perfection than it has been doing lately, for in them some of the most serious drawbacks to their class are either removed or greatly reduced in importance. Mr. McWhirter's invention is very simple, and consists in the substitution of an ironclad bobbin for the ordinary brass one. This modification, although so simple, has, as Prof. Jamieson has shown in his report, a very marked effect on the working qualities of the instrument, especially in the matter of freedom from the disturbing effect of stray magnetic fields. There have been several screened instruments produced, the most general plan being to make the outside case of iron. The evil of this plan is that the outer case, being



irregular in shape and thickness, and having of necessity an opening through which the scale can be read, becomes polarised, and thus the screen itself becomes a source of the very disturbance it was designed to guard against. In the case of Mr. McWhirter's screen, the iron case is placed on the coil only, and, moreover, forms a part of the magnetic circuit; being of even thickness and symmetrical shape, it is not at all liable to polarisation, and as the outer iron coat is ½-inch thick, the shielding is almost perfect, as shown in the tests. It may be thought that such a mass of iron would produce a great increase in the error due to residual magnetism; but this is not so, as the tests show the error is no greater than in the case of the ordinary instrument with which it was compared, and more recent instruments give results considerably better than this. The ironclad coil possesses other advantages, chief among which is the great reduction in the power necessary to work the instruments. The power used in a McWhirter voltmeter is only one half of that necessary to work a corresponding voltmeter with an ordinary coil, and it is thus possible to wind the coils either entirely of manganin, or with a much larger proportion of this alloy than is possible when a greater number of watts are necessary, consequently the errors due to internal heating and to changes in atmospheric temperature are reduced to an insignificant amount. Tests have been carried out by Prof. Jamieson, which show clearly the advantages obtained by adopting the McWhirter coil in the manufacture of electrical measuring instruments. Comparisons of the resistance when hot, after a 20 hours' run (5,112 ohms), with the resistance when cold (5,082·5 ohms) showed the error due to this cause to be very slight, amounting in all to only ·58 per cent. While the voltmeters were indicating approximately 100 volts, a horse-shoe magnet was placed so as to produce a maximum deflection of the pointer, which was noted; the poles of the magnet were then reversed, and the deflection in the opposite direction noted. The mean of the two readings was taken as the percentage error due to the external magnetic field.

The McWhirter voltmeter gave an error of...	0·75 per cent.
The ordinary voltmeter	6·00 „
A new engine room volt gauge	5·00 „

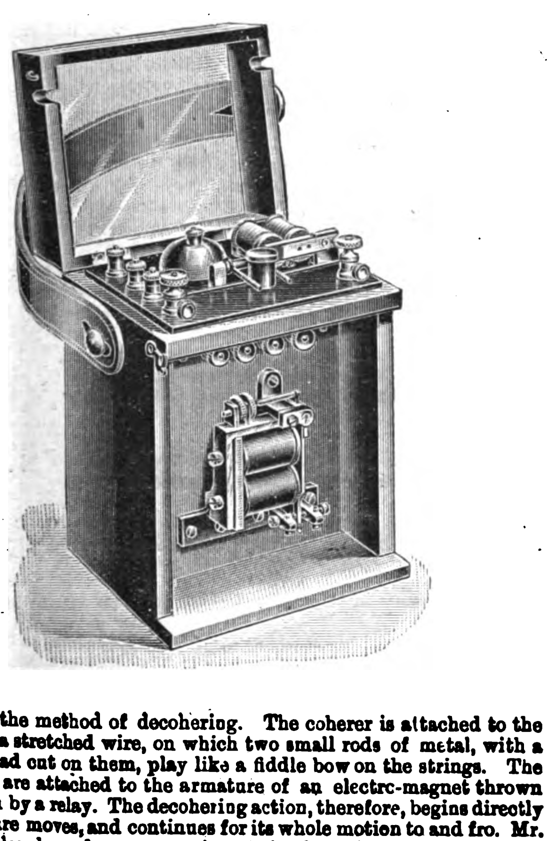
Prof. Jamieson summarises the tests as follows:—"I have to report that your newly patented shielded voltmeter is less affected by external magnetism than any other electro-magnetic one which I have seen. The temperature is also negligible, being only ⅓rd of 1 per cent., at 100 volts, after 20 hours in circuit." The General Electric Company, Limited, of Queen Victoria Street, London, and Peel Works, Manchester, are the sole licensees and makers of these improved shielded instruments.

The National Telephone Company v. Atkinson and Day.—In the Queen's Bench Division on Tuesday, before Mr. Justice Day, the case of the National Telephone Company *v* Atkinson and Day came on for hearing. Counsel's statement disclosed a curious state of facts. The action was brought to restrain the defendants from cutting, or otherwise interfering with, the plaintiffs' wires. It appeared from counsel's statement that the first defendant, Atkinson, was a tailor, carrying on business in the Fulham Road, and for a number of years telephone wires had been carried above his premises. In October of last year he had a conversation with the second defendant, Day, who asked him why he did not get a rent from the telephone company for allowing the wires to be carried over his house. Day suggested 2s. 6d. per annum per wire as rental, and stipulated that if he received this sum he was to have 25 per cent. of the proceeds. Atkinson agreed to this, and Day accordingly wrote to the company. They not replying he wrote again, threatening to cut the wires, a threat which, it afterwards transpired, was made wholly without Atkinson's authority, and, in fact, against his wish. In face of this threat the telephone company came to the court and obtained an interim injunction. It was then suggested that the motion should be treated as the trial of the action, and the plaintiffs agreed to this course provided that Day, who was in the wrong, paid the costs incurred. This he would not do, so the action went on. Counsel for the plaintiffs called Mr. Atkinson the first defendant, who bore out the opening facts, and said he never authorised Day to threaten to cut the wires. The wires had been over his house for 10 years, and he had never suffered any inconvenience therefrom. Mr. Day gave evidence on his own behalf, stating that he did not care about the injunction, as Mr. Atkinson had withdrawn his authority, he could not possibly do anything. The only thing he objected to was paying the costs. The injunction, so far as he was concerned, was not worth waste paper. Mr. Justice Day said he did not see how Atkinson could proceed with his claims to get a rental unless he had been prepared to cut the wires. The best conclusion he could come to, was to find for the plaintiffs, without costs.

Personal.—It is stated in an Aberdeen paper that Mr. W. McWhirter, M.I.E.E., of Aberdeen, is sailing for India on 25th inst., to carry out a new system of electrical train signalling. He will afterwards proceed to Cape Town on the same business. During his absence his electrical engineering business in Glasgow will be carried on by his son, Mr. Anthony C. McWhirter, A.I E.E.

Pritchetts & Gold.—This firm ask us to state that in future all their correspondence in connection with the manufacture of storage batteries will be conducted from their works at Feltham, Middlesex, to which address all communications relating to that portion of the business should be forwarded.

Receiver for Wireless Telegraphy.—We illustrate below a new receiver for wireless telegraphy, which is being made by Messrs. Miller & Woods, of 2, Gray's Inn Road, W.C. This, we understand, has been provisionally protected by Mr. L. Miller. The chief



novelty is the method of decohering. The coherer is attached to the middle of a stretched wire, on which two small rods of metal, with a screw thread cut on them, play like a fiddle bow on the strings. The small rods are attached to the armature of an electro-magnet thrown into action by a relay. The decohering action, therefore, begins directly the armature moves, and continues for its whole motion to and fro. Mr. Leslie Miller showed some experiments in signalling without wires at the Institution of Junior Engineers' conversazione last Saturday, and on that occasion no shunts whatever were used to prevent the spark of the relay influencing the coherer, but the bell only gave single rings. The coherer used consisted of an ebonite cup, in the inside of which there were some nickel filings bridging over a ⅛th-inch gap between the ends of the stretched nickel wire. The method of decohering can, however, be applied to the Marconi coherer, or most other forms. The apparatus shown is intended for lecture purposes. For working over long distances a more sensitive relay is required than that shown in the illustration.

Utilisation of Water Power in Italy.—It is reported that Messrs. Ganz & Co, of Buda-Pesth, have acquired the rights to utilise the water power of the river Tanaro, in the province of Piemont, and plant is to be put down to generate and distribute electrical energy for lighting and power purposes in the neighbourhood. It is stated that 2,000 H.P. is available.

ELECTRIC LIGHTING NOTES.

Aberdeen.—The Town Council has sent back to Committee the proposal to charge 6d. for the first hour daily of the maximum demand for current for power purposes, and 1½d. per unit after. At the last meeting, the electric lighting accounts for the year 1897 were submitted by Councillor Johnston, who said that since the new system of charging had been adopted, a good many complaints had been received from consumers who formerly paid 5d. on the first hour's consumption, and were now charged 6d. The system, which had been adopted by other corporations, was introduced last year. He did not wish to characterise the class of consumers from which the complaints came as the consumers, but they did not pay the department so well as those who came within the scope of the rule as to the rebate; and the committee had acted in as equitable a manner as they could. During the past six months they had had a rather heavy expenditure through changing the system. The engineer informed him that during the past half year there had been something like £300 spent in connection with the change of system, which would not occur again for a considerable time. Had it not been for that they would have had a good balance.

Barton-on-Humber.—The following from the *Leeds Mercury* of the 10th inst. will interest electrical firms:—"Wanted, electric light installation at Barton-on-Humber. This is a thriving manufacturing town of considerable importance, at present inadequately served by a small private gas company with exorbitant charges. A local syndicate is prepared to render considerable financial aid, and would also give other assistance which would be of value to the promoters of such a scheme. Address C, 190, Mercury Office, Leeds."

Barking.—The Board of Trade has written to the District Council inquiring whether the undertakers of the electric lighting order proposed to connect the intermediate conductor of their three-wire system of mains with earth. The Board pointed out that the concurrence of the Postmaster-General was necessary for an earth connection.

Belfast.—The engineer recently reported that machinery and boilers for the new electric station were being delivered and placed in position, and he hoped to have the first section of the establishment in working order shortly.

Blockley.—A copy of an order served on Mr. H. N. Warburton, owner of the electric lighting installation at Blockley, has been received by the Parish Council from the Board of Trade, together with the regulations as to the installation.

Bradford.—The Mayor submitted the gas and electricity accounts for the half-year at the last Council meeting. Regarding the electricity department he said that the total income for the half-year ended December 31st, 1897, was £10,842 0s. 7d., as compared with £9,570 13s. 2½d. in the corresponding period in the previous year, or an increased income of £1,271 7s. 4½d. The total expenditure for the half-year, which included interest and sinking fund, was £7,942 18s. 8d, against £5,570 4s. 1d. for the corresponding period. The profit for the half-year was therefore £2,699 1s. 11d., as against £4,000 9s. 1½d. for the similar period of 1896. The decrease in profits of £1,101 7s. 2½d. as compared with the corresponding period, was explained chiefly by the increased interest and sinking fund charges, amounting to £885 extra, together with sundry items of repairs to machinery, including renewal batteries, &c. The number of consumers was at present 640, as against 470, or an increase upon the corresponding half-year of 36 per cent. The total number of units consumed was 550,300, against 477,342, or an increase of 15¼ per cent. The total profits since the opening of these works, in September, 1889, to December, 1897, after paying interest and sinking fund, amounted to £16,733 0s. 6d., and the total amount written off for depreciation had been £7,307 15s. 6d., leaving the sum of £9,425 5s. to be appropriated as the Council might direct. The trade profit, *i.e.*, the profit before charging interest and sinking fund, was £4 11s. 9½d. per cent. for the half-year on the capital outlay. The net profit, *i.e.*, after charging interest, sinking fund and depreciation, showed £1 2s. 7d. per cent. for the half-year. Taking the December and June half-years together, the trade profit was £11,234 10s. 1d., representing £8 3s. 3d. per cent. per annum on the capital outlay. He thought this was a reasonable report, and that the Council had reason to be satisfied with the working of the department.

Brewery Lighting.—Messrs. Polkinghorne & Co.'s new brewery at Mutley is to be lighted electrically, and Messrs. Lord and Snand are putting down a Taunton dynamo for supplying 260 8-C.P. lamps.

Brighton.—The Town Council on Monday decided to reduce the price of electricity from 1½d. per unit after the first hour to 1d. The change, it is stated, will not take place for three months. The lamps in Dorset Gardens, are in future to be lighted by electricity instead of gas.

Bristol.—The Electrical Committee decided on Friday last to reduce the charges for electric current for power purposes, subject to a special agreement being entered into, from £6 per annum per kilo. installed, to £5 per annum per kilo. demanded where the customer has no private plant on his premises, and £5 per annum per kilo. installed where the customer has a private plant. It was also decided to reduce the charge for electricity consumed for motive power from 2d. to 1½d. per unit, subject to a sliding scale of discounts varying from 2 to 15 per cent. The Local Government Board has sanctioned the borrowing of £23,000 for public electric lighting. Mains are to be extended in various thoroughfares.

Buenos Ayres.—On February 12th the tenders for the public lighting of the City of Buenos Ayres were opened. A tender for electric light was presented by the City of Buenos Ayres Electric Light Company, and for gas by the New Gas Company, and the River Plate Gas Company. These tenders are, says the *Review of the River Plate*, more or less the same as those presented on a previous occasion, and it is possible that they will not be accepted. The Municipality evidently desires to get the public lighting done for nothing, and our contemporary recommends the authorities, if they desire to receive tenders that will benefit the city, to pay their gas and electric light bills when they fall due. Cash payments will soon bring about cheap gas and electricity.

Burton-on-Trent.—At the last meeting of the Council, Alderman Lowe said with reference to the defects in their electric lighting service, they had had Mr. Bailey (the engineer of the Metropolitan Electric Lighting Company) down from London, and he had made an exhaustive inspection of their appliances, but up to the present his report had not been received.

Buxton.—Prof. Kennedy has been instructed to prepare plans and specifications, and obtain tenders, for a municipal installation. The cost of the plant necessary for 6,000 8-C.P. lamps, and the necessary trunk and distributing mains—will be £12,500; buildings, £3,000; meters and house service £300.

Carlisle.—The Council has accepted the tender of Mr. John Laing, Carlisle, for the erection of the electric light station for £7,668.

Cheltenham.—The electrical engineer's report for February shows the total number of services connected was 241, with an equivalent of 14,600 8-C.P. lamps. He is reporting as to the means of improving the lighting of certain roads by arc lamps. The secretary of the Ladies' College recently complained of the large increase in the account for electric supply to St. Hilda's for the last quarter, amounting to £40 odd for 2,027 units, whereas for the corresponding quarter last year the account was £28 odd for 1,195 units, although the number of lamps in use was the same. The electrical engineer having inquired into the matter, reports that he has tested the meters, and in his opinion the principal reason for the large increase was the lavish use of the lamps and want of care in switching them off when not required. The gas manager does not consider the incandescent gas burner is yet in a satisfactory condition for street lighting.

Country House Lighting.—Kedleston, Lord Scarsdale's house near Derby, is to have the electric light. There will be a steam plant, with "D.P." accumulators, and about 250 lights fixed at present. The work has been entrusted to Messrs. Drake & Gorham.

Crickhowell.—The Parish Council is to consider whether to go in for electric lighting or to construct new gas works.

Crieff.—A report was recently furnished to the Town Council by Mr. R. F. Yorke, as to forming a company for providing electric light for the town—the motive power for which is proposed to be supplied by the Falls of Turret, some three miles north-west of the town. Mr. Yorke says that the available head is from 500 feet to 600 feet.

Darfield.—The District Council last week decided to apply for an electric lighting provisional order.

Fareham.—The District Council has decided to apply for power to borrow £2,900 for the purpose of adding to the electric light plant. It was pointed out that the proposed expenditure would provide a second plant for use in case of breakdown, and also for any increase in the demand for the light.

Glasgow.—The Electricity Committee recommends the expenditure of about £20,000 on dynamos and engines, lead-covered cables, &c., required for the new electric lighting station at Port Dundas, and for the more complete equipment of the existing station.

West Nile Street is to be lighted with electricity by means of lamps suspended from the trolley poles.

Glossop.—At the last Town Council meeting, the Town Clerk said he had received applications from three consulting engineers regarding the electric light scheme. The applications were referred to a sub-committee.

Greenock.—Mr. Teague's electric lighting scheme, which includes lighting the principal streets by means of 40 2,000-C.P. arc lamps, also the lighting of the James Watt Dock, was before the Corporation last week. The estimate is £27,500, exclusive of cost of site. The estimated revenue is about £3,300, and the expenditure:—interest on capital, £750; management expenses, £1,650; depreciation, £900. A Corporation site in Hunter Place has been selected. The Corporation adopted the scheme.

Hackney.—The Vestry has received letters from several electrical firms in reference to the electric lighting scheme, but only those schemes will be considered which were received in accordance with the published advertisement. Mr. A. T. Snell has offered his services in connection with the scheme, and his letter is before the Electric Lighting Committee.

Hampstead.—The question of electric lighting for the new workhouse buildings is in the hands of the Works' Committee.

Japan.—Of the 42 largest cities in Japan, from Tokio, with 1,368,000 population, down to those of 26,000, electric lighting systems are installed, says *Daily Tenders and Contracts*, in 24 only.

Leeds.—The *Yorkshire Daily Post* says that the Yorkshire House-to-House Electric Supply Company has refused the price offered by the Parliamentary Committee of the Leeds Corporation for its undertaking. The proposal was to give the company £210 2½ per cent. Redeemable Leeds Corporation Stock for every £100 which may have been properly expended on capital account. In view of this refusal it is understood that the Corporation will proceed with their provisional order, by which they seek power to issue 5 per cent. Irredeemable Stock.

London.—The St. George's Vestry has received a letter from the Board of Trade, stating that as the Brush Electric Lighting Company had elected to proceed with the works authorised by their provisional order of 1892, the Board did not see its way clear to sanction a provisional order, under which the Vestry can supply electrical energy. The Vestry resolved to refer the matter to the Electric Light and Dust Destructor Committee to consider the best method of approaching the Board of Trade again in relation to the subject.

Lowestoft.—In connection with the proposed combined electric lighting and destructor scheme, Mr. Hawtayne and the surveyor are to prepare a plan showing the position of the destructor. The Horsfall Furnace Syndicate is to submit drawings, estimate, &c., of a 4-cell Horsfall destructor and plant for clinker grinding.

Lynn.—The Electric Lighting Committee has received Prof. Robinson's report on electric lighting, and the Council will consider it in committee. There is to be opposition.

Maidenhead.—The Electric Lighting Committee is to engage a consulting engineer to prepare a scheme and report at a fee of 75 guineas.

Maidstone.—The Electric Lighting Committee has recommended the Council to consult Mr. Hawtayne, or some other expert, as to the best method of carrying out the provisional order.

Marylebone.—The Vestry last week resolved to proceed with the execution of the proposed electric lighting works as soon as possible after the grant of the necessary powers which are now being applied for.

Morecambe.—A Local Government Board inquiry was held on 9th inst. *re* application for a loan for £10,000 for the extension of the electric lighting works. The Clerk explained that with reference to the recent arbitration case with the old electric light company, the Council had been awarded as their share £1,179.

Newcastle.—At the last City Council meeting, when the question of street lighting arose, it was stated that the electric light companies had replied to inquiries that the price for the street lamps would be reduced if more lamps were used. It was further stated that the City Council pays £42 a year for each lamp, but if they had a larger number they could get them for £28 each. It was considered that if the Corporation put down municipal works they could have them for £14 each.

North Berwick.—The Town Council has appointed a committee to obtain information *re* electric lighting.

Perth.—The Sandeman Public Library is to be wired for electric lighting, but in the meantime no generating plant is to be put down.

Prestwich.—The District Council is to apply for a provisional order.

Sheffield.—The Sheffield Electric Light Company has given notice that after the end of the present month another 1d. will be taken off the price of the current, making it 4d. per Board of Trade unit.

The Corporation's common seal has been affixed to the agreement between the Electric Light Company and the Corporation respecting the transfer of the undertaking.

Spain.—A central station has just been completed and put in operation at Jadraque. Water power is utilised.

Sunderland.—A report has been submitted to the Electric Lighting Committee by the electrical engineer, showing that owing to the increasing demand, the station was becoming incapable of supplying all requirements. The present capacity was 745 electrical H.P. The committee will recommend the Council to apply to the Local Government Board for powers for further extensions. The amount asked for steam dynamos, switchboards, &c., will be £12,728; for the extension of feeders and mains to the Workhouse if required, £12,540; making a total of something like £26,000. It was decided to ask the Council for leave to borrow £10,000 for immediate requirements.

Taunton.—The new connections during February were equivalent to 512 8-C.P. lamps. The Mayor recently stated that whereas the expenses of the undertaking had only increased by £178 during the year, the profit realised had increased by £271 8s. 4d., and after paying all expenses they had a balance on the year's working of £43.

Torquay.—The Corporation electricity works were inaugurated yesterday afternoon.

Wallingford.—The Guardians have abandoned the idea of using electric light for the Workhouse. The annual cost (200 lights) of electric light was put at £264 16s., gas £199 4s., oil £165. Gas is to be used.

Walsall.—At the Town Council meeting on Monday, the Electric Lighting Committee reported that the number of consumers at the end of February was 104. They regretted to report that after paying interest on loans and providing sinking fund there was a deficiency of £531 17s. 7d. This, with the loss of £445 3s. 10d. on the previous year's working, made the total deficiency of the undertaking up to December 31st last £977 1s. 5d., and with a view to meeting the same the Finance Committee had been requested to include in the next rate estimate the sum of £400 in respect thereof. The report was adopted.

Wednesbury.—The Mayor was calling a special Council meeting for Wednesday last, to consider the question of providing electricity for the town.

West Ham.—The tenders for the wiring of public buildings for the electric light have been referred to the electrical engineer to report upon.

Weston-Super-Mare. — Messrs. Foote & Milne, of Victoria Street, London, have written to the District Council suggesting that they should transfer their electric lighting provisional order. The letter will lie on the table as the Council are intending carrying their order into effect.

Willesden.—The Electric Light Committee, after considering the report of the sub-committee appointed to inspect various electric lighting stations, has recommended that steps be taken to secure the services of an electrical engineer. The appointment will not take place until the new Council is elected.

Winchester.—It is expected that the electric lighting station will be completed in two or three month's time. The laying of mains has been commenced.

Withington.—The desirability of arranging terms with the Manchester Corporation for the supply of electric light to Withington, was considered by the District Council last week, and was to come up again at a special meeting to be held yesterday.

Woking.—The Surveyor reports that the Electric Light Company has promised to replace the old lamps in the streets with new.

Yarmouth.—Mr. A. W. Ranken, the Corporation electrical engineer has given in his resignation to take effect on May 31st. The Electric Light Committee has expressed appreciation of Mr. Ranken's valuable services. It is proposed to adopt the following scale of charges for electric motors: Per 1 horse-power motor, up to 100 units per quarter, 3½d. per unit; 100 units to 300 units, 3d.; 300 units to 500 units, 2½d.; over 500 units, 2d. Other size motors in proportion.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Aberdeen.—The Corporation Tramways Bill is being opposed by the House Proprietors' Association.

Alexandra Palace Electric Railway.—The new electric railway at the Alexandra Palace, arrangements for which have been progressing during the past three months, is now taking a practical form under the supervision of the consulting engineers, Messrs. Taylor & Field. The work is being carried out by the Imperial Electric and Power Company, who are working in conjunction with Messrs. Wandruszka & Co., of Berlin. The estimate of this, which was originally to be £6,000, has had to be materially increased to have a double line of rail, and the cost now will reach nearly £10,000. It is intended to run the electric cars with the overhead trolley system. Each car will seat 60 people, and will be about 40 feet long. They are *facsimiles* of the American pavilion car, and will be fitted with 70 horse-power motors. The fare will be 1d., either up or down the hill. This will be a great convenience to all visitors to the Palace travelling by the Great Northern Railway, the North London Railway, the South-Eastern Railway, and the London, Chatham and Dover Railway to Wood Green station, as well as to visitors going to the Palace Gate station on the Great Eastern, and, in fact, the whole of that enormous district including Hornsey, Wood Green and Tottenham.

Brighton "Underground."—In consequence of strong opposition on the part of the Brighton Corporation and other local interests, the Brighton Underground Railway Bill has been removed from the list of Bills which has been referred for consideration to the Committee of the House of Lords. The scheme has been referred to in these columns on several occasions.

Calcutta.—The directors of the Calcutta Tramways Company have laid before the Calcutta Corporations a lengthy communication dealing with their proposals in regard to electric traction.

Coventry.—The Stoke Parish Council has approved of the positions of the trolley poles of the Coventry electric tramways.

Dublin.—The Clontarf section of the electric tramways, which we have already described, was to be opened this week.

Electric Power Distribution.—A third time the Wolverhampton Town Council, at their monthly meeting on Monday, decided not to admit the Midland Electric Corporation Power Distribution, Limited, into the borough. At the meeting in question a letter was read from the Board of Trade regarding the provisional order sought by the Electric Corporation. The Town Council had refused to grant their permission to the company to enter Wolverhampton, and the company now asked that the consent might be dispensed with. The applicants, in their communication to the Board of Trade, submitted that the Corporations of Wolverhampton and Walsall and the Tipton District Council were not entitled to withhold their consent unreasonably, and that in this case they were doing so. Subsequently Councillor Leir Johnson moved that the Council rescind their previous resolution, and assent to the promotion of the provisional order. Alderman Jackson seconded the resolution, but after considerable discussion it was rejected.

Mr. J. F. Albright (chairman), Mr. G. L. Addenbrooke (engineer), and Mr. A. L. Lowe (secretary), of the Midland Electric Corporation for Power Distribution, Limited, were present last week at a special meeting of the Wednesbury Town Council held to discuss the scheme. It was resolved to consider the whole question at another special meeting of the Council in Committee. This was done on Monday evening, when, after a long discussion, it was decided that the Council should apply for a provisional order themselves in order to have the power of supplying electricity in their own hands.

On Monday, at the meeting of the Walsall Town Council, the Electric Lighting Committee reported that the Board of Trade had asked the Corporation to state their reasons why the Board should not dispense with the consent of the Corporation to the application by the Midland Electric Corporation for Power Distribution, Limited, and the town clerk has replied that the Council strongly object to the proposal of the company to supply electricity within the borough. The report of the Committee was adopted on the proposition of Councillor Brownhill.

The Tipton District Council has resolved to withdraw its opposition to the scheme provided the company will supply electricity for lighting in bulk to the Council at 2d. per unit, this to include the supply of mains.

Folkestone.—The Sandgate District Council has been informed that the Folkestone Electric Tramways Bill will not be proceeded with during the present session.

Hartlepool.—On Tuesday last week one of the guard wires broke in Northgate, but no one was injured.

Hastings.—Last week the Council, meeting in committee, passed resolutions favouring the placing of trams in the principal thoroughfares, excluding the Front Line and Robertson Street. The borough engineer is to bring up a report as to cost, line of route, and other details, and the Council will then probably apply for powers under the Light Railways Act.

Hendon and Finchley Light Electric Railway.—On Saturday last, at the Hampstead Vestry Hall, Mr. Fitzgerald and Colonel Boughey, Light Railway Commissioners, resumed an inquiry, opened on Friday at Hendon, into the scheme of the Hendon and Finchley Districts Light Railways Company. Mr. Vesey Knox, M.P., for the promoters, at the outset said that the line would serve what was practically a remote agricultural district, though within seven miles of Charing Cross. The line, which would be worked by electric traction with overhead wires, would start at Canfield Gardens, Hampstead, opposite the Metropolitan Railway station, following the main road to Church End, Finchley, while another ran through Hendon to the Hendon station of the Midland Railway. It was seven miles three furlongs long, a little over a mile of this being in the parish of Hampstead and County of London, seven furlongs in the parish of Finchley, and the rest in Hendon. Many of the people who lived in that part of this district, which was within six miles of Charing Cross, were two miles from the nearest railway stations. The service from Finchley to Hampstead would be one car in 15 minutes, and from Hendon one in 10, making a service of one car in six minutes through Hampstead. Evidence in support of the scheme was given by Sir Douglas Fox and Mr. Wragg, the engineers, Mr. J. T. Firbank, M.P., and Mr. W. M. Murphy, the promoters, Mr. Hearne, chairman of the Hendon District Council, and others. There was opposition from the Hampstead Vestry, the L.C.C., and the Middlesex County Council. The inquiry was adjourned.

Leith.—It is stated that a hitch has occurred in connection with the purchase of the tramway undertaking in Leith. The lessees are described in the draft lease as Messrs. Dick, Kerr & Co., and the Edinburgh and District Tramway Company. It has been discovered that the Edinburgh and District Tramway Company are not licensed lessees, not having got sanction from the Board of Trade. Until this matter is rectified, negotiations for the purchase in Leith will be practically at a standstill.

Norwich.—In the House of Commons on Monday night the Norwich Electric Tramways Bill was read a second time and committed.

Orme's Head.—The Llandudno Council, and the promoters of the Orme's Head Tramway, have agreed upon terms whereby the Council shall have the option of purchase in 28 years, on a return at the rate of 4½ per cent. on total capital invested in the undertaking.

Paisley.—The Paisley Tramways Company recently entered into an agreement with the British Electric Traction Company for taking over the tramways and working them electrically. The British Electric Traction Company has now laid a comprehensive proposal before the Town Council regarding the scheme. Conditional on the Council granting the company a lease of the streets of the burgh for a period of 28 years, it will undertake to put down and work an overhead trolley system, to extend from Paisley Cross westward to Johnstone, southward to Potterhill, northward to Renfrew, and eastward to join with the outlying extremity of the Glasgow tramways. A Committee of the Council has instructed Mr. Teague, electrical engineer to the Corporation, to make inquiries at towns which have adopted the trolley system, and report to the Council in committee. Should the Town Council accede to the agreement, Parliamentary sanction would require to be obtained, and power will be asked to acquire property in narrow streets through which the tramways may run.

The Proposed City and Brixton Electric Railway.—The engineers have prepared, for the information of Parliament, detailed estimates of the cost of carrying out this scheme. The proposed line, which will run from a junction with the City and South London Railway, under the High Street, Borough, to Brixton Hill, is estimated to cost in the aggregate £818,040, of which the railway will cost £786,415, the cost of widening the City and South London Railway, in order to accommodate the traffic, £24,725, and the proposed subway to the Oval station of the City and South London Railway £6,900. The line will be three miles five furlongs in length, and will be constructed in every respect similar to the City and South London Railway, which it is proposed to purchase from the point where the new line will join it to its termination in King William Street. The capital of the company is proposed, says the *Financial Press*, to be fixed at £1,200,000, with the right to raise a further £400,000 by the issue of debenture stock. The engineers will be Sir Benjamin Baker, Mr. David Hay, and Mr. B. Mott. It is stated that the prospectus of this company will shortly be before the public under the title of the City and Brixton Electric Railway Company.

Yarmouth.—The solicitors to the Yarmouth and Gorleston Tramways Company have written to the Town Council as follows:—"Under the Yarmouth and Gorleston Tramways Extension Provisional Order Confirmation Act, 1897, the company, as you are aware, are empowered to construct the extension of their line thereby authorised, and to work the entire traffic by electrical power. With a view to give the greatly improved service which this modern method of traction would permit, the company are prepared to carry out the powers of the Act at an early date; but as there does not appear at present any probability of the necessary current supplied by the Council on the west side of the river, it seems that the company themselves will have to provide it, and in that case the company would be willing to erect a generating station, capable of supplying not only the requisite power for working their tramway, but, also to provide current for lighting purposes on that side of the river, should the Council desire them to do so, on terms to be agreed." The company proposes to employ the overhead trolley, and suggests a meeting with the Council to explain the proposals fully. The Electric Light Committee has asked the Company to submit written particulars of the proposals.

TELEGRAPH AND TELEPHONE NOTES.

The African Trans-Continental Telegraphs. — A Reuter despatch says that the *British Central Africa Gazette* reports that telegraphic communication between Zomba and Kota Kota was opened on December 10th. The actual construction of the line is now 60 miles north of Kota Kota, and holes have been dug 84 miles beyond that place. As Kota Kota was practically only opened up to European occupation on the death of the late Jumbe in 1894, it will be seen what great progress the country has made during the last three years. There is some idea of constructing a branch line from Kota Kota to Fort Alston. In view of the present troubles in northern Rhodesia, this would be of immense advantage. The telegraph staff at Blantyre has set up a telephone system there, and it is stated that a connection will shortly be made with Zomba. Towards the end of December there was an interruption on the telegraph line between Zomba and Fort Johnston. Mr. Kennedy, who went out to effect repairs, found that the breakdown was due to the fact that a native had built his hut directly under the wire, and when the hut accidently caught fire, the wire was softened and broke with the strain. The Acting Commissioner has now issued instructions to all the districts through which the line passes that natives should be advised not to build their huts within at least 10 yards of the telegraph track. The natives of Central Africa occasionally use the telegraph to send messages to each other in their own language.

Canada-Australia Proposed Cable.—In the House of Commons last Monday Mr. R. G. Webster asked the Secretary of State for the Colonies whether any further steps had been taken in regard to establishing a direct cable communication betwixt the Dominion of Canada and Australia, and if any papers would be laid upon the table on that subject. Mr. Chamberlain, in reply, said that the question was still under consideration, and no papers could then be laid.

Delays in Australian Telegrams.—In the Australian papers of last month, just to hand, we learn that on February 2nd, the following official message was received from Adelaide:—"Port Darwin line interrupted between Oodnadatta and Charlotte Waters. Line between Perth and Roebuck Bay working badly, and little prospect getting business that way." In consideration of the fact, which we have frequently pointed out, that there are only the two lines above referred to by which telegrams to Europe can be transmitted, the "prospect" of getting business through at all is none of the brightest.

Pacific Cable.—The Committee of the British Empire League, sitting at Ottawa on 11th inst., discussed the Pacific cable question, and a proposal was made for the creation of a trust under the authority of the several Governments concerned, with power to raise funds to establish and operate the line.

South American Cable Taxes.—According to the *Financial News* there seems to have been considerable discontent in the mercantile community in Brazil at the heavy tax which is placed by the Argentine Government on telegrams in transit from Brazil, *viâ* Buenos Ayres, to the west coast of South America. It has now been strongly urged upon the Brazilian Government that some retaliatory measures should be adopted, such as the placing of a heavy tax upon telegrams to or from the Argentine Republic. There is, of course, another way of meeting the difficulty—namely, the establishment of direct telegraphic communication across the continent from Rio de Janeiro to the west coast, without the detour through the Argentine Republic. But this is obviously an expensive expedient, and the other is being more strongly pressed upon the Brazilian Government.

The Telegraph Wire Export Trade.—February proved to be a fairly active month in the export trade of this country in telegraph wire and apparatus connected therewith. The exports for the month reached a total value of £75,276, as compared with only £37,929 in January last, and only £43,710 in the corresponding month of 1897. So far as the year has gone it shows a slight improvement over last year, but is still much below the activity recorded in the early months of 1896, the respective figures for the two months being, 1898, £113,205; 1897, £105,830, and 1896, £167,064.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1898 ...	...
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Paramaribo-Cayenne ...	Jan. 27th, 1898 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Cable beyond Obidos ...	March 9th, 1898. ...	...
Cyprus-Latakia	Feb. 10th, 1898 ...	...
Aden-Zanzibar	Feb. 28th, 1898 ...	March 4th, 1898.
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1898 ...	...
Cartagena-Barranquilla ...	July 4th, 1896 ...	...
Majunga-Tananarive ...	Feb. 28th, 1898 ...	March 6th, 1898.
" " ...	March 15th, 1898 ...	...
Saigon-Bangkok	" 2nd, 1898 ...	March 3rd, 1898.
" "	" 7th, 1898 ...	" 7th, 1898.
" "	" 9th, 1898 ...	" 12th, 1898.
" "	" 12th, 1898 ...	" 13th, 1898.
" "	" 14th, 1898 ...	" 15th, 1898.
" "	" 15th, 1898 ...	...
Bolinao-Manila-Laminos ...	" 9th, 1898 ...	...
Indo-European line ...	" 10th, 1898 ...	March 11th, 1898.

The Telephone Service.—It is announced that at the annual meeting of the Association of Municipal Corporations to be held at the Guildhall on Saturday, 26th inst., the City Solicitor will move: "That it is undesirable that the jurisdiction of local authorities over telephone companies should be curtailed or interfered with by the undue exercise by Her Majesty's Postmaster-General of his rights or privileges under the Telegraph Acts; and that a representation to this effect be made to Her Majesty's Government."

The Portsmouth Chamber of Commerce is persuading its local Members of Parliament to support the movement in the House of Commons to upset the present arrangement between the National Company and the Post Office.

The London County Council has before it a report of the Highways Committee with reference to the National Telephone

Company's underground works. During last year the Council consented, subject to certain conditions, to the placing underground of the company's system in connection with 14 exchange stations. These conditions were to be embodied in an agreement, but the Highways Committee, having given careful consideration to the draft agreement, have come to the conclusion that additional conditions ought now to be inserted to provide—(1) that the company should pay a rent in consideration of its user of the public streets, and (2) that the present charges to subscribers should be reduced to amounts which in the opinion of the Council's engineer would, in the event of the Council establishing an independent telephone service for London, amply repay expenses and, as the system was extended, might possibly be reduced by 15 or 20 per cent. A draft agreement embodying these provisions has been submitted to the company, who in a letter to the Council have pointed out that, with reference to the first proposal, the company has to obtain the consent not only of the Council, but of the road authority, which latter may impose conditions, and that the company cannot be expected to make payments both to the Council and to the road authorities in respect of wayleaves under the streets, and, further, that such requirements are inconsistent with the demand for a cheaper telephone service. As regards the second proposal the company declines to discuss it, but is prepared to consent, as it has done in the case of some provincial towns and cities, not to increase the present tariff of charges. The Highways Committee think there is some force in the company's representation with reference to the possible effect of the first proposal, and they state they have reluctantly decided, should the Council approve, not to press for the clause to be inserted in the agreement. As regards the second point, they are of opinion that it is advisable in the interests of the inhabitants of London that the principle should be insisted upon. They will accordingly ask the Council to insist on the retention of this clause in the agreement. The schedule attached to the clause sets out the tariff proposed by the Council. The charges are to be—on a five years' agreement, for first connection £12 a year, second and additional connections £10, and private houses £8 a year; on a yearly agreement, first connection £15 a year, second and additional connections £12-£10, and private houses £10 a year. These tariffs are to apply to an area of 609 square miles, which comprises the towns of Dartford, Redhill, Croydon, Epsom, Richmond and Kingston on the south of the Thames; and Tilbury, Woodford, Romford, Epping, West Ham, Harrow, Ealing and Hampton Court on the north.

The Bootle Town Council will support the proposals of the New Mutual Telephone Company.

The Brierley Hill and Colwyn Bay District Council also support the company's proposals.

Western and Brazilian Telegraph.—*Money* says that some idea of a possibly impending arrangement between the Western and Brazilian Telegraph and the Direct West India Cable Company was mooted in the market last week, with the result that Western and Brazilian ordinary shares have been put up.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belgium.—March 30th. Tenders are being invited by the municipal authorities of Ghent for the supply and erection, &c., of a complete installation for the electric lighting of the town dock. Particulars may be obtained from, and tenders to be sent to, l'Hotel de Ville, Ghent, Belgium.

Belgium.—April 1st. The Municipal Authorities of Seraing are inviting tenders for the concession for the supply of electrical energy in the town for public and private lighting purposes during a period of 30 years. Particulars may be had from, and tenders to be sent to, the College des Bourgmestre et Echevins, Seraing, Belgium.

Blackpool.—March 22nd. The Corporation wants tenders for a tubular boiler, superheaters, condensers, rectifiers, boosters, transformers, lead-covered cables, arc lamps and pillars. Borough electrical engineer, Mr. R. C. Quin. See our "Official Notices" February 25th.

Bournemouth.—The Corporation wants tenders for the electric lighting of the pier and pleasure grounds. Particulars *re* plant, &c., are given in our "Official Notices" this week. Borough engineer, Mr. F. W. Lacey.

Bournemouth.—April 4th. The Corporation wants tenders for motor vehicles for the collection of house refuse, &c. Borough engineer, Mr. F. W. Lacey. See our "Official Notices" this week.

Darwen.—March 28th. The Corporation wants tenders for the supply of steam engine and dynamos, piping, accumulators, switchboards, mains, arc lamps, pillars, &c. See our "Official Notices" March 11th.

Derby.—March 24th. The Corporation wants tenders for the electric wiring of the Lunatic Asylum and premises at Rowditch. See our "Official Notices" March 4th.

Derby.—April 12th. The Corporation wants tenders for the electric wiring of its Ford Street yard and premises. See our "Official Notices" this week.

Devizes.—March 21st. Tenders are wanted for the supply and delivery of two 40-kw. continuous current belt-driven dynamos for the Wilts County Asylum, Devizes. Engineers, Messrs. Massey & Allpress, 25, Queen Anne's Gate, Westminster. See our "Official Notices" March 4th.

Edinburgh.—March 22nd. The Council wants tenders for the additions and extensions to the electric lighting at the City Chambers. See our "Official Notices" March 11th, for particulars.

France.—March 30th. Tenders are being invited by the municipal authorities of Paris for the supply of the electrical conductors, required in connection with the electric lighting of the Square Vaugirard. Particulars may be had on application, and tenders to be sent, to l'Hotel de Ville, Paris.

France.—March 31st. Tenders are being invited by the Municipal Authorities of Saint Chamond (Loire) for the concession for the lighting of the public streets of the town, either by gas or electricity. Particulars from, and tenders to be sent to, La Mairie de Saint Chamond (Loire).

Hampstead.—March 31st. The Vestry wants tenders for the supply and erection of one or two steam alternators, switchboard panels, two induced draught wet back boilers, feed water heater, steam and exhaust pipes, feed pumps, 50 kw. exciter, and a feed water softener. See our "Official Notices" this week for full particulars.

Leyton.—April 4th. The District Council wants tenders for the supply of two dynamos, one transformer, two gas engines and connections, and switchboards for extension of the electricity works. Electrical engineer, Mr. H. C. Bishop. See our "Official Notices."

Plymouth.—March 23rd. The Corporation wants tenders for the supply of alternating current meters for the year ending March 31st, 1899. Particulars from Mr. J. H. Rider, Borough electrical engineer, East Street, Plymouth.

Spain.—March 21st. The Municipal Authorities of Santona (province of Santander) are inviting tenders for the concession for the electric lighting of the public streets of the town during a period of 20 years. Tenders to be sent to El Secretario del Ayuntamiento de Santona (Santander) from whence full particulars may be obtained.

Spain.—March 29th. Tenders are being invited by the municipal authorities of the town of Zafra (Badajoz province) for the concession for the electric lighting of the public streets during a period of 20 years. Particulars and conditions may be obtained from, and tenders to be sent to, El Secretario del Ayuntamiento de Zafra (Badajoz), Spain.

Switzerland.—April 30th. Plans and estimates are being invited, says the *Contract Recorder*, by the Government authorities of Fribourg, Switzerland, until April 30th next, for a projected electricity generating station to be established at Hauterine. Water-power is to be utilised, and the station will have a capacity of about 6,000 H.P. A premium of £120 will be awarded to the three schemes submitted which are considered to be the best. Plans and estimates are to be sent to the Department des Travaux Publics, Fribourg, Switzerland, from whence full particulars of the competition may be obtained.

The War Office.—April 27th. The Secretary of State for War is prepared to receive offers, competitive designs and specifications for the supply of portable electric search light apparatus. Particulars from the Director of Army Contracts, War Office, Pall Mall, S.W. See our "Official Notices" February 4th.

Victoria.—March 21st. The Telegraph Department of the Victorian Government Railways is inviting tenders for the supply of alternating current transformers and one main switchboard. Tenders to the Telegraph Superintendent's Office, Spencer Street, Melbourne.

Victoria.—June 24th. The Council of the city of Hawthorne (Colony of Victoria, Australia) is inviting tenders for the supply and erection of buildings, boilers, engines, dynamos, transformers, mains, meters, arc lamps, poles; also running the plant for three years. See our "Official Notices" March 11th.

CLOSED.

London, E.C.—The Court of Common Council has accepted the tender of Messrs. Ashwell and Nesbit for £145 9s. for installing the electric light in certain rooms in the Guildhall Library.

Newport.—The Council has accepted the tender of Messrs. W. T. Glover & Co. for £4,288 12s. 4d. for cables and underground work required for the extension of the electric lighting of the borough. The tender of the Electric Construction Company, Limited, at £661 for transformers, and that of Messrs. G. Smith and Co., Limited, Glasgow, for 30 arc lamps at £325 have also been accepted.

Portsmouth.—Mr. T. W. Quick's tender for the extension of the electric light station at £4,198 has been accepted by the Council. Other tenders have also been accepted for additional plant, including boilers, feed pumps, &c.

FORTHCOMING EVENTS.

1898.

Friday, March 18th.—State visit to the Northampton Institute for the purpose of inspecting it and formally declaring it open.

Saturday, March 19th.—E. E. Students' visit to the works of Messrs. Easton, Anderson and Goolden, Limited, Erith.

Monday, March 21st, at 8 p.m.—Society of Arts. Prof. W. Noel Hartley, F.R.S., on the "Thermo-Chemistry of the Bessemer Process," Lecture II. (Lecture III., March 28th.)

Yorkshire College Engineering Society. Annual general meeting.

Devizes electrical plant tenders. (Wilts County Asylum.)

Tuesday, March 22nd.—Blackpool Corporation electrical plant tenders.

Edinburgh electric lighting extensions tenders.

At 8 p.m.—The Institution of Civil Engineers (ordinary meeting). Further discussion on "Calcium Carbide and Acetylene," by Henry Fowler, Assoc.M.Inst.C.E.

Wednesday, March 23rd.—Plymouth Corporation electric meter tenders.

Thursday, March 24th, at 8 p.m.—The Institution of Electrical Engineers. "Cost of Generation and Distribution of Electrical Energy," by R. Hammond, member.

At 3 p.m. — Royal Institution. Prof. J. A. Fleming's fourth lecture, "Recent Researches in Magnetism and Dia-magnetism." (Lecture V., March 31st.)

Derby Asylum wiring tenders.

Friday, March 25th, at 8 p.m.—The Institution of Civil Engineers (students' meeting). "Internal Governor Friction," by H. O. Eurich, Stud.Inst.C.E.

At 5 p.m.—Physical Society at the rooms of the Chemical Society, Burlington House. (1) "On the Circulation of the Residual Gaseous Matter in a Crookes Tube," by Mr. A. A. Campbell Swinton. (2) "On some Improvements in the Roberts Austin Recording Pyrometer, and Notes on Thermo-electric Pyrometers," by Mr. A. Stansfield.

At 8 p.m.—Electro-Harmonic Society. Smoking Concert at St. James's Hall Restaurant.

Wednesday, March 30th, at 8 p.m.—Society of Arts. Prof. S. P. Thompson, on "Telegraphy Across Space." Mr. J. W. Swan, F.R.S., will preside.

Royal United Service Institution. Captain J. N. C. Kennedy on "Wireless Telegraphy."

NOTES.

Obituary.—Our readers will have heard with regret of the death of Sir Henry Bessemer, which occurred on Tuesday evening at his residence at Denmark Hill. Sir Henry was in his 86th year, he being born at Charlton, Hertfordshire, in 1813. His name will ever be remembered in connection with his process for the conversion of cast-iron into cheap steel, and the great difficulties he encountered in introducing his process are well-known matters of history. Wednesday's *Times* contains an interesting two-column notice of Sir Henry's life. The first recognition of Bessemer's work came from the Institution of Civil Engineers, in the shape of the gold Telford medal in 1859. In 1871—73 he was president of the Iron and Steel Institute, and founded a gold medal to be given annually for the most important improvement of the year in the manufacture of iron or steel. The Society of Arts awarded him the Albert gold medal in 1872, and in 1877 the Civil Engineers made him a member of their body, at the same time presenting him with the first Howard quinquennial prize. Two years later he became a Fellow of the Royal Society, and received the honour of knighthood, while in 1880 he was presented with the freedom of the City of London. From abroad he received many honours. He was offered the Grand Cross of the Legion of Honour, but, as permission to wear it was refused, he had to be content with a large gold medal given him by Napoleon III. He was an honorary member of the Iron and Steel Board of Sweden, a freeman of the City of Hamburg, an honorary member and gold medalist of the Society of Arts and Manufacturers of Berlin, and a Grand Cross of the Order of H.I.M. Francis Joseph of Austria. It will be remembered that Lady Bessemer died last year.

Mr. Main, a native of Aberdeen, whose untimely end we announced in our last issue, was best known to the electrical world as the inventor of the arc lamp known as the Fyfe-Main. This lamp he patented in 1881 in conjunction with Mr. A. L. Fyfe, and it appeared about the time when the early fever for electric lighting was at its height. A sum was offered for the patent which would have been a small fortune for the owners, but, unfortunately, a hitch occurred in the negotiations, the opportunity passed, and Mr. Main never received anything for his valuable invention, except the ordinary manufacturers' profits for the lamps he made in his own small workshop. For the 17 years preceding the invention of the Jablochkoff candle, the Serrin lamp was the only lamp capable of giving a decently steady arc light, but its mechanism was too complicated, and its working not quite steady enough for public lighting. Mr. Main unconsciously designed his lamp on the same general principles as the Serrin, but he immensely simplified the mechanism by lifting the feeding train bodily when the arc was made, and thereby doing away with the parallel motion in the Serrin. The Fyfe-Main lamp is in use for lighting the leading newspaper offices in London, including the *Daily Telegraph*, *Standard*, and *Daily News*, and also in the brilliant example of street lighting at Electric Avenue, Brixton. Anyone who has seen this lamp will admit that it is one of the steadiest and most reliable lamps in use. Mr. Main combined great inventive and mechanical skill with a sort of intuitive knowledge of the principles underlying his mechanical creations. He was the ideal man for the inventor with an idea and an insufficiency of mechanical skill to translate his idea into practice, and many well known men have owed much of their success to his valuable assistance. One of Mr. Main's recent patents is a revolving gas lamp for advertising and show purposes. The large glass case surrounding the gas jets is slowly revolved by the action of the heated air upon a light fan or turbine mounted in the frame above the gas jets. Simple as this problem may seem, it appears to have never been practically solved till Mr. Main, after much trial and many failures, made it a complete practical success. Mr. Main's estimate of his own abilities was too modest to allow him to advertise himself, but his sterling qualities were known and appreciated by his intimate friends.

The International Ohm.—The *Elektrotechnische Zeitschrift* states that in view of the impending publication of the Bill concerning electrical units of measurement, the German Imperial Post Office authorities have resolved to introduce the ohm in place of the Siemens unit. In future all new apparatus and measuring instruments will be standardised in ohms. Existing curved handled rheostats and resistances used in connection therewith will at once be regauged, whilst other apparatus and instruments will be similarly dealt with on being sent to the workshops for repairs as occasion may arise. Statements of resistances in official reports will in future always be expressed in ohms.

Mean Horizontal Candle-Power.—The mean horizontal candle-power of an incandescent lamp is usually taken as the measure of the light emitted. This, says New York *Electricity*, is perhaps the best measurement to take, but with certain of the new types of filaments will have to be replaced by the mean spherical candle-power. The mean horizontal candle-power can be obtained either by the laborious method of taking a large number of readings at different angles, or by spinning the lamp so as to obtain optically the mean candle-power. There have been doubts, though, on this spinning process as to whether it will give accurate results. Deformation of the filament, due to centrifugal force, would be the most likely cause of error, if any. Mr. C. P. Matthews contributes an article on this subject to a recent number of the *Physical Review*. His experiments were carried out at the Purdue University, and show conclusively that no such error exists. Thus the whirling lamp gave a mean horizontal candle-power of 9·649, while the figures obtained by plotting the series of readings for different angles and integrating the curve was 9·655 C.P. This shows an error of ·06 per cent. only, which is very well within the limits of photometric accuracy.

Electrical Energy (Generating Stations and Supply).—In the House of Commons on Thursday last week, the Earl of Morley moved:—"That it is desirable that a Select Committee be appointed to join with a committee of the House of Commons to consider and report—1. Whether, notwithstanding the provisions of Section 12 (1) of the Electric Lighting Act, 1882, powers should be given in any cases for acquiring land compulsorily for generating stations; and, if so, under what conditions as respects liability for nuisance, notices to surrounding owners, and otherwise. 2. Whether compulsory powers of acquiring land for generating stations, if proper to be given in any case, should be given where the proposed site is not within the area of supply. 3. Whether, in case of a generating station, however acquired, not being situate within the area of supply, power should be given for the breaking up of streets between the generating station and the boundary of the area of supply. 4. Whether powers should be given in any case for the supply of electrical energy over an area including districts of numerous local authorities, involving plant of exceptional dimensions and high voltage; and, if such powers may properly be given, whether any, and what, conditions should be imposed—(*a*) With respect to system and plant, and to the construction and location of generating stations, in view of the powers of purchase conferred upon local authorities by Sections 2 and 3 of the Electric Lighting Act, 1888; (*b*) with respect to the relations of the promoters to other undertakers, and to local authorities within parts of the area. 5. Under what conditions (if any) ought powers to be conferred upon promoters seeking to supply electrical energy to other undertakers and not directly to consumers." The motion was agreed to.

The House of Commons had the matter brought before it on Monday, and concurred in the House of Lords' resolution referring the question to a Joint Committee of both Houses. On Tuesday the House of Lords appointed the following peers to represent the House on the Joint Committee:—Lord Cross, Lord Spencer, Lord Knutsford and Lord Monkswell.

Engineers' Strike.—With reference to the statement in our last issue that the Employers' Federation had returned Messrs. Tangye's cheque for £500, Sir Richard Tangye writes a long letter to the *Standard*, remarking that the statement is wholly misleading, and setting forth the facts of the case. We extract the following from his letter:—

. . . . At the end of January last we were urgently invited to contribute to the Engineer Employers' Special Fund, on the ground of the heavy strain which had been imposed upon the employers in the recent struggle. On February 10th my company contributed the sum of £500 to the fund. . . . So far from being "at once" returned, the cheque was cashed and paid into the fund, and an acknowledgment sent us by the Federation . . . . . under date February 11th. . . . .

On February 28th—*i.e.*, 17 days after this acknowledgment—Mr. Biggart, the secretary, sent us a banker's draft for £500, with a letter, in which he says: "We have now had an opportunity of reporting your contribution of £500 to our Committee. This is the first meeting held since your cheque was received." He goes on to say his first letter was sent *per incuriam*, but as it contained the distinct statement that he had been desired by his committee to thank us, the explanation of this extraordinary discrepancy must be left to that gentleman. I should explain that long before we gave our contribution to the Federation it was well known to every member of that body that we were not in sympathy with their policy. This fact we expressly stated at an early period of the struggle, and again laid stress upon when handing over our cheque. It was, therefore, with this knowledge that the Federation accepted and thanked us for the gift we had been invited to make. With their reasons for subsequently reversing their own action I am not concerned. . . . .

Manchester Explosion.—At 9 p.m. on 9th inst., an explosion occurred in the roadway at the junction of Withy Grove and Corporation Street, Manchester. A portion of the footpath was blown up, some of the flags being sent through a shop window. We understand that the explosion was due to the ignition of an explosive mixture of coal gas in one of the Corporation electric light junction boxes, and a 6-inch pipe communicating therewith. The mixture was fired, as far as can be ascertained, by a spark due to the failure of some rubber cables in the pipe about 200 yards away. No person was hurt, but several panes of glass were broken.

Institution of Junior Engineers' Conversazione.—The conversazione of the Institution of Junior Engineers was held on Saturday last, 12th inst., at the Westminster Palace Hotel. The gathering was opened by a reception in the large hall by the president (Mr. Aspinall), and Mrs. Aspinall, and the chairman (Mr. H. Bloomfield Vorley) and Mrs. Vorley. An excellent programme of music was executed in the large hall by Mr. W. M. Day's band, and in the music room, the Poppy Pierrot troupe rendered a selection of vocal pieces. Among the numerous items with which the company was entertained, were demonstrations by Mr. Leslie Miller, on signalling without wires, and some instructive and pleasing lecturettes on the Maxim gun by Mr. Hiram S. Maxim. Messrs. J. Thornycroft & Co. showed in operation, during the evening, a model Thornycroft water tube boiler; Messrs. Thorn & Hoddle showed acetylene gas apparatus, including "Incanto" generators; Mr. R. J. Wallis-Jones (Electric Welding Company) exhibited specimens of electric welding work; and Mr. Arthur Rigg showed the variable-stroke hydraulic engine, of which he is the inventor. Mr. J. A. Prestwich's cinematograph displays were, of course, well received, and good use was made of the electrophone room, where, through the courtesy of the Electrophone Company and the National Telephone Company, 16 instruments connected to the various theatres were available. There were also a large number of exhibits in the various halls, and we select for mention models and photographs of a Babcock & Wilcox land boiler; models of Great Eastern Railway locomotive boiler, and parts, liquid fuel injector, express engine, paddle steamer, &c., by Mr. James Holden; photographs of Lancashire and Yorkshire Railway, from the president; Maxim guns, projectiles, &c., from Mr. Maxim; stereoscopic figures of spherical catenaries, &c., shown by Prof. A. G. Greenhill (vice-president) and Mr. T. J. Dewar; also sections, drawings, &c., of the Westinghouse electro-pneumatic signalling apparatus, lent by the Westinghouse Brake Company. A large number of members and friends were present, and an enjoyable evening was spent.

Accumulator Testing.—The following reached us too late for insertion in our "Correspondence" columns:—"In reference to 'Appak's' remarks, your correspondent desires to say that 'Appak' has not comprehended the meaning of the remarks about calculating weight of cells from results of tests on one positive. It is quite easy and accurate to calculate the weight of a 17-plate cell, given the weight of plates and capacity of a 3-plate cell. And also knowing that cells increase in capacity per pound as the plates increase in number up to a certain limit, as shown by an interesting curve in ELECTRICAL REVIEW of December 10th, 1897. 'Appak' may not be able to make these calculations, but your correspondent can, and so can many others. The little experiment with eight plates suggested by 'Appak' is an ancient one, and only proves what is well known, *i.e.*, a 3-plate cell has about half the capacity per pound that a 5-plate has—a fact which does not at all prove that by taking the results of a test on a 3-plate cell we cannot calculate what would be the capacity per pound of the 5-plate cell.—YOUR CORRESPONDENT."

The Electric Cab Mishap.—With reference to the reported burning of an electric cab at Westminster, regarding which the daily press, as usual, made such sensational statements, we learn from Mr. Bersey, of the London Electrical Cab Company, that the cab in question was the one which has been running for the *Daily Graphic* for six months, and during the whole of that time has only stopped one day in order to have fresh rubber tyres put on. What happened on Tuesday was, that the insulation on the wires running under the body between the motor and the controlling switch got rubbed off, and consequently caused a short circuit, and some sparking between the wires. This went on for some little time, until it affected some of the lead connections on the cells, causing them to fuse and melt. Immediately this happened, of course everything stopped, as there was no longer a connection between the cells. There was no question of burning, or the cab being on fire whatever. We understand that the cab was running again on Tuesday night after a delay of only a few hours.

Buckingham Palace Lighting.—In the Civil Service estimates for the coming year, under the heading of Royal Palaces, there is an item of £3,500 for beginning the installation of the electric light at Buckingham Palace.

Lectures.—Mr. George Balfour, A.I.E.E., delivered an illustrated lecture on "Electric Tramways and Railways," in the Gilfillan Hall, Dundee, on 11th inst. A number of town councillors were present, and the Lord Provost presided.

Mr. J. E. Lloyd Barnes, M.I.M.E., was to lecture on Wednesday at the Town Hall, Birkenhead, on "Electric Traction."

On 8th inst. the Right Rev. Monsignor Molloy lectured at the new theatre of the Leinster Hall, Dublin, on "Wireless Telegraphy."

Pacific Cable.—Reuter says that the New Zealand Government regards as premature the proposal of the Eastern Telegraph Company in the matter of the guarantee, and favours the Pacific cable scheme.

Forthcoming Marriage.—A marriage has been arranged, and will shortly take place, between Mr. J. G. Butcher, Q.C., M.P., and Mrs. J. E. H. Gordon, widow of the late Mr. J. E. H. Gordon, who was so well known to the electrical fraternity all over the world.

NEW COMPANY REGISTERED.

British Automotive Proprietary Syndicate, Limited (56,357).—Registered March 4th with capital £55,000 in £1 shares, to adopt an agreement with Automotive Syndicate, Limited, and to manufacture, sell, and deal in electric, steam, gas, oil, and other motors and engines. The subscribers (with one share each) are:—T. E. Garlick, 17, Basinghall Street, E.C., chartered accountant; M. Warren, 17, Basinghall Street, E.C., clerk; W. P. Westell, St. Albans, clerk; J. Lewis, 17, Basinghall Street, E.C., clerk; J. M. Lewers, 17, Basinghall Street, E.C., clerk; C. E. Darling, Longdon Hall, Rugeley, clerk; G. Taylor, 60, Dyne Road, Brendesbury, clerk. The number of directors is not to be less than three, nor more than seven. The subscribers are to appoint the first. Qualification, £100; remuneration, £100 each per annum (£150 for chairman), and a percentage of the profits. Registered by Marshall & Marshall, 3, Lincoln's Inn Fields, W.C.

CITY NOTES.

Notting Hill Electric Lighting Company.

Probably no company in London engaged in the electric lighting business has shown better progress than the Notting Hill Company. For the year 1894 a microscopical dividend of 2s. per share was paid on each £10 share; in 1895 this had advanced to 2 per cent; last year 4 per cent. was returned to the ordinary shareholders, and for the year 1897 a handsome dividend of 6 per cent. has been declared. The success of this company is all the more noteworthy, because it was generally held that the district in which its operations were confined was one of the least favourable in London for an electric lighting concern.

The following shows the increase in the various accounts for the past year:—

Increase.

Capital expenditure.	Output in units.	Working expenses.	Revenue from sale of current.
£14,079	124,182	£1,016	£2,864

The following table gives the cost per unit:—

	1897.	1896.
Total capital expended	£113,184	£99,105
Number of units sold	354,969	230,787
Number of lamps connected	—	25,718
Revenue from sale of current	£10,230	£7,366
Net revenue	£6,854	£4,736
Average price obtained per unit ...	6·9d.	7·59d.

Cost of Production.	£		Per unit.	1896.
Coal	982		·66d.	·71d.
Oil, waste, water, and engine room stores	138		·09d.	·18d.
Salaries and wages at generating station	485		·33d.	·43d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	648	Works' cost 1·52d.	·44d.	·47d.
Rent, rates and taxes	129		·09d.	—
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges and insurance	1,976		1·34d.	1·69d.
Depreciation of buildings and plant account	—		—	—
Renewal fund account	—		—	—
Total	£4,358		2·95d.	3·48d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	10,230	0	0	6·9d.
Meter rents, &c.	519	0	0	—
Supply of steam	—			—
Transfer fees	36	0	0	—
Total	£10,785	0	0	6·9d.

Total cost per unit (exclusive of depreciation and renewal accounts), 2·95d.; works' cost, 1·52d.

St. James's and Pall Mall Electric Lighting Company.

The principal features of the year's work are already familiar to our readers, but a closer examination of the accounts reveals one or two interesting points. The capital expenditure has been increased by a little over £12,000, but the output has advanced from 2,401,431 to 3,028,242 units—an increase of 626,811. The items in the cost of production are, perhaps, not quite as pleasing as last year, though the total cost is slightly less. Repairs and maintenance, during the year have been exceptional, and stand at £5,104, against £2,886 for 1896.

The following table gives the cost per unit:—

	1897.	1896.
Total capital expended	£254,077	£241,328
Number of units sold	3,028,242	2,401,431
Number of lamps connected	126,827	108,803
Revenue from sale of current	£66,376	£53,967
Net revenue	£30,534	£25,339
Average price obtained per unit	5·26d.	5·39d.

Cost of production.	£		Per unit.	1896.
Coal	6,514		·52d.	·50d.
Oil, waste, water and engine room stores	922		·07d.	·08d.
Salaries and wages at generating station	5,324		·42d.	·47d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	5,104	Works' cost 1·41d.	·40d.	·29d.
Rent, Rates and taxes	2,573		·20d.	·22d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	7,400		·59d.	·67d.
Depreciation of buildings and plant account	—		—	—
Renewal fund account	—		—	—
Total	£27,837		2·20d.	2·23d.

Not included in above.

Depreciation on plant, buildings, &c.	£9,270
Miscellaneous expenses	112

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	66,376	0	0	5·26d.
Meter rents, &c.	1,529	0	0	—
Supply of steam	80	0	0	—
Other items	155	0	0	—
Total	£68,140	0	0	5·26d.

Total cost per unit (exclusive of depreciation and renewal accounts), 2·20d.; works' cost, 1·41d.

Development of Electric Lighting in London.

We give the following from the *Daily Mail* for what it is worth:—The St. James's and Westminster Electric Lighting Companies are asking for powers this session to build a joint station on some land near North Bank, St. John's Wood. It belongs to the Great Central Railway, and the idea of the companies is to relieve the stations at Carnaby Street and Davies Street. It is understood that the sole object of the acquisition is to assist the purposes of the joint companies, and not for competition with other electric light concerns, a rumour to which effect has been of late current. In two years' time both the other stations would be overloaded, and by then the new station is expected to be ready. We should not, however, be surprised to find that an assault was intended upon one of the electric lighting companies, which has hitherto endeavoured to have things very much its own way.

Kensington and Knightsbridge Electric Lighting Company.

The report for the year shows steady and substantial progress. The chairman of the company at the annual meeting referred to a feature in the development of the company's business that appears to us a most encouraging one. There had been an increase in the number of consumers over that of the previous year, although the total increase of lamps was not as large as in the year 1896. This seems to indicate that electric lighting is extending among the less wealthy class of customer, and this is distinctly satisfactory, for it is hardly necessary to point out nowadays that the consumer who keeps a small number of lamps burning long hours is one to be encouraged.

The expenditure for the year is a matter of some £22,000, nearly £17,000 of which has been spent on machinery and buildings. The increase in the output is 383,633 units, which has been obtained by an increase in the total cost of production of £3,216; the gross profits, however, showed an advance from £34,371 to £41,681, practically £7,309. The following table shows the increase:—

Output.	Capital expenditure.	Working costs.	Gross profits.
383,633 units.	£21,997	£3,216	£7,309

The following table gives the cost per unit:—

	1897.	1896.
Total capital expended	£252,162	£230,164
Number of units sold	1,898,362	—
Number of lamps connected ...	137,955	119,950
Revenue from sale of current ...	£41,681	£34,371
Net revenue	£14,639	—
Average price obtained per unit ...	5·25d.	—

Cost of Production.	£		Per unit.	1896.
Coal	5,468		·69d.	—
Oil, waste, water, and engine room stores	909		·12d.	—
Salaries and wages at generating station	3,605		·46d.	—
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	3,521	{Works' cost 1·69d.}	·45d.	—
Rent, rates and taxes	2,597		·33d.	—
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	3,928		·50d.	—
Depreciation of buildings and plant account	—		—	—
Renewal fund account	—		—	—
Total	£20,023		2·55d.	

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	41,681	0	0	5·25d.
Meter rents, &c.	1,323	0	0	—
Supply of steam	—			—
Transfer fees	—			—
Other items	17	0	0	—
Total	£43,021	0	0	5·25d.

Total cost per unit (exclusive of depreciation and renewal accounts), 2·55d.; works' cost, 1·69d.

Charing Cross and Strand Electricity Supply Corporation, Limited.

There has been no abatement of prosperity during the past year, and the Charing Cross Corporation may be now ranked among the soundest of the metropolitan supply companies. 34,078 additional lamps have been connected to the mains, an increase of 53·7 per cent. on the lamps connected in 1896. The output also shows a considerable increase upon that of 1896; in fact, some 33⅓ per cent. The capital expenditure for the past 12 months has been, however, somewhat heavy, being, in fact, £48,166. Of this sum, £24,693 has been spent on machinery, £12,017 on mains, and £5,806 on buildings, so it may be taken for granted that the full benefit of this additional expenditure has not yet been realised.

The following table shows the increase:—

Capital expenditure.	Output in units.	Cost of production.	Increase in gross revenue.
£48,166	671.108	£6,283	£9,922

It will be noted that the total cost of production per unit is identical with the figures for last year. Although the item for fuel is higher than last year, we may expect that, when the system is in complete working order, it will be very much reduced.

The following table gives the cost per unit:—

	1897.	1896.
Total capital expended	£357,770	£309,604
Number of units sold	2,615,508	1,944,402
Number of lamps connected	107,522	73,464
Revenue from sale of current	£48,027	£38,105
Net revenue	£18,907	£15,289
Average price obtained per unit ...	4·4d.	4·69d.

Cost of Production.	£		Per unit.	1896.
Coal	10,349		·95d.	·87d.
Oil, waste, water, and engine room stores	997		·09d.	·08d.
Salaries and wages at generating station	5,110		·47d.	·46d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	2,308	{Works' cost 1·72d.}	·21d.	·26d.
Rent, rates and taxes	2,467		·23d.	·25d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges and insurance	3,494		·32d.	·35d.
Depreciation of buildings and plant account	—		—	—
Renewal fund account	—		—	—
Total	£24,725		2·27d.	2 27d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	48,027	0	0	4·4d.
Meter rents, &c.	582	0	0	—
Supply of steam	—			—
Transfer fees	—			—
Other items	272	0	0	—
Total	£48,881	0	0	4·4d.

Total cost per unit (exclusive of depreciation and renewal accounts), 2·27d.; works' cost, 1·72d.

Dover Electricity Supply Company.

It is yet too early for the accounts of this company to show any beneficial results from the supply of electrical energy for the municipal tramways. It will be doubtless remembered that an agreement exists between this company and the Dover Corporation for the supply of electricity for tramway purposes, on what are undoubtedly favourable terms, as far as the company is concerned. The tramways, however, did not commence to to run before September, consequently, one cannot expect that the company has yet realised to what extent their position will be improved. It is significant, however, that the number of units sold has increased from 154,200 to 234,074, though the lamps that have been added to the circuits, 2,233, are no doubt in a great measure responsible for the increased consumption. The accounts for 1898 will be distinctly interesting, for they will reveal the practical advantages that are likely to accrue from the combined supply of electricity for lighting and tramway purposes. The following table shows the increase in capital, working costs, and output:—

INCREASE.

Capital expenditure.	Output in units.	Working expenses.	Revenue from sale of current.
£11,932	79 874	£892	£2,385

The following table gives the cost per unit:—

	1897.	1896.
Total capital expended	**£62,836**	£50,904
Number of units sold	**234,074**	154,200
Number of lamps connected	**10,187**	7,904
Revenue from sale of current	**£5,059**	£2,674
Net revenue	**£1,178**	—
Average price obtained per unit	**5·16d.**	4·14d.

Cost of production.	£		Per unit.	1896.
Coal	1,631		1·67d.	1·62d.
Oil, waste, water, and engine room stores	160		·16d.	·15d.
Salaries and wages at generating station	1,004		1·03d.	1·43d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	439	Works cost 2·30d.	·45d.	·27d.
Rent, rates and taxes	115		·12d.	·18d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	721		·74d.	1·27d.
Depreciation of buildings and plant account	—		—	—
Renewal fund account	—		—	—
Total	£4,070		4·17d.	4·92d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	5,059	0	0	5·16d.
Meter rents, &c.	114	0	0	—
Supply of steam	—			—
Transfer fees	—			—
Other items	74	0	0	—
Total	£5,247	0	0	5·16d.

Total cost per unit (exclusive of depreciation and renewal accounts), 4·17d.; works' cost, 2·30d.

County of London and Brush Provincial Electric Lighting Company, Limited.

THE fourth annual meeting of this company was held on Monday at Winchester House, Lord Rathmore presiding.

The CHAIRMAN congratulated the shareholders on the steady progress which had been made by the company since their last meeting, on the good position in which they stood, and on the encouraging prospect which seemed to be opening for them. The net revenue for 1897 amounted to £20,875, as against £5,904 in 1896, while the gross receipts had increased from £8,485 to £25,371. A large proportion of these receipts arose from profits on investments realised. They had derived already a substantial profit from their London stations, amounting to £2,521 from St. Luke's and to £1,281 from Wandsworth. When they remembered what exceptional difficulties they experienced in the preparatory stages, and bore in mind that their two stations were only started for the supply of current during the past year—in the case of St. Luke's so recently as September last—those earnings were on the whole as large as they could reasonably have expected. The remainder of the ordinary share capital had been issued, making the total of capital paid £509,808, and leaving £90,000 which fell due this year. A substantial premium was received on the second issue of the ordinary shares, and this was applied to reducing the preliminary expenses, writing off costs in connection with provisional orders, and in increasing their reserve fund, which now stood at £5,000. The loans against security had been reduced from £53,600 in 1896 to £29,700, The sundry creditors amounted to £58,344, which was nearly all represented by plant, machinery, and cables, and was more than covered by the amount of sundry debtors on the other side of the balance-sheet. As to the assets, a further sum of £141,066 had been invested in their London districts. The preliminary expenses, which stood in 1895 at £18,478, had been reduced from time to time, and now amounted to only £8,800. As to their investments, some changes had occurred during the year, the most important of which was, that they had disposed of their interest in the Bournemouth station. The sundry debtors amounted to £71,545. This was largely in respect of their interest in the Bournemouth and district company, and it had now nearly all been collected. Their metropolitan stations were those to which they looked for their largest profits in the future. They retained an interest in the Bournemouth district, represented by ordinary shares. In the Dover company they still held practically the whole of the ordinary shares, and there seemed to be a good future before it. A dividend of 3 per cent. had been paid on the share capital of the Richmond company, and the whole of this dividend had gone into this company's coffers. The broad policy adopted by the company from the first in dealing with electrical supply for the County of London had been the establishment of two large generating stations—one on the north side and one on the south side of the river—each capable of meeting the wants not only of its immediate neighbourhood, but also of supplying the requirements of other localities for which they had hoped to obtain lighting orders. At the present moment they had by far the largest area of any electric lighting company in London. Their plan was based on the belief that such a policy would be found to be more economical and satisfactory than that of setting up smaller generating stations. He ventured to suggest to the vestries of the smaller areas of London who might be now thinking of embarking on electric lighting schemes of their own to ponder whether it might not be wiser to supply their wants in that direction by means of established companies—their own, for instance, which, owing to its larger preparations for business and its special technical experience, must be able, presumably, to give a more satisfactory supply, and at moderate rates, without any material reduction of its just profits. They had erected a fine station in the City Road, adjoining the Regent's Canal, so that the carriage of their coal and other material would be cheap and easy. The building at St. Luke's was finished, and the plant installed there was capable of supplying the equivalent of 80,000 8-candle-power lamps connected. They had good ground, he thought, for expecting that the demand for electric light in the St. Luke's and Clerkenwell district would steadily increase. For the eastern portion of Holborn the provisional order was confirmed to them in the last session of Parliament, and work having been at once commenced, current was now available. As to the western portion of Holborn, and also St. Giles-in-the-Fields, they had secured the consent of the local authorities to their application for provisional orders, which now awaited the sanction of Parliament. There were several other districts on the north side of the Thames and in the East-end of London, into some of which they had already obtained, while for others they were seeking the necessary authority to enter, and all of which they would be able to supply for years to come from their station in the City Road. So far he had been speaking of electric lighting only; but they were confirmed in their anticipations of a large demand also in those districts for a supply of electric current for motive power. Special mains for the supply of such current had been laid throughout the principal thoroughfares, and he believed that all preparations had been completed, and that that evening the batteries would be charged for the service. Their Wandsworth station was completed, and the plant now installed there had a capacity of supplying more than 40,000 8-candle lamps power connected, while there was space in the building for machinery to supply three times that number. From that vast area a very encouraging demand had already sprung up; and in Camberwell there was already a considerable demand for motive power as well as for electric lighting. The policy involved, no doubt, heavy capital expenditure at first and a certain delay in obtaining a substantial revenue in return, but they had done with large capital expenditure for years to come. They had paid no dividend yet on their ordinary shares. When, however, they allotted 10,000 ordinary £10 shares last December, their market value was £15, and they were allotted at par to their ordinary shareholders in the proportion of one share for three already held, and this was equal to a dividend of about 5 per cent. for the last three years.

Mr. J. B. BRAITHWAITE, jun., seconded the adoption of the report, which was adopted.

A resolution increasing the directors' remuneration to £2,000 for 1898 was then carried.

The Oxford Electric Company, Limited.

THE report of the directors states that the revenue account shows a profit for the year of £3,996 17s. 5d., to which has to be added £13 17s. 6d. (the difference between the receipts from share premiums and the expenses attending the redemption of the old debentures) and £537 7s. 6d., the amount brought forward from last year's account making a total of £4,548 2s. 5d. After deducting £202 15s. 2d. on account of the expenses attending issue of debenture capital, and providing £1,499 1s. 10d. for debenture and loan interest, the available balance is £2,846 5s. 5d., which the directors propose to appropriate as follows:—£500 to a fund to provide for future renewals of machinery and plant, and £2,327 8s. in payment of a dividend at the rate of 5 per cent. per annum upon the capital (the new shares issued in March ranking for dividend, as provided by the prospectus, from the average date of payment of the instalments thereon), leaving a balance of £18 17s. 5d. to be carried forward to next year's account. The £25,000 of 5 per cent. debentures outstanding at the date of last accounts have been redeemed at a bonus of 5 per cent., and replaced by an issue of £35,000 debenture stock at 4 per cent. interest. The premiums received on a further issue of 2,000 shares made in March last exceeded the bonus paid on the redemption of the debentures by £13 17s. 6d., which has been carried to the revenue account. The expenses attending the issue of the new debentures, including the sum of £79 10s. which previously stood to the debit of capital account, amount to £608 5s. 6d., whereof £202 15s. 2d. had been debited to the revenue of the year, and the balance carried forward, to be liquidated out of the revenue of the next two years. The gross receipts have been to some extent affected by a reduction in the price of current to consumers as from January 1st, 1897, but the directors confidently expect that this liberal policy will yield advantageous results in the near future. Since the last report 2,630 8-C.P. lamps or the equivalent, have been connected with the mains, bringing the total on December 31st last up to the equivalent of 21,364 8-C.P. lamps. The plant at the generating station has been increased during the year by a 500-H.P. engine and a boiler of 200-H.P. capacity. A new transformer station has also been equipped in Ship Street, and two additional transformers connected to the system. A line of 3-inch iron pipes has been laid from the works at Osney to a central position in the city, to provide for extensions of the high tension feeding system, and to enable the supply to be controlled entirely from the works. The cost of these additions to plant and extensions has been provided by the proceeds of the 2,000 shares issued during the year.

Chelsea Electricity Supply Company, Limited.

The directors' report states that in October, 1897, an issue of 8,000 ordinary shares of £5 each was made, and was fully subscribed. The final instalment on these shares, due on January 1st, 1898, has now been paid, and a Stock Exchange quotation for the new issue has been applied for. The balance of premium received in 1897 in respect of this issue, after deducting the expenses of issue, amounts to £21,983 5s. 6d., and, following the course adopted in the accounts of previous years, a portion of this has been applied to the extinction of the legal and other extraordinary expenses incurred during the year. The balance remaining, £20,851 15s. 5d., has been placed to the reserve fund, making the total of that fund £36,717 9s. 5d. The sum of £2,000 has been added to the renewals and depreciation fund, out of the net revenue. After deducting this amount, and after payment of interest on debenture stock (£2,700), there remains a balance available for distribution of £11,344 5s. 2d., including £1,526 17s. 4d. brought forward from last year.

The directors recommend that this balance shall be applied as under:—

	£	s.	d.
Interim dividend of 6 per cent. per annum on the preference shares for the half-year to June 30th, 1897 (paid July 1st, 1897)	900	0	0
Interim dividend on 26,000 ordinary shares for the half-year to June 30th, 1897, at the rate of 5 per cent. per annum (paid July 1st, 1897)	3,250	0	0
Dividend of 6 per cent. per annum on the preference shares for the half-year, to December 31st, 1897 ...	900	0	0
Dividend on 26,000 ordinary shares for the half-year to December 31st, 1897, at the rate of 7 per cent. per annum, making a total dividend of 6 per cent. for the year	4,550	0	0
Dividend at the rate of 6 per cent. per annum on the instalments of £1 per share from the due date of the instalment to December 31st, 1897, on the new issue of 8,000 shares	92	1	1
Balance to be carried to next account	1,652	4	1
	£11,344	5	2

The number of lamps connected on December 31st, 1897, was 96,638, an addition of 16,178 during the year. A large part of the capital expenditure has been incurred in the purchase of freehold land in Pavilion Road, and building thereon a substantial sub-station, in the extension of the new generating station at Alpha Place, and also in the purchase of some leasehold property. Considerable amounts have also been spent on generating machinery and on mains to supply the increase in demand.

At an extraordinary general meeting, held on February 2nd last, the shareholders confirmed their approval of a Bill for the compulsory purchase of certain properties required for the development of the business.

House-to-House Electric Light Supply Company.

The tenth ordinary general meeting of the shareholders of the above company was held on Friday last at Winchester House, Old Broad Street, Mr. Henry Ranire Beeton (the chairman) presiding.

The report and accounts having been taken as read, the Chairman said: Gentlemen, in moving the adoption of the report and accounts, I should like to call attention to the fact that the satisfactory features which have characterised the working of our undertaking of late years, have repeated themselves during the past year. The extension in the demand for electricity has continued undiminished, and a further reduction in the cost of production has been effected; so that our increased revenue has again been earned without any appreciable addition to our expenditure, and the increase of profit is larger than in any previous year in the company's history. In regard to the future, the applications so far received from new consumers during the current year exceed those received at the corresponding date last year, and although the cost of production cannot be indefinitely reduced, there is no reason to believe that finality has been reached in this particular. In order to obtain the satisfactory results which our accounts disclose, we have had to adopt, wherever it was possible to do so, the best machinery and methods which advancing experience has made available. This is no reflection upon our system of supply, which, I think, we are justified in regarding as the best suited to a district such as ours, but is a necessity incident to all systems in the earlier stages of the industry. Already our works' cost is nearly as low as those of other metropolitan supply companies whose output is four and five times larger than ours, while our capital outlay per unit of productive power compares most favourable with that of our neighbours, notwithstanding that most of them are more favourably situated than we are. The credit of this position, of which we may justly be proud, is largely due to the ability and devotion of the company's engineer and manager, Mr. Bowden, to whom the thanks of the shareholders are due. The effect, however, of the rapid development in the methods of supply and distribution during the past eight years in which the foundation of our business has been laid, has been that some of our plant has been superseded in the process. In these circumstances, our capital account has had to suffer somewhat for the benefit of our revenue account, and we have frankly recognised in our report that the normal provision for depreciation must accordingly be supplemented in future years if our capital is to remain intact when our undertaking falls in to the local authority under the purchase clause of our provisional order. I am happy to say, however, that so far as we can ascertain our loss of capital from this cause, it is already much more than compensated by the value of the goodwill which we possess to-day, and that as the value of our goodwill declines with the lapse of our concession, such loss can be provided out of revenue without any additional burden on profits, owing to the extinction of the preliminary expenses which has now been accomplished. Before concluding my observations, I should like to call attention to a plan which we have recently inaugurated for advancing the popularity of the electric light in our district, which we commend to the notice of our consumers and to the emulation of our neighbours. Alone among the electric lighting companies in the metropolis to-day, we are prepared to give householders a limited installation, not only free of all initial expense, but free from any additional charge for electricity. We believe that when consumers realise that they can enjoy the electric light without incurring any capital expenditure, and especially leasehold consumers whose expenditure would not benefit their own property, many will be disposed to adopt the electric light in preference to gas, and as we can make a larger profit on the same number of lights in the form of many small installations than in the form of fewer large installations, it will pay us to expend the capital necessary to extend our business in this way.

Mr. R. A. Germaine seconded the motion, and the report was adopted.

The retiring directors and auditors having been re-elected, the proceedings terminated with a vote of thanks to the chairman for presiding.

The Windsor Electrical Installation Company, Limited.

The directors' report states that the business of the company is progressing satisfactorily. The number of lamps installed on December 31st, 1897, was equivalent to 4,985 of 8-candle power; since that date 395 have been added. In the course of the year a new engine, twice the size of the original ones, has been added, and the storage cell capacity has also been doubled. Extension of mains have been made in St. Leonard's Road, Osborne Road, and King's road. The net profit for the year is £1,256 16s. 7½d., as shown on the net revenue account, No. 4, and out of this sum the directors recommend that a dividend of 4 per cent., free of income-tax, be declared on the paid-up capital of the company, the dividend on the new shares being calculated from the dates of allotment and call. This will absorb £652 7s. 4d., leaving a balance of £604 9s. 3½d. to carry forward. The directors have now been in office for two years without any remuneration whatever, and in view of the very satisfactory progress of the company, they will, at the general meeting, ask the shareholders for a vote on account of their past services. Mr. A. W. H. Good resigned his position as secretary of the company in the early part of the year, and your directors did not consider it necessary to appoint another permanent secretary, as Mr. A. W. Shipley, in addition to being a director of the company, kindly accepted the position of managing director, and the board consider themselves very fortunate in securing his valuable services. It is proposed to issue the remaining capital—£5,000—during the current year. The directors recommend that the shares be issued at a premium of 2s. 6d. per share, and any shareholders desiring an allotment should apply at the company's offices for a form of application. The allotment will be *pro rata* to existing holdings, but any shareholder not applying within one month of the date of this report will be deemed to have renounced his right to an allotment. Current is now being supplied at 7d. per unit, but the directors hope to reduce the price to 6½d. when 8,000 C.P. lamps or their equivalent are installed. This reduction in Windsor is equal to 3d. per 1,000 feet of gas.

South London Electric Supply Corporation.

The first report of the directors, with accounts to December 31st last, to be presented to the ordinary general meeting to be held in London on Monday, states that the works of the corporation are proceeding in a satisfactory manner. The first subject which claimed the board's attention was that of obtaining a suitable site for the central station and dust destructor, which, by virtue of an agreement with the vestry, had to be approved by that authority. This presented much difficulty, and caused unavoidable delay. The inconvenience was, however, fully compensated for by the ultimate acquisition of the most favourable site for the purposes of the corporation within the parish of Lambeth. The land is freehold, and consists of three acres on the north-west side of the London, Chatham and Dover Railway, between Loughborough Junction and Denmark Hill stations. Possession was obtained at Michaelmas, 1897, when the contractors, Manlove, Alliott & Co., Limited, were instructed to proceed with the erection of the necessary buildings and dust destructor. Arrangements have been made by which current is being obtained from a neighbouring electric supply company, pending the completion of the central station, and thus the nucleus of a promising business is being formed. About two and a half months have elapsed since a portion of the mains were made available for a supply of current. The total number of 8-C.P. lamps for which energy has already been applied for amounts to 2,659. The whole of the issue of share capital offered last March, amounting to £325,000, has been subscribed. This places the corporation in a strong financial position, and obviates the necessity of curtailing the contracts which at one time appeared inevitable. The action of the board in placing the balance of the original issue which was not applied for when the corporation was brought out has been somewhat criticised. The directors are satisfied that they acted in the best interests of the corporation, and are confident their action will be supported by the general body of the shareholders. As so short a time has elapsed since the commencement of operations, and no electric supply had been made up to the end of 1897, the accounts merely take the form of a balance-sheet to December 31st, showing the position of the company at that date. Mains already laid are shown on maps which can be seen at the corporation's offices, and amount in all to 21 miles laid in about 8 miles of streets. The necessary machinery and plant is being constructed as rapidly as possible.

Sheffield Electric Light and Power Company.

The report of the directors for the past year states that the net profit, including a balance of £99 brought forward, is £11,492, which it is proposed should be appropriated as follows:—Interest on debentures, £1,125; in payment of a dividend of 12½ per cent., free of income-tax, £9,464; and carry forward £903. The last issue of shares at £2 premium was wholly taken up, and realised a premium of £3,792, which was applied to costs of increasing capital, £200; to depreciation fund, £1,903, making that £6,643; and to reserve, £1,689, bringing that fund up to £2,970. On January 1st, 1897, the price of current was reduced from 6d. to 5d. per unit, and an increased demand had followed. The amount derived from the sale of the current during the five completed years of the company's operations were—1893, £3,555; 1894, £4,849; 1895, £6,935; 1896, £11,258; 1897, £14,319. During the year £19,980 had been expended upon machinery, mains, and other appliances, being £1,600 more than in the preceding year. In consequence of the difficulty in obtaining new machinery from English manufacturers, owing to the dispute in the engineering trades, the directors in July last notified their inability to accept new customers for attachment before Christmas. The difficulties are now removed, as new machinery had been laid down. At the annual meeting the shareholders will be asked to approve of an agreement for the sale of their undertaking to the Corporation. The capital expenditure is fixed at £124,472, and the Corporation agrees to pay £320 Sheffield 2½ per cent. redeemable stock, or £213 8s. in cash for each £100 of the capital property expended by the company. The sale takes place as from December 31st, and until its completion the company is entitled to a dividend of 10 per cent. per annum upon their paid up capital. The directors think the terms proposed are fair and equitable, and they advise the shareholders to accept them.

Hastings and St. Leonards Electric Light Company.

The directors' report congratulates the shareholders upon the increasing business of the company, and points with much satisfaction to the fact that the increased income has been obtained at a very small increase of cost, the receipts for the past year having exceeded those of 1896 by £1,633, whilst the expenditure or works' cost has only increased £157. This result has been obtained by constant watchfulness of the staff, in the expenditure of fuel, and by improvements made in the machinery, whereby greater economy has been possible. Since the last ordinary general meeting the Corporation has taken and paid for the mains, lamp-posts, and other plant relating exclusively to the public lighting, and consequently the repairs to, and renewals of, such plant now fall on the Corporation, although the company is still supplying the current, and will probably continue to do so for some time longer. The directors have also (with the sanction of the shareholders) entered into a provisional contract with the Corporation for the sale of the undertaking, and the Corporation is applying to the Board of Trade for a provisional order to enable it to carry the contract into effect, but, in the meantime, the directors are carrying on the business for the benefit of the shareholders, as if no such contract existed. The result of the past year's trading is exceedingly satisfactory, and shows a net profit of £1,990 18s. 4d., out of which the directors recommend a dividend at the rate of 6 per cent. (which will exhaust £1,633 4s.) to be paid; £300 to be placed to reserve, and the balance of £57 14s. 4d. to be carried forward.

Isle of Man Tramways and Electric Power Company.

The annual meeting of this company was held at Douglas yesterday week.

The directors' report submitted stated that the balance available was £11,155, and recommended dividends at the rates of 6 per cent. per annum on the preference and 7 per cent. per annum on the ordinary shares.

Mr. A. Bruce, chairman of directors, in moving the adoption of the report and accounts, said the extension of the electric system from Laxey to Ramsey would be open next July, and he anticipated that this would be a source of considerable revenue to the company.

The motion was adopted.

Messrs. A. Bruce and F. G. Callow, the retiring directors, were re-elected, and Messrs. William Aldred, Son & Co., Manchester, were re-appointed auditors.

Birmingham Electric Supply Company.

A meeting of this company was held last week at Birmingham.

Mr. Buckley, chairman, in proposing the adoption of the report, congratulated the shareholders on their receiving, for the first time in the history of the company, a 5 per cent. dividend. The prospects of the future were very hopeful, as was shown by the continued increase in the business. During 1895 they supplied 18,199 lamps; in 1896 the number was 25,876, and last year 39,232. Their supply of current in 1895 was 490,000 units, 1896 756,000, and last year 1,133,000 units. Therefore he thought he was justified in saying that the company was created for a proper purpose, and that there was a field for their operations. By the aid of wall diagrams he then showed to the satisfaction of the shareholders how the supply of their light was extending not only among manufacturers, but also to the residential parts of the city. This increased output had necessitated enlargement and additional plant at both the Dale End and Water Street premises, and he thought that they had reason to look upon the future with the greatest satisfaction. With regard to the proposal of the Corporation to take over the concern, one of the council committees was looking into the matter to see if it was advisable to recommend the purchase; and the shareholders would therefore see that it was impossible for him to make any statement on the question at present. It would be wrong to the Corporation and inimical to the company. Whatever was done, however, would be subject to the approval and ratification of the shareholders. As to the increase of capital, the directors would in this case also consult the shareholders as to the time when the new shares should be issued. The motion was then adopted.

Crompton & Co., Limited.

We have received the following circular signed by Mr. John Trotter, chairman:—"The directors have to inform the shareholders that in consequence of certain differences of opinion between themselves and Mr. J. F. Albright as to the management of the company's business, Mr. Albright is relinquishing his position as a managing director, and has also informed the board that as soon as may be convenient to the company, he is desirous of resigning his position as a director. The directors regret that this course should have become necessary. To provide for the future management of the company, the directors have appointed Mr. F. R. Reeves, the company's secretary, to the post of general manager, Mr. R. E. Crompton continuing to superintend the technical part of the company's business. The directors are pleased to be able to inform the shareholders that arrangements have been made by which Mr. Albright undertakes for 12 months to give the company all advice and information reasonably in his power."

Stock Exchange Notices.—Application has been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to—W. T. Henley's Telegraph Works Company, Limited—Further issue of 2,500 ordinary shares.

The Stock Exchange Committee has appointed Wednesday, March 23rd, a special settling day in County of London and Brush Provincial Electric Lighting Company, Limited — Further issue of 10,000 ordinary shares of £10 each, £2 paid, Nos. 30,001 to 40,000; and has ordered to be quoted in the Official List:—County of London and Brush Provincial Electric Lighting Company, Limited—Further issue of 10,000 ordinary shares, Nos. 30,001 to 40,000.

The Direct Spanish Telegraph Company, Limited.—The board has decided to recommend the payment of the dividend at the rate of 10 per cent. per annum on the preference shares, and a dividend, free of income-tax, at the rate of 4 per cent. per annum on the ordinary shares, both for the half-year ended December 31st, 1897.

Chelsea Electricity Supply Company, Limited.—The annual meeting of this company was held yesterday afternoon, at Cadogan Gardens, S.W., for the adoption of the report and accounts for 1897. A report will appear in our next issue.

TRAFFIC RECEIPTS.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending March 11th, 1898, were £2,259 13s. 2d.; corresponding period, 1897, £2,125 17s. 6d.; increase, £133 15s. 8d.

The City and South London Railway Company.—The receipts for the week ending March 13th, 1898, were £1,077; week ending March 14th, 1897, £1,031; increase, £46; total receipts for half-year, 1898, £11,796; corresponding period, 1897, £11,806; decrease, £10.

The Cuba Submarine Telegraph Company.—The receipts for the month of November were £3,413, as compared with £4,545 in the corresponding month of last year.

The Dover Corporation Electric Tramways.—The receipts for the week ending March 12th, 1898, £100 5s. 9d.; total receipts to March 12th, 1898, £1,048 11s. 6d.

The Dublin United Tramways Company.—The receipts for week ending Friday, March 11th, 1898, were £381 4s. 1d.; corresponding week last year, £392 11s.; decrease, £11 6s. 11d.; passengers carried, 65,867; corresponding week last year, 63,023; aggregate to date, £3,975 18s. 5d.; aggregate to date last year, £4,305 18s. 6d.; decrease to date, £330 5s. 1d.; mileage open, 8 miles. Cars, 1898, 209; 1897, 227. Miles, 1898, 18,887; 1897, 17,865.

The Liverpool Overhead Railway Company.—The receipts for the week ending March 13th, 1898, amounted to £1,330; corresponding week last year, £1,280; increase, £50.

The Western and Brazilian Telegraph Company, Limited.—The receipts for the week ending March 11th, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,996.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, March 9th.	Closing Quotation, March 16th.	Business done during week ended March 16th, 1898. Highest.	Lowest.
137,400*l*	African Direct Teleg., Ltd., 4 % Deb.	100	4 %		...	100 104	100 104	103	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	6½ 7½	7 — 8	...	...
125,000	Do. do. 5% Debs. Red.	100	...	...	...	93 — 96	93 — 96	...	...
923,900*l*	Anglo-American Teleg., Ltd.	Stock	£2 9s.	£2 13s.	3 %	59 61	59 61	61	60½
3,038,020*l*	Do. do. 6 % Pref.	Stock	£4 18s.	£5 6s.	6 %	108½ 109½	108½ 109½	109½	108
3,038,020*l*	Do. do. Defd.	Stock	...	...	...	11⅞ 12½	11½ 12	11⅝	11½
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	...	...	16¾ 17½	16¾ 17¼	17 1/16	16 3/16
75,000*l*	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	...	...	112 116	112 116	...	...
44,000	Chili Teleg., Ltd., Nos. 1 to 44,000	5	4 %	4 %	...	3 3½	3 — 3½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	...	187 – 192	187 —192	189½	...
918,297*l*	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	..	...	106 —108	106 —108	107	105
224,850	Consolidated Teleg. Const. and Main., Ltd.	10/-	1½%	2 %	...	1/16 3/16	1/16 – 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	...	6½ 7½	6½ – 7½	7½	6 13/16
6,000	Do. 10 % Pref.	10	10 %	10 %	...	14½ 15½	14½ — 15½	15	14 9/16
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 11	10 — 11	10⅝	...
30,000*l*	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	4½%	103 —106%	103 106%	...	...
60,710	Direct United States Cable, Ltd.	20	2½%	2½%	...	10¾ 11¼	10¾ 11¼	11 1/16	10 15/16
120,000	Direct West India Cable 4½% Reg. Deb	100	...		...	93 —101	93 —101	100	99⅞
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	...	17¾ 18¼	17¾ 18¼	18⅛	17¾
70,000	Do. 6 % Cum. Pref.	10	6	6%	...	18½ 19½	18½ 19½	19	18⅝
89,900*l*	Do. 5 % Debs., repay. August, 1899	100	5 %	5%	...	100 —103	100 103	...	...
1,302,615*l*	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4%	...	129 —132	128 131	131½	129
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7%	...	18¾ 19¼	18¾ – 19¼	19⅛	18⅞
25,200*l*	{ Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,949, 3,976 to 4,326	100	5 %	5%	...	99 103	99 103	...	...
100,500*l*	Do. do. Bearer, 1,950—3,975 and 4,327—6,400	100	5 %	5%	...	100 –103	100 103	...	...
320,000*l*	Do. 4 % Deb. Stock	Stock	4 %	4%	...	130 133	128 – 131	130	...
35,100*l*	{ Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5%	...	99 103	99 – 103	...	...
46,500	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5%	...	100 103	100 —103	...	...
300,000*l*	Do. 4 % Mort. Debs. Nos. 1 to 6,000, red. 1909	100	4 %	4%	...	102 —105	102 – 105	...	...
200,000*l*	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4%	...	108 —111%	108 111 %	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	...	11¾ 12¼	11¾ 12¼	12 1/16	11 11/16
180,042	Do. do. 6 % Pref.	10	6 %	6%	...	17¾ – 18¼	17½ — 18	17⅞	17⅝
150,000	Great Northern Teleg. Company of Copenhagen	10	10 %	10%	...	29 — 30	29 — 30	...	...
160,000*l*	Do. do. do. 5 % Debs.	100	5 %	5%	...	100 —103	100 —103	...	...
97,000	{ Halifax and Bermuda Cable Co., Ltd., 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	95 —100	95 —100	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10%	...	52 — 55	52 — 55	...	...
100,000*l*	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6%	...	106 – 109	106 —109	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	...	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5½%	5½%	6 %	6½ — 6¾	6½ — 6¾	6 11/16	6½
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 – 18	16 — 18	17¼	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	15⅝	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5¾ — 6¼	5¾ – 6¼	6 1/16	5⅞
1,129,471*l*	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	104 —109	102 107	104½	104
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	⅝ ¾	⅝ ¾	...	...
100,000*l*	Pacific and European Tel., Ltd., 4 % Guar Debs, 1 to 1,000	100	4 %	4 %	...	105 —108	105 108	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	8 9	8 – 9	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	139 – 144	139 144	140	...
58,000	United River Plate Teleph., Ltd.	5	4 %	...	...	4 – 4½	4 – 4½	...	...
146,733*l*	Do. do. 5 % Debs.	Stock	5 %	...	...	106 109	106 109	106½	102
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	nil	...	4 5	4 — 5	...	...
213,400*l*	Do. do. do. 5 % Debs.	100	5 %	5 %	...	101 104	101 104	...	...
64,269	Western and Brazilian Teleg., Ltd.	15	3 %	2 %	...	11½ 11¾	11½ 12	11 9/16	11⅝
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	...	7½ 8	7½ 8	...	...
33,129	Do. do. do. Def. Ord.	7½	1 %	...	...	3½ 3¾	4 – 4½	4 3/16	4
389,521	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	106 —109	106 —109	107½	...
88,321	West India and Panama Teleg., Ltd.	10	⅞%	1 %	...	½ ¾	½ ¾	⅝	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	6 %	...	8 — 8½	8 8½	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	6 %	...	5 – 7	5 – 7	6½	5½
80,000*l*	Do. do. 5 % Debs. No. 1 to 1,500 ...	100	5 %	5 %	...	105 108	105 108	...	...
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7%	...	105 110	105 —110	...	...
168,100*l*	Do. do. 6 % Ster. Bonds	100	6 %	6%	...	100 105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

Present issue	NAME.	Stock or Share.	1895.	1896.	1897.	Closing Quotation, March 9th.	Closing Quotation, March 16th.	Highest.	Lowest.
30,000	Charing Cross and Strand Electy. Supply	5	5 %	6 %	7 %	13½ 14½	13½ 14½	...	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6½ — 6¾	6 9/16	6½
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	...	11½ — 12	11½ — 11¾	11⅝	11⅜
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	4½%	4½%	...	115 —117	115 —117	116½	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	7 %	10 %	28 – 29	26 – 27 xd	28½	26¼
10,000	Do. do. Prov. Certs.	5	...	..	10 %	27½ — 28½	26 — 27 xd	26½	26½
10,000	Do. do. Nos. 90,001 to 100,000 £2 pd.	10	...	...	...	13½ — 14½	13 — 14	13½	13
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17½ – 18½	17½ — 18½xd	18⅜	17¾
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	129 —134	129 – 134	...	...
30,000	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—30,000	10	*nil*	*nil*	*nil*	14¾ — 15¼	14¾ — 15¼	15⅛	14¾
20,000	Do. do. do. 6% Pref., 40,001—60,000 ...	10	6 %	6 %	6 %	15¾ — 16½	15¾ — 16½	16 5/16	16 3/16
17,400	Edmundsons Elec. Corp., Ltd., ord. shares 1—17,400 ...	3	...	...	...	......	3½ — 3¾	3 7/16	...
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5			.	11 — 12	11 — 12	11⅝	11½
10,000	Do. do. 7 % Cum. Pref. ...	5	...	...	...	11¾ — 12¼	11¾ — 12¼	11⅞	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	4 %	5 %	...	20½ — 21½	20½ – 21½	21⅜	21
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem.	10	...	...	...	20 — 21	20½ — 21½	21½	20¾
220,000*l*	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	117 — 121	117 —121	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	2 %	4 %	6 %	20 — 21	19½ — 20½xd	20½	20¼
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	7½%	10½%	14½%	18½ — 19½	18½ — 19½	19	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	10 — 11	10½ — 11	...	...
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	4 %	107 —110	107 —110	...	...
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2¾ — 3	2¼ — 2½	2 15/16	2 3/16
79,900	Westminster Electric Supply Corp., Ord., 101 to 80,000 ...	5	7 %	9 %	12 %	17½ — 18½	17½ — 18½	18	17⅝

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	896.	1897.	Closing Quotation, March 9th.	Closing Quotation March 16th.	Business done during week ended Mar. 16th, 1898 Highest.	Lowest
30,000	British Electric Traction	10	...	...	...	16¾ — 17½	16¾ — 17½	17	...
90,000	Brush Elect. Enging. Co., Ord., 1 to 90,000...	3	...	...	...	1⅞ – 2⅛	1⅞ 2⅛	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	...	...	2¼ – 2½	2¼ – 2½xd	...	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	110 —114	110 114	...	...
50,000	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	02 —105	102 —105	...	...
19 894	Central London Railway, Ord. Shares	10	...	...	...	10½ — 11	10½ — 10⅞	10⅞	10$\frac{9}{16}$
129,179	Do. do. do. £6 paid	10	...	...	...	6¼ — 7	6½ — 6⅞	6½	...
59,254	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1½ — 2	1½ — 2	...	...
67,680	Do. do. Def. do. £5 pd. ...	...	...	...	...	4¾ — 5	4⅝ — 4⅞	4⅞	...
630,000*l*	City and South London Railway	Stock	1$\frac{3}{16}$%	1$\frac{9}{16}$%	1⅞ %	67 — 69	66 — 68	68	66⅞
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	nil	...	...	2¼ 2⅝	2¼ 2⅝	2¼	...
99,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 99,261	5	5 %	5½%	...	2½ 3	2½ 3	...	...
[illegible]	Do do. do. "A" Shares 01—017,139	5	5 %	5½%	...	4 — 5	4 — 5	...	...
194,023	Do. do. do. 4% Deb. stock Red. ...	100	...	...	...	103 —105	103 —105	...	...
1[illegible]	Electric Construction, Ltd., 1 to 110,000	2	5 %	6 %	...	2⅝ 2⅞	2⅝ 2⅞	2⅞	2$\frac{11}{16}$
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343	2	7 %	7 %	...	3⅛ 3⅜	3⅛ 3⅜	...	...
111,100	Do. do. 4% Perpetual 1st Mort. Deb. Stock	Stock	...	...	...	106 —108	106 —108	107½	106
91,166	Elmore's Patent Cop Depotg., Ltd., 1 to 70,000 ...	2	...	...	...	½ ¾	½ ¾	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm	2	...	...	...	⅜ ⅝	⅜ ⅝	...	...
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600	10	10½%	...	...	9 — 11	9 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord. ...	10	8 %	10 %	12 %	23 - 24	22½ 23½xd	23⅝	22¾
3,000	Do. do. do. 7% Pref. ...	10	7 %	7 %	7 %	19 — 20	18½ 19½xd	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½ %	110 —115	110 115	112	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	21½ 22½	21½ 22½	22$\frac{3}{16}$	21⅞
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	104 —108	104 —108	106⅝	...
37,500	†Liverpool Overhead Railway, Ord.	10	2⅞%	2⅞%	3½ %	10$\frac{11}{16}$ 10$\frac{13}{16}$	10$\frac{11}{16}$ 10$\frac{13}{16}$	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15¾ 16½	15¾ — 16½	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	15 %	15 %	37 40	36 — 39 xd	39	36½
[illegible]	Do. do. do 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105	...	...
540,000*l*	Waterloo and City Railway. Ord. Stock	100	...	...	...	136 - 139	136 —139	139	135

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7%; 1890—8%.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

* Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 10⅜.

House-to-House Company, 4½% Debentures of £100, 107—109.

Kensington and Knightsbridge Electric Lighting Company. Limited Ordinary Shares £5 (fully paid) 17—18; 1st Preference Cumulative 6 %, £5 (fully paid), 8½—9. Dividend, 1896, on Ordinary Shares 7 %.

* From Birmingham Share List.

London Electric Supply Corporation, £5 Ordinary, 4—4½.

* T. Parker, Ltd., £10 (fully paid), 14.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8—8½. Dividend for 1896—6 %.

Bank rate of discount 3 per cent. (October 14th, 1897).

STEAM RAISING BY WATER TUBE BOILERS.

The Gloucestershire Engineering Society was recently selected by Mr. H. W. Kolle, as the audience to which to expound his theories of the water tube boiler. Naturally Mr. Kolle is biased in favour of water tube boilers, and considers them as near perfection as boilers have yet arrived. It may be well, therefore, to review the eight requirements of a perfect steam boiler as enunciated by him. These are far more than eight in number, but we give them as arranged under eight heads, but divested of the curious lack of the rules of elementary construction which seems to cling to so many technical descriptions. They are as follows:—(1) Best materials for construction, perfect workmanship, durability, highest class fittings. (2) Great margin of strength, construction free of expansion stresses. (3) Sectional water space so arranged as to avoid general explosion. (4) A combustion chamber arranged to secure complete combustion before escape of gases to chimney. (5) Heating surface at right angles to the gas currents. (6) Constant and thorough circulation. (7) A steam and water capacity sufficient to prevent sudden change of pressure or water level. (8) Accessibility of parts for cleaning or repairs.

As the above requirements are claimed to exist in the Babcock boiler *par excellence*, we may not unfairly follow the claims and see if they are all substantiated. Of the first requirements there is no difficulty in using the best possible materials and workmanship, and the highest class of fittings. This is merely a matter of choice. The question of durability is an open one. Perhaps the worst fault of the water tube boiler is the short life of its internal brickwork or of its lower tubes when water is hard. We hope there is now no further use of cast-iron in any water tube boiler, but for a long time there was far too much cast-iron in the ends of the steam drums and in the tube headers, and the claim for best materials has at most only lately been tenable.

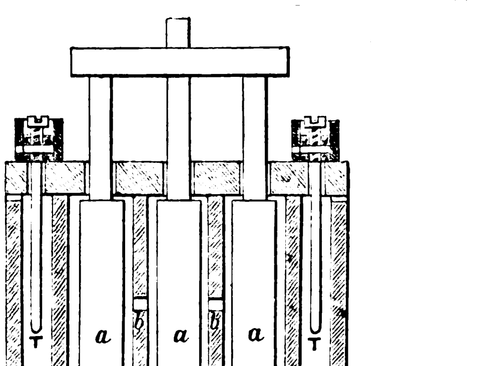
Claim (2) for large margin of strength can only be tenable if all parts are of wrought-iron or steel, and if any cast-iron is still used must be disallowed. Advocates of water tube boilers, while claiming great strength because of small diameter of parts, have thrown away such advantages by resorting to the wholly unsuitable metal cast-iron. Stresses from unequal expansion are provided against fairly well by the water tube arrangement. Claim (3) is fairly well earned. Claim (4) cannot be considered tenable. The gases from the fire rise up directly among a nest of cold tubes, and then enter the so-called combustion chamber—so-called by courtesy only. A combustion chamber placed behind a lot of water pipes cannot act as a combustion chamber if the pipes have done their duty. Moreover, the ordinary arrangement of the furnace is anything but good. There is no bridge, and the products of the fire rise directly amongst the tubes above them. A fire cannot be smokeless unless the products from it are mingled by sweeping over the whole fire surface and pass, via the bridge, to the combustion chamber beyond. Experience with Lancashire and Galloway boilers proves that even under the best conditions the presence of cross water pipes in the tubes beyond the bridge wall will induce smokiness. The water tube boiler as arranged in the Babcock type, must either burn smokeless fuel, or it must have its furnace arranged with an over-arching firebrick roof, so as to compel the gases to travel somewhat as in other forms of boilers. Combustion should be complete before the tubes are reached, or there will be very little later chance of securing this desirable result. As to claim (5) there is probably no particular value in this arrangement. Gases travelling across tubes only impinge on one-half the tube, and the other half is untouched. It is probably better that the gases should travel with the tubes, completely enveloping them. Claim (6) is fairly to be maintained. For stationary work the arrangement of sloping tubes is such as to induce continuous circulation. Claim (7) is one on which great differences of opinion prevail. In a battery of boilers the smallness of capacity of each individual item is perhaps of little consequence. It is when there is but one boiler that the lack of steadiness becomes apparent and the water tube boiler gives least satisfaction. Of claim (8), that of accessibility for repairs, this, of course, depends on the arrangement possible with the seating. With ample space it can be secured. Our author is apt to lay far too much stress upon the heat transmission being hindered by the thick plates of the furnaces of large shell boilers. A single homogeneous thick plate does not readily burn; lap joints may burn, but it is the air space at the lap which causes this. Water tubes, though thin, often tear open in a most disastrous manner, and are not looked on as particularly safe by boiler insurance companies who prefer shell boilers despite Mr. Kolle's statement that they explode almost every day. Moreover, this statement is not borne out by fact. More water tube boilers explode per cent. of these at work than shell boilers. Nor have water tube boilers proved themselves to be economical as compared with shell boilers. Probably the marine class of land boiler as now made and arranged affords the best example of fuel economy and economy of space and bricks. The setting of the water tube boiler is unfortunately somewhat tender and gives rise to great cooling effects from air leakage. In a less but similar degree the Lancashire boiler is exposed to the same losses. We have seen a good many tests reported of water tube boilers, but none to substantiate the claim for superiority over any other type. True a report was published which claimed, we believe, 13½ lbs. evaporation although the chimney temperature was high, but who believed it? Water tube boilers have a future. There are places, thanks to the follies of architects, where water tube boilers are almost compulsory. At the same time, there is room for much improvement in their construction. The makers of them must get over that idea of small diameters. They make it a question of salvation, and it has not tended to better materials. Large shell boilers have had to face big pressures. No pandering to the devil for poor materials has been possible with them. Where a man has to deal with 200 lbs. pressure in a 12 feet shell he is obliged to be on the alert for good materials, but there is an idea that anything will do for 4 inches, hence the employment of cast-iron and the talk about the safety of small diameters. We fear this has to bear some of the responsibility for split tubes. It is far better to live up to a high pressure than to live down to a small diameter. While many engineers object to water tube boilers because of their small contents, others like them because they soon respond to a forced fire. Later practice seems to favour a combination of shell and water tube boilers so as to secure both the staying power and the sudden response to a pushed fire. Our author looks to the universal adoption in the near future of the water tube boiler and the superheater with high pressure. Water-tube boiler makers seem to have forgotten that the stress of present day pressures on the steam drums of water tube boilers is greater than the stress a few years back on shell boilers, which were then declared to have seen their last days, yet, if judged by the boiler of to-day, were only in their infancy. It is not safe to prophecy too closely on the limits of mechanical engineering.

THE SOCIÉTÉ INTERNATIONALE DES ELECTRICIENS.

The monthly sitting of the Société Internationale des Electriciens was held on March 2nd, 1898, at 8.30 p.m., with Dr. D'Arsonval in the chair.

The Secretary read the report of the last meeting, presented the new members, and spoke of the works published. The president announced the death of M. Gauthier-Villars, and expressed condolence. The committee proposed the following candidates for the official elections that will take place at the next meeting: President, M. Violle; vice-presidents, Messrs. Clérai and Monnier; treasurer, M. Violet; secretaries, Messrs. Abraham and Grosselin.

First, M. P. Janet presented, in the name of M. Bouchet, various interrupters and circuit breakers based on a new mode of breakage. In a box made of insulating material are arranged two cavities separated by an insulating partition; they are filled with mercury up to a



certain height; if a plunger is inserted into each cavity, the mercury rises, flows over the insulating partition, and closes the circuit. In the same way, in withdrawing the plungers, the mercury separates, returns into each cavity, and cuts the circuit. It might be feared that the mercury, bringing impurities with it, would leave a trail behind it; but experience has shown that after a long period of working—1,000 breaks, for instance, the traces left behind by the mercury were not sufficient to close the circuit.

On the basis of the above principle the inventor has constructed various models of interrupters. It is only necessary to put a lid on the box of insulating material; in the centre is a lever for working the plungers. This lid has on its sides two metal rods connected with external terminals. The mercury, as it rises, touches these rods and closes the circuit; we therefore get closing and breaking at three points.

M. Barbarat has arranged an interrupter with three plungers, *a*, *a*, *a*, for high tensions (see illustration), and with two insulating partitions, *b*, *b*. This apparatus has been tried with alternating currents at 12 amperes and 3,000 volts on the sector of the Champs Elysées. Magnetic circuit breakers have also been constructed with this mode of breaking. For this purpose a rod of iron is connected with the dippers, and is displaced within a solenoid traversed by the current. The mechanism is arranged so that the action of the electro-magnet on the armature is balanced at the beginning by the weight. As soon as the movement has begun, two springs placed at the sides and immediately set free, continue it, and raise the rod so as to bring about the breaking.

Various other instruments have been constructed, in particular an interrupting circuit breaker, and minimum circuit breaker. Two electromagnets have also been arranged one above the other; one to make and one to break the circuit. Thus the interrupter can be worked from a distance. M. P. Janet has worked in this manner the interrupter of a circuit of 100 lamps.

M. Barbarat then described the new underground cables with air insulation employed by the Telephone Administration of Paris. These cables are insulated with paper, and the insulation is ensured by injecting from time to time dry air under pressure. For this purpose, the compressed air is supplied by the compressed air company; it passes over chloride of calcium, and is sent into each cable by means of taps. This dried air removes every trace of dampness and ensures the insulation. Sometimes the operation can be facilitated by sending a workman to heat it on the spot.

These cables have been tried over long telephonic systems, and have given good results.

CROWDUS STORAGE BATTERY.

The following is the description of this battery referred to in our "Correspondence" columns, and is apparently a copy of a patent specification:—

This invention relates especially to that type of accumulators or secondary batteries known as the "heterogenous" formation, in which elements are formed by applying lead salts mechanically to conducting supports.

The objects of this invention is to provide a simple, economical and efficient secondary battery and process for manufacturing the same. A further object of this invention is to increase the efficiency of conversion between charge and discharge, and most of all to decrease the weight of the cell without impairing its commercial value, and consists principally in the improvement of the structure of the metallic supports for holding the active material and in the successful adaptation of the metal aluminium as a substitute for lead in the negative plate. It consists, further, in the method of forming the spongy lead of the negative element. It consists, further, in the electrolyte employed in the cell. It consists, further, in the method of electrically connecting the elements of the battery together so as to secure a uniform and equal electrical and chemical action over all parts of each plate. It consists, further, in the arrangement of the insulating and bracing separators that are arranged between opposing plates; and it consists, finally, in the processes, features, combinations and details of construction hereinafter described and claimed. In the art to which this invention relates, it is well known that many different kinds of conducting supporting plates and grids have been designed to prevent the active material from falling out, and also to guard against buckling of the plates, but as is also well known, these plates have not secured these results in the most economical or commercial manner. In order to prevent the warping or buckling of the supporting plates, manufacturers and inventors have attempted to prevent the same by hardening them with alloys and by using an increased weight of lead, the increase of the lead being such that the metallic support presented the largest percentage of the plates, while the real active proportion thereof was relatively small.

It is well known that the attempts to use aluminium as a support for the lead paste or active material have failed for the reason that paste does not adhere readily to the aluminium, and as a consequence fell away therefrom, so that the attempt to use such material in storage batteries has been abandoned, and such material has never entered into commercial use in the art.

My invention is intended to obviate these objections and to provide simple, economical, and efficient secondary batteries of very light and large capacity.

In experimental use and tests I have discovered that the hitherto damaging results from the expansion of the lead salts of positive plates can be turned to good effect by using a thin or mechanically weak rolled lead conducting support, which is free to expand under pressure from the salts, but has its expansion directed principally in straight lines parallel with the face of the plate, that is, the plate may stretch equally in all directions so that there is no tendency to buckle. I also prevent the buckling and increase the rigidity of the plates by inserting vertically corrugated and perforated insulating separators between each pair of elements in the battery.

In constructing a secondary battery in accordance with these improvements, a positive plate is made of thin rolled sheet lead and the same is provided with a series of rectangular or elongated perforations. The supporting plate is provided with terminals at the top and bottom portion thereof so that plates of the same polarity may be electrically connected together at the top and bottom, and thus ensure uniform electrolytic action.

The ribs formed by and between the elongated perforations are bent alternately to opposite sides of the plate, so as to form longitudinal recesses substantially the entire length of the plate, and openings on each side thereof, to hold the active material which consists preferably of a specially prepared hard but porous paste of red lead. This arrangement permits of a very light plate, the presenting of a large active surface, and a greater amount of active material than any other form of construction.

In order to make the improved negative element I use a plate similar to the plate above described in connection with the positive element, with the exception that I use the metal aluminium for the supporting plate, instead of lead, and the same paste for active material by placing the material in the plate, it is locked therein from side to side and throughout its entire length as in a cage, and prevented from falling out, while at the same time the surface of the active material represents a larger percentage of the surface of the plate than ever accomplished before, thereby greatly increasing the surface of the active material and the output of the plate, the weight of the cell being also largely decreased per unit of work.

In practice the weight of my positive lead support, when compared to the active material upon it, is as 1 is to 2, a result never practically obtained before.

The elements are connected together by bending the terminals substantially at right angles to the plate and connecting the plates of similar polarity to each other by means of rivets for the negative plate, and also by autogeneous soldering in the positive plate. The sets of plates are then immersed in the special forming bath, consisting of an aqueous solution of about one-third saturation of sulphate of zinc with 15 per cent. by volume of sulphuric acid.

In this solution I place the plates to be formed, suitably arranged between sheet lead anodes as dummies, and pass a current of about 1 ampere for every 3 square inches of the plates to be formed. On passing the current to the plates, the sulphate of zinc is decomposed, depositing pure zinc upon the negative pole plates, which is resolved from the plate as fast as it is deposited by the sulphuric acid of the solution, thus producing a quantity of hydrogen. By the reducing action of the hydrogen the oxide of lead is rapidly converted into spongy lead. By this process the time of formation is reduced to about two hours, about one-fifteenth of the time required in the processes in actual use at present.

By this method of forming the elements, the dissolved zinc is returned to the solution so that the same solution can be used over and over again for an indefinite period. I have found in experimental tests that the positive plates when first formed into negatives of spongy lead by this process, and then into positives, will give almost their full output on the first discharge, while the old methods require several charges and discharges before the positive plates are fully formed. I therefore also quicken and cheapen the formation of positive plates by the use of quick negative formation.

After formation the elements are placed in the battery, and in order to strengthen and insulate the plates and prevent warping or buckling of the same, I insert between the opposing pairs of plates a corrugated insulated perforated separator which touches such plates at their inactive portions.

By this arrangement no active material is covered by contact with the insulated rubber separator and the internal resistance of the cell is thereby greatly reduced. A ⊤-shaped terminal lug of lead is then secured to the terminal of the positive lead plates and a similarly shaped lug aluminium to the aluminium terminals of the negative plates to which the circuit wires are intended to be attached. It is well known in this art that each time a cell is recharged the negative element decreases in capacity, and that after a time a reversal of the polarity of the positive and negative elements is necessary to bring the cell back to its original capacity. This is avoided and the efficiency of the conversion increased between charges and discharges by adding to the usual sulphuric acid electrolyte (with which all batteries are supplied) a very small proportion of sulphate of zinc, just sufficient to hasten, as described in the former bath, the restoring of the negative element so that its full capacity is restored fully as quickly as that of the positive element.

In the construction of storage batteries all builders connect the elements together by a terminal at the top end, and at one point only. I have discovered in connecting the elements in this manner that in the charge or discharge of the battery, the escape of the current to and from the positive and negative plates is greatest nearer to the terminal lugs, and that it gradually decreases to the more remote points. This action brings about uneven electrolysis upon the plates, to the extent that one portion of the plate (that nearest the terminal) is exhausted or restored quicker than the more remote portions, in consequence of which the capacity of the battery is decreased below the capacity of the active material. It also produces partial polarisation and unequal expansion, and consequently distortion or warping of the plates. In my construction, I remove these objections and obtain a much more uniform electrolysis on every portion of the plate, by connecting the plates of similar polarity at two or more points below the line of the electrolyte. It will be understood, however, that instead of using two terminals, one only may be used, and that one extending nearly the entire length of the plate, or three terminals or even more may be used. In further carrying out the benefits derived from the above described points, the plates of opposite polarity are placed in juxtaposition with each other, so that the connected edges are on opposite sides of the pile. Further, in the use of batteries, the terminals of the plates, or the elements above or outside of the electrolyte are destroyed by the sulphating of the lead, due to the combined corrosive action of the air and acid, and to overcome this, heavy lugs are resorted to. I avoid this objection by completely immersing the terminals of the elements at the point where they connect, so that I can successfully use thin plates in my elements where hitherto destructive sulphating has made it impossible.

TEST OF THE CHICAGO STORAGE BATTERY ROAD.*

(*Concluded from page* 348.)

Data on Batteries Obtained at the Time of Power House Tests.

Two complete power house tests made on November 5th and November 26th, 1897, showed the amount of coal required to deliver a kilowatt-hour upon the switchboard. At the same time a complete log of the operation of the battery charging pit was kept, which shows the history of each battery for the entire time of the test. In the test made November 5th the batteries were charged by the "three-voltage" method, but on November 26th the station was operated with one generator, and but one voltage was used to charge the batteries. During the latter part of this test the tracks became covered with ice, due to a sleet storm, and it became necessary to change the batteries every half trip, which will account for the shorter time of charging indicated upon the latter part of the power station log of the test, and also the smaller average number of miles per trip shown November 26th. The data obtained at the charging tables were checked up with the conductors' reports. These reports show the number of the car, the time occupied by each trip, the length of the run, and the number of the battery used. The following table shows a summary of this information for the two days. This table shows the battery mileage for each day from the time of starting the road in the morning until the last trip at night.

Table of Battery Mileage.

No. of battery.	November 5th.		November 26th.	
	No. of trips.	Miles run.	No. of trips.	Miles run.
1	2	33·0	...	...
2	2	22·4	...	...
3	4	63·9	3	44·5
4	1	11·8	3	66·9
5	5	100·7	2	33·9
6	4	67·2	5	56·6
7	4	68·4	6	77·0
8	...	...	...	...
9	3	43·6	3	41·4
10	5	49·5	4	53·7
11	...	...	5	58·6
12	5	79·6	...	...
13	1	11·5	6	68·1
14	1	23·0	...	...
15	1	11·5	5	7[illegible]·8
16	...	...	...	...
17	...	...	...	...
18	...	...	...	...
19	1	11·5	4	62·2
20	...	...	5	56·9
21	5	80·2	2	34·2
22	5	79·0	4	55·4
23	1	10·6	.	...
24	...	...	...	...
25	3	47·1	3	57·2
26	5	79·6	2	22·4
27	1	10·6	4	57·2
28	1	11·8	3	50·6
29	4	79·0	4	56·3
30	4	73·9	4	31·2
31	2	45·4	...	...
32	6	68·1	...	...
33	4	79·3	4	56·2
34	4	78·4	2	34·2
35	...	...	6	89·9
36	...	...	5	78·7
37	3	67·8	3	35·1
38	4	81·6	3	46·0
39	...	...	...	...
40	5	77·8	5	67·8
41	4	80·1	6	90·2
42	4	68·1	3	30·6
43	2	22·6	4	43·4
44	4	80·2	3	34·2
	110	1,821·8	123	1,668·4
Average miles each trip		16·56	...	13·56

This table shows the actual number of miles which the batteries ran the cars on the two days. In addition to this, batteries were used to operate the auxiliary motors of the plant. These motors are upon the transfer carriage used to handle the batteries in the charging pits, and upon the transfer carriage used to move the cars in the car barns. No record was obtained of the power used by these motors. A recording wattmeter was secured to place in these auxiliary circuits, but unfortunately it was injured in transportation, and could not be used. An effort was made to obtain an average value of the power used for each operation by means of readings made at

* *Street Railway Review.*

intervals of two seconds upon standard volt and ampere meters, but owing to the sudden fluctuations the data obtained were unsatisfactory. However, as the power used in the operation of handling the batteries in the pits and the cars in the barns may properly be charged to the operation of the cars, the total amount of energy delivered to the charging tables divided by the actual car mileage will give the total power required per car mile. With the data at hand, however, this entire energy cannot be exactly divided into the amount used in the barns and the amount used on the road. The former amount will be a very small proportion of the latter, but this proportion will increase as the average length of battery trips decreases.

The power delivered to the switchboard and the amount of coal required upon November 5th is shown in the records of the test made that day. The power delivered upon November 26th was obtained for nine hours from the records of the test made from 3 p.m. to 12 m., and for the remainder of the day from the charts of the recording ammeter. The readings of this ammeter were carefully compared with the readings upon a standard ammeter, and found to be correct. These ampere readings were multiplied by the value of the average voltage found upon the test made that day, and the resulting watts added to those obtained during the test.

The following table shows a summary of the results of the two days' run:—

Date of test	Nov. 5th	Nov. 26th
State of weather	Rainy	Rainy and cold
Kilowatt-hours delivered to switchboard	2,638	2,895
Kilowatt-hours used by cooling tower motor	151	174
Net kilowatt-hours delivered to charging bus bars	2,487	2,721
Total number of car miles ...	1,821·8	1,668.4
Kilowatt-hours on switchboard per car mile	1·87	1·63
Pounds of coal per net kilowatt-hour	6·9	6·44
Pounds coal per car mile ...	9·45	10 50
Cost of coal per ton	$1.90	$1.90
Cost coal per net kilowatt-hour	·00655	00611
Cost coal per car mile	·00897	·00996

It will be noticed that although the cost of a kilowatt-hour upon the switchboard was less in the second test, the cost of fuel per car mile the same day was something more than in the test November 5th. This result is due to the fact that the kilowatt-hours required per car mile were greater in the second case. The difference in the amount of energy required per car mile is to be explained by the presence of a coating of ice upon the rails during the latter part of the day (November 26th). It is unfortunate that a freezing sleet-storm should have occurred at this time, though the results of the test indicate to a certain extent the amount of power required to operate the road under adverse conditions. Owing to the storm, the results of the two tests do not furnish a fair basis for a comparison of economy of the two different methods of charging the batteries.

Efficiency Test of Battery on Car.

This test was made November 8th, 1897, and was made to determine the efficiency of a battery under actual operating conditions. The battery was charged in the regular way by means of the three-voltage method. It was then discharged while making a round trip, and was then placed upon the charging table and again charged, thus giving two charges and one discharge to determine the efficiency. The battery used was one which had operated at that time over 8,000 miles, and was taken for the purpose of this test immediately after it had made a trip similar to the one upon which it was tested.

The current and voltage upon the two charges were obtained by means of standard instruments, and readings were taken every five minutes.

The observations made upon the car while the battery was discharging consisted in taking voltage and ampere readings every five seconds, while the car was in motion, the time between stops and the length and location of each stop, and a continuous record of the speed.

The voltmeter was a standard Weston instrument, and was connected across diagonal corners of the battery tray.

The voltmeter was so connected that it gave the voltage at the battery terminals for each combination. The car tested was 20 feet long in the body, 30 feet long over the platforms, and had a seating capacity of 28 passengers. The car weighed 13½ tons with the batteries, the batteries and trays adding about 4 tons to the usual weight of a car of that size.

The motor upon the car was a 50-H.P. Walker four-pole series motor. The entire current used at any one time passed through the armature, so that the ammeter was inserted in the positive brush leads. The ammeter used was of the round-pattern Weston type, and had been found to be correct by comparison with a standard. Five observers were used to obtain the ammeter and voltmeter readings. One called the time every five seconds, two read the instruments, and the other two kept the records. At time of starting the instruments were read oftener than at five-second intervals. A trial trip was made with another battery to get the observers acquainted with their positions, and as the fluctuations in the current were not violent nor many, it is believed that the results represent very nearly the actual facts.

The duration of the stops, and the time the car was in motion between stops, was obtained by means of a stop watch.

The record of speed was obtained by means of a Boyer speed recorder belted, by means of a flexible belt, to the car axle. By means of pressing lightly upon the recording pencil a dot was made in the speed curve every five seconds.

No attempt was made to indicate upon the diagram the ampere or voltmeter readings, as this information is given upon a larger scale in the acceleration tests.

The test may be divided in four parts, as follows:—

——	Distance.	Time.	No. of stops.	Average speed miles per hour.
1. Power house to Blue Island ...	5 9	28:20	12	12·5
2. Blue Island to power house ...	5 9	29:55	19	11·8
3. Power house to Sixty-third Street	5·3	27:40	13	11·5
4. Sixty-third Street to power house	5·3	27:50	13	11·5
Total number of stops ...	...	...	57	

Total time from start, not including stops	...	113:45
Total distance	...	24·40 miles.
Length of one back-up stop, 18 ...	...	·04 „
Total distance travelled	...	22·44 „
Average speed	...	11·84 miles per hour.

In making the stops, an effort was made to approximate actual service and in every way reproduce the conditions of an actual trip. No regular passengers were carried, however, the load consisting of nine observers, the motorman and conductor. The motorman was instructed to follow his usual custom of coasting, where possible. The track was dry for the first two parts of the test, but during the last two parts it was raining, and the tracks were wet. The energy taken from the battery was as follows:—

——	Distance. Miles.	Watt-hours.	Kw.-hours per car mile.
1. Power house to Blue Island ...	5 9	5,533 1	·920
2. Blue Island to power house ...	5·94	5,098	·868
3. Power house to Sixty-third Street	5 3	4,394·6	·820
4. Sixty-third Street to power house	5·3	4,689 6	·885
Total	22 44	19,715·3	·878

It is to be regretted that a profile of the road cannot accompany this report. The road, however, is practically level. The results of the last table would seem to indicate that in general the grade rose from the power house toward the two terminals.

The efficiency of the battery is shown as follows:—

Kilowatt-hours, first charge	36·757
Kilowatt-hours, discharge	19·715
Kilowatt-hours, second charge	31·681
Efficiency (discharge ÷ first charge) ...	53·6 per cent.
Efficiency (discharge ÷ second discharge ...	62·32 per cent.

The graphical log of the two charges were shown, and they differed considerably. This is due to the fact that the charging of the battery was left to the regular operators of the plant, who used their judgment both as to the voltage and as to the time the battery should charge at each voltage. They also determined when the battery was fully charged. In the first charge there is no doubt but that the final voltage was too high, and in the second charge it would seem that the battery was charged too long, both of which conditions reduced the efficiency obtained. The result, however, shows the efficiency in actual service, but does not represent the possibilities of the battery.

The amount of the first charge was, of course, influenced by the immediate previous history of the battery, and for this reason the efficiency obtained by using the second charge as a basis is the more reliable. This test showed that the car used 1·41 kilowatt-hours per car mile, as measured at the charging table, and ·87 kilowatt-hour per car mile was delivered from the batteries to the motor on the car.

Acceleration Tests.

In the tests made upon a car in actual service no opportunity was afforded for actual acceleration tests. These were made November 13th, 1897, upon a straight stretch of track along Vincennes Road, extending south from the power house. In these tests the same instruments and observers as on the other car test were used, and readings were taken in much the same way, with the exception that in this test the observations were made at the time of passing from one point to another of the controller. After the fifth point was reached the readings were taken at 5-second intervals. The time between points was obtained by means of a stop watch, and no effort was made to change the motorman's method of procedure in bringing the car up to speed. The average results of five trials showed clearly the power delivered by the batteries at the different points of the controller and the energy required to accelerate the car.

The current curve showed a maximum of 320 amperes. At this time all four sets of batteries are in parallel, so that this total of 320 amperes indicates a total discharge rate of each cell of but 80 amperes. At the fourth notch it coincides with the total current curve, and at this point indicates the highest discharge rate, which is seen to be 220 amperes, and this rapidly decreases until it reaches 100 amperes, which may be taken as a fair value of the current with the car in full motion. It is to be understood, of course, that the practice of coasting, in which the current is shut off, makes it impossible to obtain the power required per mile from this curve.

In conclusion, it may be said that the foregoing tests do not demonstrate the best results that may be expected of accumulator traction, and were not made for that purpose. No excuse is to be offered for the fact that the road was not operating under ideal conditions while being tested, as the primary object of the test was to determine where improvement could be made. If this is kept in mind when comparing the results with those obtained upon the trolley systems of about the same size, it will be seen that the cost of fuel for accumulator traction, of something less than 1 cent per car mile, is very favourable to storage battery traction. The improvements suggested by the test are now being made. The overhauling of the engines, the repair of the economiser flue, and the securing of a better coal than was used on the test, at a cheaper price, should bring the fuel cost per car mile well within ·5 cent. Figures upon the labour and maintenance factors in the cost per car mile would be of interest in this connection, but are not covered by the figures of the test. The labour account will no doubt be as small as that of any nine-car road, while figures upon maintenance would be premature at this time. The batteries have operated from 8,000 to 14,000 miles, and are standing the service remarkably well, so that the maintenance account, up to the present, has been comparatively small.

THE ECONOMY AND EFFICIENCY OF THE LARGE GAS ENGINE.

Writing to the *Engineering Magazine*, Mr. Dugald Clerk, the well-known gas engine expert, discusses the gas engine in its relation to large powers. We may take it that for small powers the gas engine has, for a long time, been a decided success. It is the only economical prime mover for small powers, and the smaller the power required the more striking has been its success and convenience. As soon, however, as powers are required such that to start the engine is difficult for a man by himself, the inconveniences of the gas engine appear. Until 1890 the gas engine was in a state of development. The Otto patent had given wealth to its owners, and this wealth was used to crush every other patentee who could be brought within striking range. After the expiration of the Otto patent in 1890, the superiority of the Otto cycle was made plain by the abandonment of other cycles of operation and competition in engines really commenced, and competition lead to the attempts at increasing sizes and powers. So far about 200 I.H.P. is the maximum size to which the Otto cycle has been successfully applied.

In 1879 *the* big engine was a 16 H.P.; it held the title for several years. In 1888 the hot tube igniter displaced the old revenue producing slide valve. In 1889 the Simplex engine of Delamere-Deboutteville & Malandin was exhibited at Paris. Its power was 100 H P, and it had an electric igniter and a self starter. Since that time the growth has been to 200 H P. and not a large number of really big engines have been made, the average power of the 5,000 engines built annually in the United Kingdom being 20. The largest engines built by Messrs. Crossley for the Blackpool Tower Company are of two-cylinder type, each cylinder facing its fellow and using the one crank. With coal gas they show 220 H P. The cylinders are 18½ inches diameter and the stroke is 2 feet, the speed being 160. With producer gas they indicate 208 H.P. This engine is really a pair of 100 H P. cylinders on a 200 H.P. crank.

This arrangement, which gives two impulses in a revolution and leaves one revolution with no impulse, has proved better than the side by side cylinder, one crank type which gives one impulse every half revolution. Altogether, Messrs. Crossley have made about 30 engines of over 100 H.P. for various purposes, including the direct driving of dynamos and centrifugal pumps.

Messrs. Tangye have also turned out a considerable number of engines of over 100 H P. and several other makers have made large engines, one by Messrs. Robey & Co. at Messrs. Luke & Spencers, of Broadheath, working on 1⅝ lb. of coke per H.P. hour, including the coke used at night to keep the producer in form, but our author does not consider the total of large engines can exceed 100. As a large engine of 80 H.P. will run for about 1 lb. of anthracite per hour, or of common engine slack, how is it there are not more big engines with such an economy in view for the best steam engines of 80 H.P. would use quite double the above fuel? There are two sets of difficulties, those of the engine and those of the producer; of the first there is the proportion of burned gases left in the compression space—a fault which does not much trouble small engines, whose cooling rate is greater, and the burned-out gases are cooled below the point where they ignite the incoming charge. Some lingering flame remains to ignite the incoming charge in large engines, this ignites the charge in the inlet pipe and the engine loses an explosion. Hence the use of the scavenging charge which Mr. Clerk himself used first. This was in 1881. The Otto engine only adopted scavenging in 1886, and the Griffin engine is well known as having a scavenging stroke, but scavenging was not frequently done until Messrs. Crossley adapted Mr. Atkinson's inertia method. This consists of a long exhaust pipe, the momentum of the discharged gases in which was made to pull a charge of fresh air through the cylinder. Messrs. Wells Bros. had a special annular scavenging cylinder worked as an air pump by the expanded forward part of one piston in their 200 I.H.P. engines of tandem type. Scavenging is admitted to almost completely overcome the difficulty of premature ignition from residual flame, but an engine must be well designed so as to avoid hollow spaces and ports which might not be swept out by the scavenging air. Nor is it to be wondered that there should be premature ignition. With a temperature of 1,800° C. in a compression cylinder and a stroke lasting only one-sixth of a second there is little time for complete combustion. With small engines at even 400 revolutions per minute the ignition is complete, and premature ignition is even difficult to obtain, but large engines are different, having so large a cylinder volume for their capacity or rate of cooling. In many gas engines the initial pressure of compression is nearly 100 lbs. before ignition. In most large engines the terminal temperature exceeds 1,200° C. High compression has reduced this, and enabled more heat to be converted to work, and with scavenging nearly got rid of untimely firing on the charging stroke. But there is still the premature explosion during compression, which is due to the temperature of the high compression, and the piston end of an even well designed piston can hardly be less than a dull red, or, say, 700° C., while the gas must be probably 250° C. when compressed to 100 lbs., so that early ignitions are not to be wondered at. Carbon on the piston and projecting bolt heads are all in favour of causing ignition during compression, and should be avoided. Rich gas mixtures must also be avoided. There is also the risk of a cylinder becoming filled by a mixture of rich gas after several missed explosions. This may be caused by wrong adjustment of the gas and air admissions, and an explosive pressure 30 per cent. in excess of normal may occur. This never takes place with steam engines, and it demands special strength in crank pins, &c., and generally ample margins. Gas engines, therefore, are unduly heavy per H.P. developed, both because of this and because they are only half single-acting. Thus, in spite of all its thermo-dynamic advantages, it has not ousted steam power to the extent which might have been expected. Our author also does not think gas producers are by any means perfect. The Dowson producer requires anthracite at 18s. per ton, so that with a Dowson producer the half weight of fuel used cost more than the double weight of cheaper fuel for the steam engine.

Dowson producers now use coke, but the difficulties with coke are not yet overcome. The Mond producer, according to Mr. Clerk, is the only one making gas fit for use in the gas engine, and this producer is cumbrous and only excellent where ammonia recovery is also carried out. Our author has evidently not seen the Thwaite duplex producer at the works of Mr. Arthur Porritt of Cleckheaton, where, we believe, the cheapest slack is being used and every satisfaction is being given. So far as we can learn, this duplex producer is doing exactly what Mr. Clerk says is required to cause the rapid development of gas power.

A 10 H.P. Crossley engine with 95 lbs. initial compression is showing 22·2 B.H.P., with a consumption of 14·32 cubic feet of Manchester gas per B.H.P. Apply the same economy to large engines and no doubt a B.H.P. hour would be got from 12 cubic feet or 30 per cent. of the heat given to the engine will be returned as work.

In 10 years' time engines of 1,000 H.P. will be as common as those of 100 H P. are to-day. Before applying gas engines to large marine work they must be improved in construction, governing and operation. When the time arrives for this use of gas the equivalent fuel will be easily as low as half a pound per I.H.P. hour.

A good deal of labour has been spent on self-starters. We do not look on self-starters as having a use except between the small engines and those of the maximum size yet made, but are inclined to the view that large gas engines will be started by the intermediation of small engines as with the little so-called barring engines of the textile districts. Undoubtedly there is a future for gas power at sea because of their economy, on land because of the millions of feet of good producer gas sent to waste from every blast furnace.

THE TELEGRAPH TROUBLES.

The Clerks' Point of View.

By CHAS. H. GARLAND.

(*Continued from page* 276.)

There may seem to be a lack of logical arrangement about the order in which the points have been discussed in these papers. This arises to a great extent from the necessities of the case. Such a multiplicity of reasons exists to be discussed that the arrangement has to depend largely on the nature of the evidence rather than on the point contended for. But, undoubtedly, any point which involves a positive wrong, a breach of the promised conditions of service, assumes a greater importance than any claim for an improvement of such conditions. This will explain why the restitution of a scale already conceded was discussed, before dealing with necessary improvements in that scale.

One of the most important improvements asked for has been a better salary after five years' service. "After five years' service" is equivalent to saying at 21 years of age. The average age of entrants into the telegraph service is 16 years; hence, five years later, they enter upon manhood. If it were not for the many objections to an age-scale in the Civil Service, the claim would in all probability have been made for men of 21 years of age instead of "after five years' service." However, the number of entrants under 16 years of age is almost a negligible quantity. The claim, then, is practically a claim for a salary upon which a young man can live, which should be given him at the time he passes from adolescence to manhood. The reasonableness of his claim has been admitted by heads of departments. Thus Mr. H. C. Fischer, C.M.G., Controller of the Central Telegraph Office, in giving evidence before Lord Tweedmouth's Committee on this point, on November 8th, 1895, said: "With regard to the five years' service men, I am of opinion that they are underpaid at that period. The commercial value of the service they perform at that time is much higher than the wages they receive." "I have always held that telegraphists are not getting sufficient at that time. They scarcely get sufficient to keep themselves, and yet are, as a rule, rendering very efficient service." Asked how much the salary should be increased, Mr. Fischer suggested £10 or £12 per year, adding that less would be insufficient. This is a most pathetic picture. The head of a large State monopoly confessing that despite, or perhaps because of, the postal profit of three to four millions per year, a number of its young servants do not receive enough salary to keep themselves.

It is proverbially difficult to reach the heart and conscience of a corporate body, but surely we have here a thing that should touch the individual hearts of even so impersonal a corporation as "the Department," or, if need be, that mysterious and callous entity, the Treasury.

Mr. Fischer was not alone in his view. Support was given by other officials, and from the most unlikely quarters. Mr. J. C. Badcock, Controller of the London Postal Service, on November 11th, 1895, when giving evidence before the same committee, said: "I think the pay in the lower stages is somewhat inadequate." "There should be a material increase after five years' service." Mr. W. H. Preece, F.R.S., said: "I have no doubt that a clerk of five years' service under the present scale does not acquire sufficient to keep himself in a proper position." Even Mr. Lewin Hill, with all his dislike to generous scales for the minor establishment, provided for an increase after five years' service in the proposed revision he submitted to Lord Tweedmouth. When the reasons for an increase at a certain point are so strong as to convince the heads of departments that a readjustment is necessary, it is a fair assumption that overwhelming evidence must exist in its favour. Yet nothing, or practically nothing, has been done. Under Mr. Raikes's revision a clerk got £63 after five years' service; under the present system he receives £64. So, in the face of all the evidence of the necessity for a "material increase," which Mr. Fischer thought should be £10 or £12 a year, he receives the munificent sum of £1, or 4½d. weekly! Really, one is inclined almost to agree with the view expressed by Mr. H. M. Hyndman, in the January *Cosmopolis*: "The Post Office .... employs men and women in vast numbers, with as little regard for their general well-being as if the State were itself a greedy private employer or an unscrupulous limited company."

But it were unfair not to state here that in order to encourage a knowledge of both postal and sorting duties and the acquirement of technical knowledge, an extra increment of £6 is offered to all those clerks who pass an examination in sorting duties, and a further £6 for passing an examination in technical telegraphy, telephony, and in magnetism and electricity, such double increments not to affect the maximum of the scale. This latter condition means that technical knowledge is of no value in a man at his maximum, although it be valued at £6 annually in a man lower down the scale. For telegraphists at the Central Telegraph Office the sorting increment is a dead letter. Of 18 men who have attempted to obtain it—a sufficiently small proportion of 2,000—all have discarded the attempt because of the difficulties attendant upon it. The other increment for technical work is being taken up.

That such encouragement—small as it is—should be given for the acquirement of technical knowledge is a matter for rejoicing, but that it should be regarded as in any way meeting the difficulty of inadequate pay, is food for many reflections. The pay after five years is inadequate, it does not pay the men the commercial value of their services; but before giving any relief the Department exacts further services—further qualifications. The pay is at least £10 or £12 per year less than the value of the work already performed, and yet you must give us more and better work before we increase it by £6. So, in effect, says the Department. A body of young men who are admittedly receiving "scarcely sufficient to keep themselves," are taxed in class fees, cost of books and time, before they receive a very inadequate measure of relief. Telegraph clerks are as little inclined as others to look a gift-horse in the mouth, but when, after praying for years for necessary bread they are offered a stone, can it be wondered at that they grumble? So the underpaid five years' man it still discontented.

There are many other points in connection with the salaries of telegraph clerks which are anomalous and unjust, but a volume could be filled with an exhaustive exposition of them. These papers will only deal with some of the main points, and constitute a summary. But they will be a summary which will throw a light on methods and principles which should have no place in a State Department. The scales asked for by the Postal Telegraph Clerks' Association, as a means of settling the whole matter, are moderate, and meet all the difficulties. Before passing to the question of annual leave, which is a vital question with the men, a quotation from a letter by the genial, but just Mr. A. Birrell, Q.C., M.P., will, I hope, justify itself. "What is the duty of a State Department to its servants?" he asks: "That telegraph servants are cruelly underpaid is certain; on the other hand, such is the state of trade, and so overcrowded are the markets, that there would be no difficulties in filling the places of any of the servants of the Department who chose to vacate them. The taxpayer is the ultimate employer in this case. Is it fair to him to make him pay fancy wages? This much is clear—that a public establishment which brings in a revenue, ought to treat its workmen as generously as the highest class of private employer; a wealthy man who sweats a poor man is admittedly a rascal. If the State cannot afford to run the telegraphic system, except by underpaying its servants, let it give the business up. All public departments are sickening institutions, and nobody can contemplate the State becoming the universal employer without dismay, except by assuming that in future public departments will be totally unlike what they are and always have been."

The question of annual leave is one which causes much bitterness of feeling among the staff. What is the object of annual leave? To be a rest from the work and worry of the office, from the stress and turmoil of the City. The majority of the readers of the Electrical Review look forward to their annual holiday, I am certain, as a period of happiness and sunshine, of rest and quiet. In one's mind the prospect of annual leave is always pictured on a background of hill and dale, green meadows, or foam-flecked sea. The days are long spells of light, of sunshine, and the nights are canopied with a vault of spangled, deep-hued blue. So should a holiday be. But what is the background of the underpaid telegraph clerk's holiday? Mist, fog, rain, sleet, and all the wintry grime of a city's streets. No sunshine at home, nothing but a leaden sky, and no money with which to fly to the South of France in search of warmth and light. Year after year the young men of the telegraph service take their holidays in winter, and year after year they will continue to do so unless some radical change be effected. The periods are chosen by seniority, and are spread equally over the whole year. So one-twelfth of the staff goes in November, one-twelfth in December, one-twelfth in January, and one-twelfth in February. And the same unfortunates continue to be relegated to these months year after year.

Sir Albert K. Rollit said at the Treasury Conference last year: "No matter what class a person may be in, the public are dependent upon skilled labour, and the staff should not be compelled to take its holiday during the winter, whatever the alternative may cost, so long as there is a balance of revenue." He further declared, when the female representative was under examination, "I think it is revolting to hear a young person such as that say she is never to have a summer holiday. It cannot be to the interest of the individual or the State." Mr. Hudson Kearley, M.P., himself a large employer of labour, on the same occasion, said: "There is no other service in the country—public or private—where holidays have always to be taken in the winter. No railway company and no private employer imposes such a condition." Lord Tweedmouth's Committee in their report, said: "We think that the request that the annual leave should be granted in the better months of the year is natural, and are agreed that whenever the conditions of service will permit, every endeavour should be made to meet it." The Duke of Norfolk and Mr. Hanbury promised, after the Conference at the House of Commons, that an attempt should be made to devise means of improvement. And on this promise the telegraph service relied, with the result that the holidays at the Central Telegraph Office are based upon the same principle this year as last. What is the real difficulty in the way of granting this natural request. The Controller or the Central Telegraph Office should know, at least so far as his own office is concerned. The following abstract from his evidence before the Tweedmouth Committee is therefore conclusive.

4,064. The CHAIRMAN: Is it not practicable to confine the holiday period to the eight months of the year?—It is a question of expense.

Later on, following leading questions from his chief, Sir S. Walpole, he added other reasons; but to anyone who understands the ordinary human being, no comment is needed. Undoubtedly the question of expense is the stumbling block in the way of deleting the four months, January, February, November and December from the holiday sheets. Yet the Duke of Norfolk and the secretary to the Treasury have pledged their personal words to devise some improvement. Are telegraph clerks unreasonable in asking that some of the annual profit of four millions should be spent by the Postmaster-General in redeeming his word of honour? In Germany, where the conditions of pressure are the same as in England, the additional expense is incurred, and the summer months are the holiday months. And even in other branches of the English postal service the holidays are confined to the eight best months. Up to now, no hint has reached us, that the Postmaster-General and his immediate staff ever take their annual leave in winter, whatever the conditions of work or expense.

(*To be concluded.*)

STORAGE BATTERY TESTING AT HIGH DISCHARGE RATES.

By RANKIN KENNEDY.

It is well known that in all storage cells in which solid active materials are used the capacity falls rapidly as the rate of discharge is increased. Without entering into the cause of this peculiar phenomena we can endeavour to ascertain the amount of drop in various cells as we increase the discharge rate.

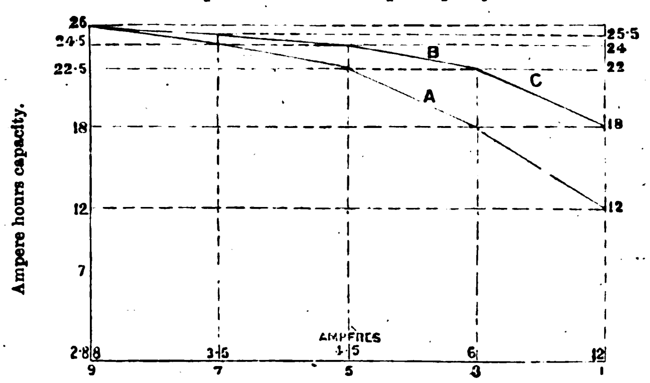
Some of the drop is due to internal resistance of the electrolyte, this can be measured by the difference in terminal pressure with and without the current flowing, but the greatest fraction of the drop is due to something more than internal resistance, and this something varies in value in different cells.

For traction purposes cells are tested for watt-hours per lb. gross weight, spread over a time of from 5 to 8 hours' discharge, but for lighting purposes the gross weight of the cell is of minor importance, while the drop in capacity as the discharge rate increases is of very great importance. Cells at central stations may be called upon to deliver their full discharge in 1 or 2 hours, hence the cells which give the greatest capacity at highest rates are best for that purpose.

If we take two cells of different makes, we will find that if the cells are made for the same discharge rate and capacity on a fairly long discharge, or that at low rates they are practically equal, say, that at 2·88 amperes the capacity for both comes out 26 ampere-hours on a 9-hours' run; if we now discharge them at 3·5 amperes we find cell A finishes in 7 hours with a capacity of 24·5. Cell C in same time has not run down but gives 25·5 capacity, and so on we can obtain readings which, when plotted out as in diagram, give curves, showing that although the cells are equal in capacity at the low 9 hours' discharge, that they are not equal at the higher rates, C being by far the better cell.

The curve, A, is one found by actual tests. The figure 1 on horizontal is cut by an ordinate passing through 12 and 18, showing that cell A discharged in one hour, gave a

Comparative curves for drop in capac'ty.



Hours in which cell is completely discharged.

capacity of 12, while C, discharged at same rate, gave 18, that is, at 12 amperes A discharged in one hour while C ran on for 1·5 hours. A is here taken as a standard for comparison.

On the 3 hours' discharge at 6 amperes, cell A gives 18 ampere-hours, cell C gives 22, and so on, the difference diminishing as the rate diminishes.

That cells can be improved in this direction is clear by one example. Thus the E.P.S. central station cell, K-type, is made for 310 amperes rate discharge in 7 hours; at this rate it gives a capacity of 2,170 ampere-hours, but discharged in 1 hour it gives only 1,050 ampere-hours' capacity, while their improved F.K. cell for same capacity at the low 7 hours' rate of discharge, now gives 1,230 ampere-hours' capacity in a 1 hour discharge—a very well marked improvement. In this comparison we take two cells equal at the 7 hours' discharge, and find that they are to each other on a 1 hour discharge as 10·5 is to 12·3.

For all practical purposes cells for rapid discharges may be compared in this way by making two tests only; one at a 6 or 7 hours' run, or any other time at which the cells to be compared are equal or nearly equal in capacity, then make another test at a rate to discharge the cells in one hour, the difference in capacity between the two cells at the higher rate indicates the difference in efficiency between the two cells. Thus, to take the above example :—

$$\text{This efficiency is equal to the } \frac{\text{ampere-hours at high rate}}{\text{ampere-hours at low rate}}$$

With a perfect cell it would be unity.

In the above example the discharge of K cell at low rate is 2,170, and at high rate 1,050, therefore efficiency is

$$\frac{1{,}050}{2{,}170} = 0{\cdot}484, \text{ the F.K. cell } \frac{1{,}230}{2{,}170} = 0{\cdot}567.$$

The figures are not the gross efficiency given by watt-hours put into cell and watt-hours given out by cell, but are comparative values indicating the drop in output as the rate of working increases.

It would be instructive and interesting if the data were available to compare these curves for a cell of the strip type like Blot's, with a cell of grid type. Theoretically the curve should be better in cells where the active material is spread thinly over large surface.

Whether this is borne out in practice cannot be proved by the author owing to the absence of data.

In this way the all-round performance of any cells can be indicated, even for traction cells it is the best test between two cells of nearly same watt-hours per lb. at the long discharge.

Some such test is necessary, for traction cells have to work at all rates of discharge, so that to arrive at an approximate idea or value of the cells under working conditions the two tests are required to fairly compare two cells.

Of course, this is a supplementary test in the case of traction cells, and whatever the cells may be which are to be compared they must give same capacity in the 6, 7, 8, or 9 hours chosen as the low rate time. Two cells may give same capacity at low rates, and if their watt-hours' capacity per lb. is equal, or nearly so, at that rate, it is clear the watt-hours' per lb. of the cell which has highest capacity at the high rates will have the highest value in actual work on a variable load.

Only in the impossible case of a cell with no drop in capacity on an increasing load is the test of capacity, at one or two low rates, any reliable index of the capacity under the varying rates found in practice.

It has hitherto been too readily assumed that if a cell is superior to another at one or two rates of discharge it is therefore superior all along the line.

In concluding these occasional articles on battery testing, it may be pointed out that while actual testing and noting down results is a simple matter quite within the capacity of a student at school, the laying out of the plan of the tests and the making of comparisons between the results observed and other results already published, is a task which presents some difficulties to those who are considered capable experts.

We have well known accepted methods for comparing engines, dynamos, motors, transformers, lamps and other appliances, but it seems we have no recognised methods for testing and reporting upon storage batteries in such a way that the results are comparable and above suspicion of errors.

REVIEWS.

The Law and Practice of Letters Patents for Inventions. By Lewis Edmunds, D.Sc., Q.C. Second Edition by T. M. Stevens, D.C.L. London: Stevens & Sons, Limited, 119 and 120, Chancery Lane. Price 32s.

The annual number of patents granted to inventors appears to be one of the best indications of the manufacturing activity of a country. At least, the United States, Great Britain, and Germany stand at the head of the list in both these respects. Probably the greatest number of inventions per annum are patented in this country, but though there may be some doubt whether we or the U.S.A. stand first in numbers, there can be no doubt that the patent law of this country is the oldest in the world.

We learn from the interesting history of Patent Law in Dr. Edmunds's volume that the grant of Letters Patent conferring a monopoly is one of the last survivals of the once extensive prerogative of the Crown. As late as the reigns of Edward III. and Richard II. the king claimed to give special privileges to individual traders, but the first patent for an invention in the modern sense appears to have been granted in the reign of Henry VI. to two aldermen "that they and their assignees should have the sole making of the philosopher's stone." Up to the time of Elizabeth patents were granted for new inventions, and also for restraint of trade in articles or arts already known. The latter class of monopolies were after a long struggle during the reigns of Elizabeth and James I. declared to be illegal, and the prerogative of the Crown was restricted to granting patents for new inventions only.

In 1624 the Statute of Monopolies was enacted, and it is on Section 6 of this Act that Letters Patent for invention depend. The present term of 14 years was then fixed, and the patent was to be granted to the true and first inventor only. The procedure for taking out Letters patent was subsequently modified by Acts passed in 1852 and 1883 and amending Acts in 1885, 1886, and 1888. Some idea of the long and cumbrous procedure necessary to obtain a patent before 1852 may be obtained, when we learn that the applicant had to make application at least 10 separate and distinct times to almost as many different officials. The Home Secretary, the law officers, the Lord Chancellor, all had a finger in the pie, and the wonder is invention was not strangled with red tape. Happily our Patent Law has now been simplified, and the cost of obtaining a patent reduced to a very moderate amount. Our patent system is still behind those of its leading modern rivals in one respect; it takes no steps to ascertain that patents are granted for new inventions only. The United States has examined inventions for novelty for the last 60 years, and the leading European countries, with the exception of France and Great Britain, have also adopted the American system.

Our patent practice has been otherwise brought, by a long series of legal decisions, to a state of great perfection, and in no treatise will a better exposition of Patent Law and Practice be found than in Dr. Edmunds's volume. The present edition extends to almost 1,000 pages, and appears to contain sufficient information to start a patent barrister or a patent agent in business in a small way. The subject matter of the volume is well arranged and indexed. It is divided into two parts; Part I. discussing Patent Law and Practice, and Part II. containing the Patent Acts at present in force, with full and valuable notes. Wherever we have tested the matter in this huge volume, we have found it reliable, accurate, and up to date; the style and arrangement is so clear, that a consulting engineer, or even a patentee without legal training might, in many cases, settle points in dispute about patent rights, and save the parties concerned from expending thousands of pounds on patent litigation.

Glass Blowing and Working. By T. Bolas, F.C.S., F.T.C. London: Dawbarn & Ward, Limited, 6, Farringdon Avenue, E.C.

The author, at the commencement of his book, points out that glass blowing is an interesting recreation as well as an industry, although very few people seem to recognise this. As cultivating delicacy of touch and perception, Mr. Bolas says it stands almost alone, though this is probably an exaggeration which an enthusiast always credits to the art in which he is particularly interested. A few pages which are devoted to the historical aspect of glass are decidedly interesting. Careful details are first given as to the best standard form of blowpipe; also various forms of bellows are described, and it is even shown how two pairs of ordinary domestic bellows may be adapted for blowpipes. The various tools required are next described in detail; in fact, attention to detail is a characteristic of the book. The working of glass for all kinds of philosophical instruments is fully gone into, so that the whole work makes an excellent treatise which can be highly recommended.

Journal of the Institution of Electrical Engineers, No. 131. London: E. & F. N. Spon, 125, Strand.

The general contents of this number are as follows:—"Accumulator Traction on Rails and Ordinary Roads," by L. Epstein.

The Workmen's Compensation Act, 1897. By W. A. Willis, LL.B. Third edition. London: Butterworth & Shaw and Sons, 1898.

This third edition of a really important little book has been revised and somewhat extended. We doubt if employers generally have given to the Act of 1897 that consideration which it deserves. They will find in the very near future that they have made a mistake by not so doing. The Act was that of a Conservative government, and probably had such an Act been brought into being by a Liberal or a Radical government there would have been such a terrific outcry through the length and breadth of the land, that all England would have been roused to a full and proper sense of the ruin of the constitution and the dangers of socialism, and all that sort of thing which is allowed to pass for statesmanship when hall-marked by the Tories. The new appendix consists of a form of application for certificate to scheme issued by Chief Registrar where employers and employed alike agree to a contracting out scheme. The Act itself is remarkable as the first instance in the history of English Jurisprudence, wherein a liability has been cast upon an individual to pay damages for injuries which are not the result of any negligence or other unlawful act either of himself or his servants, for whose conduct he is legally responsible.

An employer by this new Act is practically made to compulsorily insure his workmen, or failing to do so, he is liable for all or any of their injuries, to the extent of bankruptcy. Under common law an employers' liability has three limits, known as the doctrine of common employment, accepted risks, and contributory negligence. The Act of 1880 was intended to destroy the first limitation. This Act left the door open for much evasion of its provisions and for much litigation. Mr. Asquith's Bill of 1893 was introduced to meet these objections, but was withdrawn because of the insistence upon contracting out by the Lords. By the Act of 1897 one limitation alone seems to be preserved, where a man's serious and wilful misconduct shuts him out of any compensation. What a field is here for litigation ! ! Serious and wilful misconduct ! ! ! Who is to be the judge ? Contracting out is limited to where a scheme has been formulated and certified by the Registrar of Friendly Societies as conferring benefits equal to the Statute. An employer cannot evade liability by sub-contracting. Perhaps this may help to wipe out the ridiculous objection to sub-contracting by London vestries and other bodies.

Speaking generally, however, the employers' lot is not a happy one. If he cannot be got at under the new Act the Act of 1880 may be brought to bear on him, and failing that the common law is still a weapon in the hands of his enemy. Then there is a Fatal Accidents' Act of 1846. The employers only chance, if he be a small employer, is to insure against all liability; if he be a large employer he may join his workmen in a scheme of contracting out. We would advise all employers to buy and read this book, and study its very stringent clauses. We are not quite sure if an employer would not be liable if one of his late workmen out on strike got hurt while on picketting duty.

General Elementary Science. Edited by WILLIAM BRIGGS, M.A., F.C.S., F.R.A.S. London: W. B. Clive, University Correspondence College Press.

We have received from the University Correspondence Press a copy of another edition to the long list of books that have appeared in recent years for the use of science students. This work, written by four authors of considerable reputation, under the editorship of Mr. William Briggs, covers the general ground of elementary mechanics, physics, and chemistry, and is particularly designed for the Matriculation Examination of the University of London. It is arranged in a series of more or less disconnected paragraphs, as, indeed, many successful educational books have been, from Euclid and Routh's Rigid Dynamics, downwards. Regarded as a cram book, *i.e.*, a book arranged with the definite purpose of preparing candidates for examination, we do not see how it could well be improved. The arrangement of the propositions is logical and consecutive, the explanations are simple and exact; where a complete definition may be beyond the students' comprehension, *e.g.*, in that of electrical potential, a note is added; the illustrations seem sufficient for the purpose. Every page contains evidence of the intellect required for the production of a good elementary book. The volume is of a convenient size for the pocket, and the typography is excellent.

NEW PATENTS.—1898.

[*Compiled expressly for this journal by* W. P. THOMPSON & Co., *Electrical Patent Agents*, 322, *High Holborn, London, W C., to whom all inquiries should be addressed.*]

4,879. "An improved method of distribution of news and music by telephone." L. E. WILSON. Dated February 28th.

4,895. "Improved manufacture of insulating conduits for electrical conductors and appliances employed in connection therewith, and for laying the conductors therein." F. T. WOODCOCK. Dated February 28th.

4,900. "Improvements relating to joints of telegraph wires." A. A. COMMON. Dated February 28th.

4,903. "Improvements in primary batteries." J. E. FULLER. Dated February 28th. (*Complete.*)

4,910. "Improvements in, and relating to, primary batteries." C. KOENIG. Dated February 28th. (*Complete.*)

4,926. "Improvements in, and relating to, portable electric lamps and batteries therefor, and for other purposes." H. H. LAKE. (L. Paget, United States.) Dated February 28th.

4,929. "Improvements in, or relating to, electric railway conduits and conductors." A. J. BOULT. (R. Snyers, Belgium.) Dated February 28th. (*Complete.*)

4,995. "Improvements in electro-magnets or magnetic closers for use on electric railway vehicles." J. N. THOMAS. Dated March 1st. (*Complete.*)

4,999. "Improvements in, and relating to, electric railways." W. M. BROWN. Dated March 1st. (*Complete.*)

5,001. "Improved controlling system for electric railway vehicles." S. H. SHORT. Dated March 1st. (*Complete.*)

5,029. "Improvements in regulating apparatus for arc lamps." H. LEITNER. Dated March 1st.

5,034. "Improvements in, or relating to, electrolytic electrical meters." C. O. BASTIAN. Dated March 1st.

5,048. "Improvements in electric meters." EVERSHED & VIGNOLES, LIMITED, and S. EVERSHED. Dated March 1st.

5,049. "Improvements in alternating current motors." W. STANLEY. Dated March 1st. (*Complete.*)

5,054. "Improvements in current collectors for dynamo-electric machines." G. W. NELL. Dated March 1st. (*Complete.*)

5,062. "Improvements in incandescent electric lamps." W. P. THOMPSON. (J. T. Lister and W. S. Chamberlain, United States.) Dated March 1st. (*Complete.*)

5,064. "Improvements in non-synchronous electric motors." R. BELFIELD. (B. G. Lamme, United States.) Dated March 1st.

5,065. "Improvements in arc lamps." R. BELFIELD. (H. P. Davis and F. Conrad, United States.) Dated March 1st.

5,066. "Improvements in electric switches." R. BELFIELD. (H. P. Davis and E. F. Harder, United States.) Dated March 1st.

5,067. "An improved means for feeding the carbons in electric arc lamps." C. WOOD. Dated March 1st.

5,068. "Improvements in and relating to the carbon-feeding mechanism of electric arc lamps." C. WOOD. Dated March 1st.

5,083. "An improved means of and apparatus for varying the strength of electrical currents." R. HOPE-JONES. Dated March 2nd.

5,130. "Method of utilising the interior of electric incandescent lamps for advertising purposes." L. BISHOP. Dated March 2nd.

5,133. "Improvements in electric lamp fittings." J. M. HUSMAN and H. C. GOVER. Dated March 2nd.

5,162. "Improvements in the manufacture of waterproofing coating compositions for wearing apparel, covers, engine and other packings, acid tank linings, electrical insulating compositions, and for other uses." C. J. GRIST. Dated March 2nd.

5,172. "Improvements in telephone transmitters." J. V. COLLINGWOOD. Dated March 2nd.

5,176. "Improvements in means or apparatus for starting and regulating electric motors." J. H. HOLMES. Dated March 2nd.

5,177. "Improvements in dynamo-electric machines." W. B. SAYERS and MAVOR & COULSON, LIMITED. Dated March 2nd.

5,178. "Improvements in the manufacture of electrical transformers, and other alternating current apparatus having iron cores." A. F. BERRY. Dated March 2nd.

5,185. "Improvements in electrical conducting apparatus for tramways, railways and the like." C. F. P. STENDEBACH. Dated March 2nd. (*Complete.*)

5,186. "Improvements in or relating to secondary batteries." R. HADDAN. (H. Dolter, France.) Dated March 2nd. (*Complete.*)

5,208. "Improvements in electrically operated gas valves for burners." THE ACTIENGESELLSCHAFT FUR FABRIKATION VON BRONCEWAAREN UND ZINKGUSS VORM., J. C. SPINN & SOHN and S. J. VON ROMOCKI. Dated March 3rd.

5,260. "An improved primary battery." E. A. MITCHELL. Dated March 3rd.

5,287. "Improved coin feed mechanism for making and breaking electrical contacts." R. HADDAN. (M. Vidal, France.) Dated March 3rd.

5,288. "Improvements in globes or bulbs for electric incandescent lamps for decorative advertising and other purposes." P. HERBE. Dated March 3rd.

5,300. "Improved means for lighting railway trains electrically." R. R. MEACOCK and A. J. HARPER. Dated March 4th.

5,343. "Improvements in fluids for impregnating bodies or suitable fabrics, threads, fibres, or the like, for incandescent lighting purposes." F. P. FOSTER and G. (BODO) PUCHMULLER. Dated March 4th.

5,379. "Improvements in the manufacture of deep sea telegraph and telephone cables." W. T. HENLEY'S TELEGRAPH WORKS COMPANY, LIMITED, and G. SUTTON. Dated March 4th.

5,418. "Improvements in electric telephony." C. ADAMS-RANDALL. Dated March 5th.

5,423. "An automatic electric switch for hoists and cranes." J. GODDARD. Dated March 5th.

5,449. "Improvements in 'oscillographs' or apparatus for indicating or recording rapidly varying electric currents or potential differences." W. DU BOIS DUDDELL. Dated March 5th. (*Complete.*)

5,469. "Improved system of electric traction and apparatus therefor." A. J. BOULT. (J. P. Anney, France.) Dated March 5th. (*Complete.*)

5,478. "Improvements in alternating electric current transformers." J. A. MCMULLEN. Dated March 5th.

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ELECTRIC POWER SUPPLY FROM CENTRAL STATIONS.

NOTWITHSTANDING the enormous progress that has been made in this country in the last half-century in perfecting and cheapening our methods of production, and of transporting the raw material to, and the finished article from, the manufacturer, we find that other nations have advanced as fast or faster than ourselves, and that our manufacturing supremacy is no longer so marked as in past times. The causes of this increased competition are many and various, and if we wish to maintain our position in the front, we must take care to make the most of such advantages as we possess; employers must not be slow to adopt labour-saving appliances, nor to replace existing tools by others of improved design and greater possible output; the management must keep a sharp look out for, and at once remove, all possible causes of waste; and the workman must realise that his chance of increasing his weekly earnings lies in doing his best to increase the output of the machinery he tends.

We have been accustomed to think that our coal fields and railways give us an advantage over our rivals; but this is not always so, as there are cases where transport freights are lower in other countries than with us, and the introduction of electric transmission of power has made it possible in some districts to do without coal, and to utilise the energy of falling water. The fact that in our manufacturing districts coal is cheap, and that in many cases the cost of power is only a small item of the total cost of production, has made many of our manufacturers somewhat neglectful of this branch of their operations; and we too often see boilers, worked at ridiculously low pressures, supplying steam through long ranges of pipes to small and uneconomical engines, or engines transmitting power through such an amount of shafting, gearing, and belting, as to leave but a small percentage of the power produced available at the machines.

The importance of keeping down the cost of power is beginning to be more fully recognised, and already a certain number of works have electric generating stations whence power is transmitted electrically to motor-driven machinery with a gain in economy over the older methods; and it is now proposed by the Midland Electric Corporation for Power Distribution to go a step further, and to put down a central station for the purpose of electric power supply over an extended area. The paper by Mr. Addenbrooke, "Electric Power Supply from Central Stations," which was read a fortnight ago before the South Staffordshire Institute of Iron and Steel Works' Managers, deals with this question of cost of power; and, after some remarks on the cost of water-power as compared with that of power produced by coal, gives an outline of the Midland Electric Corporation's scheme as an example of the best way of getting the power from the coal to the machinery it is to drive.

The comparison of cost of power obtained from water or coal is disappointing, as the paper gives nothing but general and somewhat vague expressions of opinion, arriving at the conclusion that the difference in annual cost between water and steam power is practically the cost of coal and stoking or handling it; and that "the whole of this difference can only be debited against the coal power on the assumption that no rent is paid for the water-power, nor any inordinate sums for its conservation and utilisation." The subject is a difficult one, and the paper before us does not add much, if anything, to our knowledge of it; as we cannot consider any arguments of much value which are unsupported by figures of the capital cost of existing water-power installations. Mr. Addenbrooke says that the cost of buildings, dynamos, switch gear, motors and mains, will be the same in both cases, except that, as regards the mains, water-power will generally be at some disadvantage, because large waterfalls are often not very accessible. It appears to us that this point may be of considerable importance, as either the distance that power has to be transmitted will be very much greater, or, if works are erected near the water-power, the cost of transport of material to and from the works will be increased. It must not, however, be forgotten that this very inaccessibility of the water-power often permits of the use of bare overhead wires, and a cheaper line construction than would be possible in South Staffordshire or other districts equally well placed as regards cost of coal.

We are next told that we shall not be far out if we put the cost of turbines, turbine pits, sluice gates, and general arrangements against that of steam engines of similar power, but no figures are given; indeed, the only figure of capital cost given in this part of the paper is that the cost of boiler plant, with condensers and economisers, will be about £4 per horse-power, and we are asked if the necessary canals, tunnels, embankments, weirs, or dams could be constructed for the same figure. But this is just the question we would ask the author of the paper; as, unfortunately, English engineers have little chance of gaining personal experience in such work, although they would have no difficulty in fixing the cost of a boiler plant of any given size. It would, therefore, have been much more satisfactory if Mr. Addenbrooke had been able to tell us the capital cost of various water-power installations, even if he had left us to supply the figures for steam power.

With regard to working expenses and general charges, we are told that whilst the depreciation on buildings, dynamos, switch gear, motors, and mains will be the same in each case, on boilers and engines it will probably be greater than on turbines, canals, and other constructional work, and that the cost of administration, of engineering staff, and of rates, taxes, and other standing charges, will probably be the same. By balancing the greater depreciation on steam plant against the probable greater capital cost of water plant, Mr. Addenbrooke arrives at the conclusion that the cost of coal and stoking is the only unbalanced item, and proceeds to calculate this cost per I.H.P. per annum. The figure arrived at, viz., £2 10s. per I.H.P. for a working year of 8,000 hours, is quite possible of attainment with a good load factor; but if steam-power had to compete against water-power with that extra charge against the former, it would be a serious handicap in an industry where power is used continuously, and where its cost forms a large proportion of the total cost of production. A working year of 8,000 hours is not, however, the normal thing in England, the usual conditions being a 54-hour week, or, say, 2,800 hours per annum, and Mr. Addenbrooke argues that, under these conditions, coal can compete better with water, because the extra charge will be reduced from £2 10s. to 17s. 6d. per annum. This is, of course, true, if the comparison is restricted to one between coal and water, with the same load factor and hours of working; but the statement must not be taken to mean that there is any economy in short hours, as owing to the cost of coal being, in the majority of our manufactures, a comparatively small item in the total cost of production, a steam factory working 10 hours per day may easily produce cheaper than a rival water-power factory, if this latter works only nine hours per day. The load factor is the important item, and we do not think that Mr. Addenbrooke has allowed sufficiently for it in fixing the cost of coal for the smaller number of working hours; as, although the bulk of the demand for power may come between the hours, say, of 6 a.m and 5 p.m., there will always be some demand outside these hours, and the cost of coal per horse-power-hour will undoubtedly be increased by the smaller load factor, and by the stand-by losses.

With regard to the proposals of the Midland Electric Corporation, the paper does not tell us much that has not already been made public, as the system to be employed, whether direct current, two-phase, or three-phase, remains still undecided; but we learn that current will probably be transmitted at 5,000 volts pressure, and some figures are given of the cost of the primary mains. Considerable attention has been given to the method of charging for the electricity, and it has been decided to charge on the Demand meter system, the rates for power supply having been fixed in the agreements with certain local authorities at 3d. per unit for the first hour's use per diem taken on the maximum demand, and ·825d. for each subsequent hour. A table is given in the paper which shows the average price per unit for any number of hours of maximum demand per diem, from which we see that for most manufacturing establishments the average charge per unit would be about 1¼d. At this price it would certainly pay all small power users to take current from the Corporation rather than to generate it with their own plant, but there is no reason why users of 50 horse-power or even less should not be able to generate electricity on their own premises at the same or a lower cost.

Let us consider a case where there are 312 working days of nine hours each per annum, and where the average load is half the maximum. The average charge made by the Midland Electric Corporation would then be 1·3d. per unit., and the charge per kilowatt for the year would be £15 4s. 2d., of which, taking Mr. Addenbrooke's figures, only about 27s. 6d. would represent the cost of coal and stoking at the central station. Of course in an isolated plant the consumption of coal will be much greater, but there should be no difficulty in obtaining boiler, engine, dynamo, and piping for a 50 kilowatt plant at the rate of £25 per kilowatt, and producing the kilowatt-hour for a consumption of 10 lbs. of coal with a load factor of 50 per cent., all stand-by losses included. One man, with occasional extra help for boiler cleaning or other extra work, could look after this plant, and an allowance of £100 per annum for labour will therefore be sufficient. The average output being 25 kilowatts for 2,808 hours, the output in the year will amount to 70,200 units, and the cost of labour will therefore be ·342d. per unit. Taking coal at 5s. per ton, the figure given by Mr. Addenbrooke for the neighbourhood of South Staffordshire, we see that coal will cost $\frac{10 \times 60}{2,240} = \cdot 268$d. per unit, and if we add ·05d. per unit for oil and waste we get for material and labour a cost of ·660d. per unit, leaving a margin of ·640d. per unit for interest, depreciation, and repairs, to make up the cost of 1·3d. per unit which would be charged for a supply from the central station. As the output is 70,200 units per annum, this represents a sum of £187 4s., or practically 15 per cent. on the £1,250 which we have taken as the cost of the 50-kilowatt plant.

It would appear, then, that there is no need for manufacturers to wait for a central station supply to realise the economy in the cost of power which is offered by Mr. Addenbrooke, except for the saving in capital expenditure. This is, to many of them, a very important point, and the fact that no money will have to be spent on generating plant, and that it will be possible to hire motors from the Midland Electric Corporation should be a great inducement to the introduction of electric power by many who hesitate about making the change on account of the considerable capital expenditure involved.

Water Power for Crieff.

THERE is a water power scheme in the air at Crieff, the source of power being the falls of the Turret, which are on the estate of Sir Patrick Keith Murray, who offered to give the falls for power purposes and had measurements taken which he submitted, says the *Scotsman*, to a London electrician. This gentleman said the falls were not sufficient for the purpose. Mr. Arnot, of Glasgow, had also reported unfavourably of the falls as insufficient to light the town of Crieff. Sir Patrick intimated the London decision to the town in order to save them further trouble and expense. Mr. R. F. Yorke also furnished the Town Council with a report, and he writes to the *Scotsman* to say that no other electrician but himself has been consulted, but that a turbine manufacturer to whom wrong data were submitted stated the power as insufficient. Mr. Yorke writes he has since further explained matters to Sir Patrick, and that the fall is of 300 cubic feet of water per minute through a height of 250 to 600 feet, and not 100 feet as originally stated, which, of course, may make all the difference. Sir Patrick's factor writes, that if the Council are satisfied the fall is still open to them. It is quite possible that an apparent fall of 100 feet may easily be convertible into one of a much greater depth. Assume 300 cubic feet falling 400 feet instead of 100 feet, and at once the net horse-power will be 150 in place of less than 40. Most falls of water are preceded by a series of small falls and rapids, and where the flow is small a pipe line from above the rapids enables the fall to be better utilised, and may also enable the power house to be located well below the falls, the after rapids often being as valuable as the main fall itself. We see no reason to doubt that an oversight may have been made, and the occasion is useful if it draws attention to the fact that there are numerous falls available for power purposes if the system of pipe lines be adopted from above to below the available total declivity. In the Southern Californian water-power plants the pipe lines and tunnels are often brought from an initial point some miles distant, so as to secure a maximum possible fall, and if this can be combined with a dam, the uniformity of flow throughout the year can be thereby very much improved.

SEPARATION OF THE IRON LOSSES OF A TRANSFORMER.*

By Prof. H. S. Carhart.

THE following elaboration of a method of separating the iron losses taking place in a transformer is based on the measurement of these combined losses at two frequencies. A series of measurements is made at each frequency for a number of different voltages. From these two series we may obtain several pairs of equations connecting together the hysteresis and eddy current losses, each pair being taken for the same value of the maximum instantaneous induction, β, of the magnetic wave at the two frequencies. From each pair of equations may be obtained both the eddy current loss and the loss by hysteresis for the voltage corresponding.

To keep the magnetic induction constant, the E.M.F. E must be proportional to the frequency. This is evident from the general formula for the effective E.M.F., which is

$$E \times 10^8 = \sqrt{2}\, \pi\, n\, A\, \beta\, N \text{ volts},$$

where n is the frequency, A the cross section of the iron, β the maximum induction, and N the number of turns of wire. If β is constant, E is proportional to n.

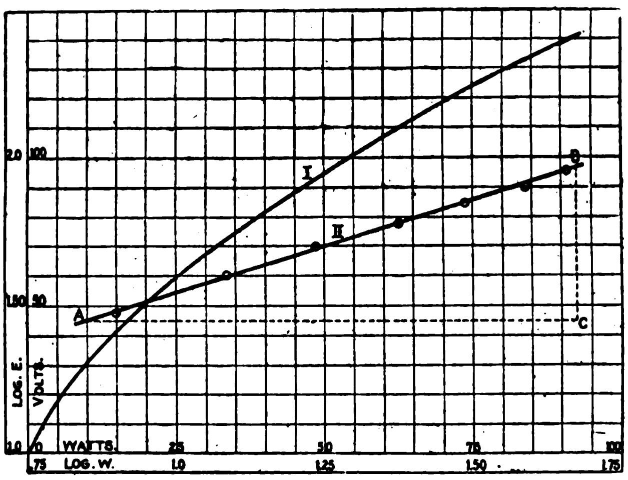
If, then, W and W′ are the total iron losses for the two frequencies n and n', both with the same value of β, we may write for the equations of these losses the following:

$$W = a\, n^2 + b\, n \qquad (1)$$

$$W' = a\, n'^2 + b\, n' \qquad (2)$$

These equations are written on the assumption that the eddy current loss is proportional to the square of the frequency. The loss by hysteresis is, of course, proportional to the first power of the frequency. The constants a and b are respectively the eddy current and hysteresis loss per cycle for the same value of the maximum induction β.

If W′ is the iron loss for an E.M.F. E′, then the value of E for the same magnetic induction in the other series is E′



n/n'. The corresponding watts W lost in the iron at the frequency n may be read from the curve representing the relation between volts and watts lost at that frequency.

The measurements below were made on a 2-kw. Slattery transformer. The current was furnished by the small laboratory alternator, which I have described in another place. (*American Electrician*, November, 1887.) The following series of observations were taken:

Series A. Frequency, 154·7.		Series B. Frequency, 108·7	
Volts.	Watts.	Volts.	Watts.
30	9·0	30	9·8
49	12·8	40	15·1
50	19·4	50	21·3
60	25·2	60	28·4
70	31·6	70	36·1
80	38·9	80	44·5
90	46·5	90	53·1
100	54·2	100	62·2
110	62·7		
120	71·5		
130	81·1		
140	91·5		

* New York *Electrical World*.

Curve I. in the diagram expresses the relation between volts and watts for Series A. It is used to find by interpolation the watts corresponding to the voltages under A in the following table. These voltages are found, as already explained, by multiplying those of Series B by the ratio n/n'. In the present case this ratio is 1·491.

Series B.		Series A.	
Volts.	Watts.	Volts.	Watts.
30	9·8	44·73	16·0
40	15·1	59·64	24·7
50	21·3	74·55	34·75
60	28·4	89·46	45·75
70	36·1	104·37	57·7
80	44·5	119·28	70·6
90	53·1	134·19	84·75

By substitution in equations (1) and (2) we may now obtain seven pairs, viz. :—

$$16 = 154{\cdot}7^2\, a_1 + 154{\cdot}7\, b_1$$
$$9{\cdot}8 = 103{\cdot}7^2\, a_1 + 103{\cdot}7\, b_1 \qquad (1)$$
$$\cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot$$
$$84{\cdot}75 = 154{\cdot}7^2\, a_7 + 154{\cdot}7\, b_7$$
$$53{\cdot}1 = 103{\cdot}7^2\, a_7 + 103{\cdot}7\, b_7 \qquad (7)$$

The intermediate equations can be filled in from the table above. Solving these equations for the eddy current losses, we get the following for the frequency 103·7 :—

Eddy loss.	Total loss.	Hysteresis loss.	Volts.
1·9	9·8	7·9	30
2·9	15·1	12·2	40
4·09	21·3	17·21	50
4·66	28·4	23·74	60
5·29	36·1	30·81	70
5·81	44·5	38·69	80
7·63	53·1	45·47	90

We have thus separated the losses for the frequency 103·7; the same equations may be used to separate them for the frequency 154·7.

Since these seven pairs of equations involve different values of the magnetic induction β, they may evidently be employed to determine the exponent of β in Steinmetz's formula for the hysteretic loss. For the same value of n the hysteretic loss in watts may be written $W = c\ ^x$, where c is a constant. Hence:

$$\log W = x \log \beta + \text{constant}.$$

But for the same frequency, β is proportional to the volts E. Let β equal k E. Then, since k is a constant,

$$\log W = x \log k + x \log E + \text{constant}$$
$$= x \log E + \text{constant}.$$

The relation between the logarithms of W and E is evidently the equation of a straight line, and the desired exponent x is the tangent of the angle which this line makes with the axis of log E. The logarithms of the loss by hysteresis and of the corresponding volts of the last table are plotted in Curve II. of the diagram. The tangent of the angle A B C, measured in terms of the two scales on which the logarithms are plotted, is quite closely 1·6.

The method obviously gives better results when the measurements are made on a transformer having iron losses which can be read on the best part of the scale of the wattmeter. The small readings are not so reliable as the larger ones.

I have applied the same method to the small transformer described in the *Electrical World*, September 18th, 1897. The plot of the logarithms gave the same result, viz., 1·6. This confirms Steinmetz's formula for the loss by hysteresis.

TOPICS OF INTEREST TO CENTRAL STATION MEN.

An address upon this subject was delivered on January 19th last by Lieut. Francis A. Badt, before the North-Western Electrical Association, Milwaukee, Wis.; and, as will be seen in the present review, there *is* much not only to interest but also to amuse central station men. He starts off on the rather threadbare—or, as he calls it, "the old, old subject of alternating *v.* direct currents," and appears to distribute his favours about equally between them—a thing, by the way, that very few electrical men are unbiassed enough to do. He then plunges into the troubled waters of "pressure," and after detailing the difficulties he experienced in getting manufacturers to produce a 220-volt incandescent lamp, practically takes the credit for its production as a commercial article. He takes considerable trouble to explain the advantages of a 220-volt direct current two-wire system over the three-wire system, and states that the former is really simpler! We should have thought it unnecessary to explain (!) this to an electrical association. The 220-volt enclosed arc lamp he considers to be a decided advance, as it can be run direct across the mains instead of using two or three in series, and as the arc is three-quarters of an inch long it practically casts no shadow. Obviously, the longer the arc, the less likelihood of shadow *from the carbons;* but he overlooks the fact that the shadows from the supports and spark catchers are much greater than those cast by the lower carbon, no matter what length the arc may be, while the colour of the light produced by any long arc lamp is usually far less pure than that from a short arc for the same expenditure of energy, and in England, at any rate, the colour and steadiness of the light are matters of considerable importance. He is doubtless right in stating that fluctuations of pressure affect a high voltage arc lamp much less than it does a low voltage lamp, and where arc lamps are required to be used on power circuits, there would probably be some advantage in using the higher pressure. Seeing, however, that on lighting circuits a steady pressure is essential on account of the incandescent lighting, its superiority even in this respect is not obvious, and we fancy that the consumer would prefer a lower pressure lamp with a reasonably steady arc and white light. He contends that "you can supply a customer with one lamp without making that lamp depend upon somebody else's lamp, doing away with all series connections." This throws rather a strong side light upon American central station practice, and reminds one of the complaint made many years ago in England by a consumer in a south coast town, that when he wanted to light a single lamp in his bath-room, he also had to light up his drawing room! the lamps being on the same circuit in a parallel series system. He states that "Our friends over the water have declared time and again, and have proven it to us mathematically, that the enclosed arc is no good; that the open arc is of greater efficiency and has many advantages over the enclosed arc, but in spite of these theoretical demonstrations the enclosed arc is the arc to-day in the United States, and the open arc for constant potential circuits is getting out of vogue entirely. It is a back number, and gives us one of the illustrations where theory and practice do not coincide. *The American is, if anything, practical,* &c." Lieut. Francis A. Badt is probably not aware of the large number of enclosed arc lamps in use in England, nor must he assume that the opinions of one or two or half-a-dozen does of necessity represent the opinions of the electrical men of England.

He thinks it will not be very long before they will have an enclosed arc lamp of 500 volts which can be attached directly across the wires of a railway circuit! But why stop short at 500 volts? Why not run up to 2,000, or 10,000 volts for that matter, and connect directly across the feeders of a high tension system? An arc lamp with a 3 feet arc would be a novelty, and *would cast no shadow!* A street lighted with a double row of such lamps would be a sight worth seeing, and we confidently expect practical America to show us the way.

Lieut. Francis A. Badt is in trouble about the "gas cap" of the enclosed arc lamp, *i.e.*, the cover of the inner cylinder, and through which the upper carbon passes. He complains that carbons vary so much in diameter, that either the carbons stick in the hole, or are so loose, that the air gets in too readily, and the life of the carbon is materially reduced. We, in England, would usually surmount this difficulty by specifying for a certain diameter of carbon, and a certain size of hole, and seeing that we got it, or else promptly return the goods to the makers. We presume this remedy has not occurred to practical Americans, and the remedy suggested by the speaker was the standardising by the Association he was addressing of the diameter of the hole and the carbon. The old story of leading a horse to the water. The Association may standardise, but the maker will supply carbons and gas caps out of standard if the purchaser is not smart enough to see that he gets what he wants. He says that all the above refers to the direct current system, *of course.* Why of course? A pressure of 220 volts is not confined to direct current systems—at any rate in England—neither are enclosed arc lamps, or two-wire or three-wire systems, and if a 500-volt arc lamp is a desiratum for direct current supply, it would be equally advantageous to alternating current systems.

His opinion is—referring now to alternating currents—that the single-phase system will eventually be the system, and makes the astonishing statement that "We have *now* (italics are ours), of course, incandescent lamps burning on alternating currents." (Must we assume that America has not been accustomed in the past to run glow lamps on alternating current circuits?) With alternating arc lamps and single-phase motors he thinks the single-phase alternating system *the* system for large areas The speaker criticised an objection made previously by a Mr. Dow: "That each customer had to have a transformer for the maximum capacity of the dwelling, or whatever it might be, and he cited that as a great disadvantage of the alternating system as against the direct current system." He (the speaker) said, "Now I think that a good deal of that could be avoided in the alternating system by using larger transformers for a number of customers," and goes on to remark that of course it could not be done economically with 50-volt lamps, and it may not be possible to do it economically with 110-volt lamps; but why not use 220-volt lamps?

We should strongly recommend our old friend of years ago to run over to England, for while we are not practical Americans, we have never used any other alternating system than the single-phase for central station supply, and he may be surprised to learn that "banking" transformers is the rule, and is nearly as old as the system itself, that we have never experienced any trouble in running incandescent lamps on alternating current circuits, that stations have been made to pay on 110-volts pressure; and, finally, that 200 or 220-volt lamps are largely used, and have been since their introduction as a commercial article. In conclusion, he draws attention to another threadbare subject, viz., the low efficiency of steam plant, and finally becomes prophetic. "The steam engine of the future (he says) will have a much higher efficiency, of course. It will do away entirely with boilers. It will be a steam engine that burns the fuel, &c."

Then he proceeds to give himself away by saying, "I am not guessing here; but I am just describing an engine which is now on exhibition on the other side of the water," &c., and after explaining that Americans are now trying to buy the patents of this wonderful engine, he goes on to describe an American Utopian city in which street railways will be abolished, and motor cycles and motor buses "running in all directions" (!) on asphaltum pavements, will be the ideal form of locomotion, and the new engine is going to help them realise it! We should like to know something more of this steam engine without a boiler, and which burns its own fuel; but we are content to wait until America has purchased the patents and blown off some of its enthusiasm. We may then hope to get some reliable information, and shall probably find that this wonderful swan is but a very inferior sort of goose after all. We have seen too many of the inventions that were going to revolutionise engineering practice to feel any excitement over one or even half-a-dozen more.

THE ELECTRIC ARC AS A TELEPHONE.

A PAPER by Hermann Th. Simon, in *Wied. Ann.*, Vol. 64, p. 233, describes some exceedingly curious experiments, which show that the electric arc is capable of acting either as a telephone transmitter or as a receiver. Herr Simon first observed accidently in an arc light a peculiar crackling noise, which he traced to the influence of an intermittent current supplying an induction coil, and flowing in a conductor, which ran for some distance parallel to the leads of the electric arc.

Experiments with the rotating mirror failed to show that the electric arc was in a state of vibration; but this was explicable on the hypothesis that the alternating induced current superimposed on the steady current producing the arc, caused so little variation in the light, that the changes could not be perceived by the eye. The alternating current, however, was quite capable of producing changes of temperature in the arc, which expanded and contracted the gases sufficiently to generate sound waves perceptible to the ear. Conversely, it was found that when sound waves were allowed to fall on the arc, variations of the current were produced, which were capable of reproducing the sounds in a distant microphone.

The following arrangement was devised to show these effects. The primary of a small step-up transformer was connected up in the circuit of the electric arc; a microphone and battery were put in circuit with the secondary of the transformer. When the end of a sounding tuning-fork was placed in contact with the microphone, the same note was heard distinctly at the electric arc. Whistling, knocking, singing, and even speech were transmitted and distinctly given out with all the most delicate variations of tone by the electric arc. With loud tones of a certain pitch, the notes given out by the arc were accompanied with a hissing sound. To collect the notes from the arc a glass funnel is held opposite to the arc, and connected to the ears by two tubes.

Herr Simon has calculated the variations of density of the gases which would be produced by the changes of the current, and found that they lie within the limit fixed by Lord Rayleigh for audible sound waves, and he fairly concludes from this, that the notes heard in the arc are due to these variations of density.

When the arc is lengthened, the sounds emitted become essentially louder and more distinct. This is due to the fact that, the resistance of the arc being greater, a greater fraction of the work of the current is expended on ~~the arc~~, and a larger volume of gas is heated.

In order to show that the electric arc is capable of acting as a telephonic transmitter, the microphone in the above-described arrangement is replaced by a telephone, and the sound waves are concentrated on the arc by a funnel. Speech, singing, whistling, thus directed on the arc, are heard distinctly at the telephone. The explanation of this phenomenon is plain, when it is remembered that the resistance of the arc varies with the density of gases through which the current passes; the variations of the resistance will produce corresponding variations of the current which, by lateral induction in the transformer, are transmitted in an intensified form to the telephone.

We do not recommend this invention for commercial use; the language transmitted through the present telephone is usually heated enough; at least, there is no necessity for passing it through an electric furnace.

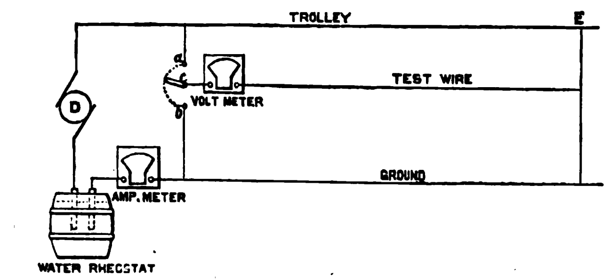
TESTING THE RESISTANCE OF THE RAILWAY CIRCUIT.

IN a communication to the *Street Railway Journal*, Mr. Sherwood F. Jeter, of Atlanta, says:—

"Having become interested in testing the resistance of the feeder and return circuits of a street railway system, it has occurred to me that a very practical rigging for making such tests, and also one that would definitely locate any trouble that might exist, would be the one outlined in the accompanying diagram. The test wire may be of iron and of any convenient size, and is strung from the station to any point at which it is desired to make tests.

"The tests can only be made at night when the line is not in use. The water rheostat is adjusted so that when the line is short-circuited, a small amount of current will flow, say, from 50 to 150 amperes. Any nice adjustment of the amount of current flowing may be made by changing the voltage of the generator so that the water rheostat need not be disturbed after once adjusting it. Now, if it is desired to test the resistance of the line from the station to a point E, a connection is made from the trolley wire at E, directly to the ground, and E is also connected with the test wire. The operator at the station now places the double-throw switch (c) on (a) and the reading of the voltmeter gives the drop on the trolley and feeders from the station to the point E, and likewise by placing (c) on (b) obtain the drop on the return circuit.

"If the resistance of the test wire is small as compared with the resistance of the voltmeter used (as would ordinarily



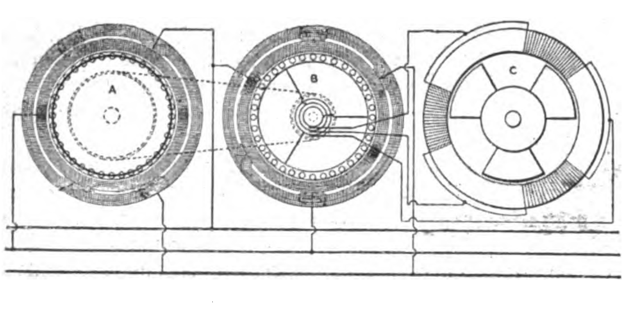
be the case), the effect of this resistance on the readings may be neglected, but if it is desirable to have them absolutely correct, the drop on the entire circuit from (a) to (b) may be taken, and the sum of the first two readings compared with this and corrected accordingly. The test-wire may also be used for signalling to the station to notify the operator when the line is ready to be tested at the various points. I have never seen an auxiliary test-wire used in making such tests, and would like to get the opinion of some of your readers as to its practicability."

ALTERNATING CURRENT REGULATION.

THE *Electrical World* for February 12th, 1898, contains abstracts of two patents recently issued for devices for phase regulation in alternating current systems.

One of these is due to Messrs. C. P. Steinmetz and Edwin W. Rice, and is called by them a phase regulator. It consists in adapting induction machines to the production of leading currents with which to nullify the troublesome, and sometimes harmful, effects of lagging currents due to any inductive apparatus connected to the supply mains.

The arrangement is diagrammatically shown in the figure, in which A represents an ordinary induction motor with short-circuited rotor windings; B is a second induction machine



driven by the motor A, either by belt, or by being direct coupled at a speed above that corresponding to synchronism with the alternating current. The rotor of the machine, B, is wound with open coils connected to slip rings, from which the induced currents can be led off and controlled in a third machine, C, which is a diagrammatical representation of another device for varying the self-induction of the three coils wound on it without altering their resistance. The internal rotative segments in C are arranged to close or open the magnetic circuits around the three windings on the fixed part. This is intended to be arranged for hand manipulation by means of a worm wheel.

The arrangement is based on the principle that inductive circuits, such as is represented by C, when inductively connected, cause lagging currents to pass in the line circuits as long as the secondary of machine, B, runs below synchronism, but cause leading currents when the speed is run above synchronism. In this way, by properly adjusting the self-induction of the coils, C, a suitable leading wattless current can be superposed to exactly balance the lagging wattless component of the line current, and thus bring the power factor to unity as far as the generators and the transmission system are concerned. The machine, A, may be any available source of power, since the essentials of the compensating arrangement are contained in machines B and C.

In practice it is preferable that machines A and B should be direct coupled. If A is a motor, its number of poles should be less than those of machine B in order to run B above synchronous speed.

DOES MOISTURE FACILITATE THE PRODUCTION OF OZONE.

By EMILE ANDREOLI.

PROF. W. A. SHENSTONE read before the Chemical Society (February 17th, 1898) a paper on "Observations on the Influence of the Silent Discharge of Electricity on Atmospheric Air," which upsets all the notions hitherto accepted regarding the production of ozone.

The learned professor says that oxygen, when diluted with nitrogen, as in the air, yields a very large proportion of ozone; 80—85 per cent. of the oxygen present may readily be ozonised in the presence of moisture, and if great care be taken, as much as 98 per cent. of the oxygen may be converted into ozone, and he adds that the presence of water promotes the formation of ozone, but retards that of nitric peroxide.

My impression has always been—and is still—that one of the conditions for obtaining a good yield of ozone is that the air must be dry, and my experience is that moist air does not give good results.

Prof. Shenstone does not explain how and why the water vapour may assist the production of ozone, while the necessity for using dry air is justified by this fact, that under the action of the silent discharge at a high tension, there is formation of water vapour and hydrogen, this latter being burnt in contact with ozone and producing heat, which destroys a considerable quantity of the ozone produced.

Years ago, a great scientist stated that water vapour absolutely prevents the production of ozone, and that no great yield of ozone can be obtained unless the oxygen is perfectly dry. This doctrine has been universally supported, and for the first time, a chemist advocates the presence of moisture for the transformation of oxygen into ozone.

Considering this question merely from a practical point of view, I will say that I have two ozonisers, the electrodes of which represent a surface of 640 square feet, and which produce a fair amount of ozone when I work them by passing dry air. I am sure that if I ventured to pass moist air between their electrodes there would hardly be any ozone generated, and in no time the apparatus would be out of order.

What is true in laboratory experiments ought to be true also when the experiment is repeated on a large scale. This does not appear to be the case, as there is an absolute discrepancy between the results obtained by Prof. Shenstone and those which are obtained by practice, and everyone interested in the production of ozone on a commercial scale, and in its application to industrial purposes, will repudiate the idea of submitting atmospheric air to the action of the silent discharge, in presence of moisture.

CORRESPONDENCE.

The Burning Question.

Mr. Liversedge lifts a corner of the curtain at Ealing. The wet sludge, says he, is drained through a certain proportion of the refuse, but he opines that this, of course, will not remove as much water as the filter press. It all depends on the drain. Suppose a nice thin layer of the rougher refuse and a free outlet. All that would remain of the sludge would be match stalks, corks and bungs, scrubbing and nail brushes, pieces of soap, candles and kitchen grease, clothes pegs, paper and rags, spinning tops and rubber balls, currants about Christmas time, Gallic literature and an occasional baby. There is a good deal of carbon in this collection which may account for the arc lamps.

A filter press, on the other hand, stops practically the whole of the solids, no matter how fine their state of division. The filtering medium becomes so close grained in a few seconds that a pressure of about 120 lbs. per square inch is required to force the liquid through. Naturally where the press is in use the amount of solids to be burnt is formidable. Why do not other towns adopt that charmingly simple drainage plan then—where a few inches of head on top of a few cinders does the whole business? Is it that they have not yet discovered the secret of dealing thus with their sludge, and at the same time giving satisfaction to the river authorities? As Mr. Liversedge hints, the thing, like the origin of Jeames, is "wrop' in a mistry."

The town of Leyton has ever listened to inventors with a greedy ear. "A Difficult Problem Solved" is a headline over the latest scheme; but the same headline has been used before to describe the exploits in sewage treatment achieved in that Eastern suburb. There was the Astropp system, two stories high, which took in wet sludge at the top, strained it (the liquid being run away in secret channels), dried the solids by hot air, and delivered them into a sack through a spout below, the whole ready and smoking hot for application as valuable manure to hungry lands. One of the great merits of this system was the small amount of solids left. A suburban garden could have taken the whole production for a year, without any symptoms of overfeeding being manifested by the plants.

This earlier solution of the problem was boomed mightily too; under cover of a marquee, solids and liquids disappeared in the most gratifying way; an earl presided, and the ears of the luncheonees were judiciously tickled by optimistic orators. As Mr. Ralph Nickleby grimly remarked, "These things have their uses in business." And, finally, the Astropp system passed into that limbo where hundreds, perhaps, thousands, of solutions of the sewage problem have preceded it.

There is a sentence in Mr. Liversedge's letter which is interesting to note. He says: "Leyton saves over £300 a year in coal in operations connected with her sewage." We should like further particulars of this saving. Is it really net? What are the operations at the sewage works requiring so much power as this sum represents? Are any coals now required? It would serve a useful purpose if Mr. L. would enlarge on this item.

It has been seriously proposed to burn the solids in London sewage, and in a way that only a genius would suggest. When you think of it, if a mere strainer will separate solids and liquids as Mr. L. says it does at Ealing, there is no sense in putting down and running costly precipitation processes with presses to deal with their resultant sludge. You have merely to pass the whole of the sewage as it comes to hand through the strainer, and the separation is effected right away. Accordingly, a man of supreme insight did suggest this way of dealing with London sewage, and published plans showing a kind of dredger with finely meshed buckets working in the sewage. This apparatus dried and burnt the solids as fast as it extracted them. It was discussed in the London press about the time eels were so plentiful in the East London water mains, and I suggested its adoption by that company for ridding their water of these, delivering stewed eels at the other end. This process never got to the marquee and oratoric stage, but expired soon after its inception for want of capital.

J. Hetherington.

Knots.

In the discussion of technical matters loose and inaccurate phraseology is always to be deprecated, and hence it is as well to decide whether a length of "a knot of cable" and "a speed of 6 knots per hour," are or are not correct. I have asserted that they are inexact and wholly unscientific, and make this statement on the authority of such men as Kelvin, Greenhill, and others. "Another Cable Engineer" takes exception to this, and begs to differ, &c. That is, he differs from the distinguished authorities named. If "Another Cable Engineer" were an authority on this matter, his opinion would be entitled to consideration; but he evidently is not, because he gives an altogether incorrect derivation of the knot.

In Harbord's "Glossary of Navigation," a knot is defined as "a division of the log line; so called from the line being divided into equal parts by pieces of string, rove through the strands and *knotted* in order."

The number of knots passing over the ship's rail in a certain number of seconds gives the *rate*, or nautical miles per hour. With that laxity of expression that so distinguishes seamen "knots per hour" were easily substituted for nautical miles, or even miles per hour. This, however, does not invalidate the fact that the original and proper meaning of the knot was that just stated.

Again, "Another Cable Engineer" derives the knot from the circumference of the earth; that is, he makes it a function of longitude. Allowing for the moment that a knot is a sea mile, his definition is still wrong. Harbord says "the length of a minute of the earth's circumference is very inadequate. . . . It was sufficient before the spheroidal figure of the earth was taken into account, and when the assumption was that the earth's circumference was a great circle, the measurement of which had not been accurately determined."

The nautical, or sea mile, or, as it is usually termed, the Admiralty mile (not *knot*), is "the length of a *minute* (not parts or knots) of a degree of latitude," but inasmuch "as the earth is an oblate spheroid, the degree of latitude increases as we advance from the equator towards the pole, and hence its 16th part, a minute, or the nautical mile, also increases (*vide* Robinson's "Marine Surveying.") The mean value of a minute of latitude, or that value on the parallel of 45° is 6,077 feet. The Admiralty have adopted as their standard mile a length of 6,080 feet which is the length of a minute of latitude on the parallel of 48°.

Again, in the latest standard text book of navigation used by the Admiralty, Stebbing's, the knot is strictly defined as a *rate* of a nautical mile per hour. "Knots per hour," then, means nautical miles per hour, per hour—either an acceleration of velocity, or a redundancy of words. It is never *meant* as an acceleration. It is, therefore, a redundant expression, that is, it is inexact and unscientific.—Q. E. D.

"Another Cable Engineer," and possibly others, may regard the whole question as a quibble, but if we admit it is a quibble, why not employ, in defining the power of an engine, so many horse-power *per minute?*

It is true that the expressions in question "have been used for scores of years by naval officers and others." It may interest "Another Cable Engineer" to know that it has been a lax practice for such to speak of minutes of arc either of latitude, longitude, or as shown by a sextant as "miles." This comparison of knots with miles and miles with minutes of arc is most curious and is characteristic of the uninstructed seaman. This misuse of terms is none the less a sure and certain sign of a deficient professional education. Lastly, no modern naval officers or writers of repute on naval service, in which, as I need hardly say, much electrical science is included, employ the objectionable expressions referred to, and I am sure that if "Another Cable Engineer" will look up the subject he will see the error of his ways.

Geo. Herbert Little,
Master Mariner, &c.

Your correspondent, "Another Cable Engineer," in last week's Electrical Review gives the circumference of the earth as 131,385,465 feet. Is not this a mistake, and should it not have been 131,385,464·287 feet? If so, the length to which he has given the name of one knot, and which he makes out to be 2·66 feet greater than the Admiralty knot should be corrected accordingly.

"Another Cable Engineer" is evidently labouring under the impression that he is replying to Mr. Little's previous letter; but instead of doing so, he gives us the above definition of a new unit of length, and then goes on to explain the use of the log-ship, apparently for the benefit of those who are unacquainted with this old-fashioned device for measuring the speed of a vessel. He sums up by saying that the whole question *appears* to be a quibble.

Now, if he does not know that *his* knot is the nautical or geographical mile, whereas Mr. Little's knot is a speed, and nothing but a speed, let him read Mr. Little's letter through once more, and then ask himself who is the quibbler.

Why not adopt Mr. Little's suggestion and use the word "naut" to express the length known as the geographical mile? One naut per hour would then be a knot, which can clearly not be a nautical mile, but must be a speed; the nautical mile being a naut, not a knot, notwithstanding your correspondent's assertions to the contrary. Surely this is simple!

X. Y.

Testing Accumulators.

If 3 kilowatts are required for a car to move up a gradient with a battery giving 50 volts, it must be evident to Mr. A. Campbell that to move it up the same gradient with a battery reduced to 45 volts will require still 3 kilowatts, and that means plainly more current in the motor armature.

The question is not how this increase is brought about, but whether experts in reporting on tests should not state which of the three conditions referred to were observed: Constant resistance, constant amperes, or constant watts in circuit during test. The first gives highest results, the second lower results, and the third lowest of all. Constant watts would, of course, be obtained in the same way as constant amperes during a test, namely, by varying the external resistance.

The Writer of the Article.

Mr. Ranken's Resignation.

Having heard that the approaching termination of my appointment has by many people been connected with the recent engine breakdown at these works, I should like to point out that my resignation was accepted by the Electric Lighting Committee nearly a week previous to the accident. The Chairman has kindly allowed me to publish his letter in confirmation of the fact.

A. W. Ranken,
Corporation Electrical Engineer, Yarmouth.

[Copy]

7, South Quay,
Great Yarmouth,
March 19th, 1898.

Dear Mr. Ranken,

It is a matter of regret to me that the resignation of your position as chief engineer should be in any way connected with the recent accident at the works. As a matter of fact your resignation was accepted on February 28th, and the accident occurred on March 5th.

Yours very truly,
Rd. Martins,
Chairman of Electric Lighting Committee.

Supply Current for Electro-plating.

I want to do electro-plating direct from the mains supplied me by the Brighton Corporation. I want a pressure of 2 volts and 15 amperes current. The mains come to me at 115 volts. How am I to lower the voltage and at the same time get the 15 amperes necessary to do my work. If you can give me an answer in your next issue I shall feel greatly obliged. Perhaps if you inserted my request in your excellent journal some eminent electrician would not think it beneath him to give a reply, which would enable myself and others to get over our difficulty.

R. T. Dick.

Gas Driven Plant.

As a subscriber to your valuable paper, I should feel much obliged if you would inform me through the columns of your journal as to the proportion of private installations, driven from gas engines *direct* to the dynamo, bears to similar installations driven *through a countershaft* fixed on the floor of the building which is lighted, *e.g.*, when the engines are put down solely for generating the electrical current, and when no other source of power is available.

Gas Engine.

Information Wanted.

Could you let me know where I can find any particulars of any methods of electrical printing with acetate of lead, other than the well-known method used in the electrical printing telegraph, of Bain, with potassium iodide and starch. Thanking you in advance.

T. J. Hughes.

LEGAL.

Crompton & Co. v. Liardet.

In the Queen's Bench Division on Thursday last week, before Mr. Justice Day, a claim for £89 3s., balance of account for supplying two electric motors, was brought by Messrs. Crompton & Co., Limited, the well-known electrical engineers, against Mr. J. E. Liardet, a gentleman living at Hyde Park Gate. Mr. McCall, Q.C., appeared for the plaintiffs and Mr. E. G. Hills for the defendant.

Mr. McCall said it was only necessary to bring before his Lordship the point in dispute. In July, 1896, the defendant sent an engineer, named Mr. Rogers, down to plaintiffs' works at Chelmsford to select two electric motors for a yacht of his. Mr. Rogers presented his report to his principal, and plaintiffs subsequently wrote a letter to defendant informing him that they supplied motors of 8 9 horse-power, with 900 to 1,000 revolutions a minute, and motors of 10½ horse-power, of 1,000 revolutions a minute. Mr. Liardet ordered a pair of motors, which were sent in due course. Defendant paid a sum of £100 on account, but the plaintiffs had been unable to obtain the balance from him.

The defendant said that for the past 26 or 27 years he had been engaged in electrical experiments, in which he had been assisted by a Mr. Rogers. In July, 1896, he was fitting up a launch of 65 to 70 tons. This would be the largest yacht afloat driven by electricity. After his assistant had seen certain motors at the plaintiffs, at Chelmsford, he ordered a pair of twin motors from them, which were to have revolutions of from 500 to 1,000 a minute. The motors were delivered about August 16th, and immediately afterwards he forwarded the plaintiffs a cheque for £100. He stated at the same time that the motors were incomplete, and asked that they might be completed. Time passed, and the season became too advanced to have a trial test. Under the circumstances, he wrote to plaintiffs, saying that they must wait for the balance of their account until he had made a trial test of the motors. He found that the motors were not equal. They were to be used for twin propellors, and, therefore, the speed should be equal, otherwise the rudder would always be over, and thus retard the speed. The motors were two right-hand ones, and were not suitable for driving twin propellers in a launch. One motor ought to be a right-hand and one a left-hand motor, in order that both might work properly.

Cross-examined: The motors were to be paid for on delivery, but when he received them he saw at once that they had been wound wrongly. He admitted that he had written subsequently to plaintiffs saying that he hoped to try the motors in April, when, if they were satisfactory, he would pay the balance. But he was suspicious of the motors from the first sight of them.

His Lordship gave judgment for the plaintiffs for the amount claimed.

Williamson & Joseph, Limited, v. London County Council.

This was a claim which came before Mr. Under-Sheriff Burchell and a jury at the London Sheriffs' Court last week, for compensation in respect of the compulsory acquirement by the L.C.C., of riverside premises at Coxon Place, Horseleydown, under the Tower Bridge Approaches Act, 1895. Mr. Dickens, Q.C., and Mr. Church, represented the claimant, while Sir W. Marriott, Q.C., and Mr. H. C. Richards, M.P., were for the L.C.C. The claim was stated to be principally regarding fixtures, and it was agreed that the figures with regard to these, should not be placed before the jury, but should be considered by Prof. Robinson for defendant, and Mr. Sherley Price as arbitrators between the parties; the learned Under-Sheriff to appoint an umpire, who should decide between the arbitrators in the event of their failing to agree. Sir Wm. Marriott mentioned that the items referred to amounted to something like £3,560, and, in answer to the learned Under-Sheriff, said the jury would only have to consider the value of the lease and loss of business. The award of the arbitrators or umpire would be added to the verdict.

Mr. Dickens, in opening the case, said the claimants were Messrs. Williamson & Joseph, Limited, who carried on business at the premises mentioned as mechanical and electrical engineers. The business was established in 1889, in which year the premises were leased for a term of 21 years from March, 1890, at a rental of £180 per annum. Notice to treat was served in July, 1896, but it was not until the latter part of 1897 that the County Council, as a result of negotiations, gave the claimants notice to vacate their premises on or before March 25th next. This date was, however, subsequently altered to June 24th. Counsel proceeded to refer to the various advantages of the premises in question, which were stated to be particularly suitable for the carrying on of the claimants' business. It had not been found possible to secure other premises at a less rental than £300 a year. For the purpose of comparison counsel gave figures, which showed that the sales had been doubled since 1895.

Mr. Edward L. Joseph, manager of the company, said that there had been a steady increase in the sales since the conversion of the business into a limited company. The County Council gave a notice to treat in July, 1896, which had a very injurious effect on their work, because they could not guarantee the date of delivery of an order. The present offices were at 92, Queen Victoria Street, about 12 minutes' walk from the manufactory. He had made about 200 inquiries, and could not find suitable premises equal to those taken in the immediate neighbourhood. He had obtained a new factory at Highbury, four or five miles away, on lease for 21 years, at a rent of £200 a year, but they would have to fit up and repair the premises, and make other alterations, at a cost of £1,500; the accommodation was one-third less than in the other premises. Under the most favourable circumstances the removal could not be carried out under four months, owing to the nature of the fixed machinery, and there being about 1,000 different and small parts that must be skilfully removed. They would have to refuse business for four months, and he estimated his total loss during that time at £2,000. The £1,500 was what they must spend on the new premises; but they did not charge the County Council with all that sum. The notice to treat came at a critical time, when the business was beginning to "turn the corner." The works undoubtedly showed a profit in 1897.

Evidence was given by Mr. Edward Stimson, auctioneer and valuer (Messrs. Stimson & Sons); Mr. Francis J. Bisley, surveyor and auctioneer (Messrs. F. J. Bisley & Sons); and Mr. Frederick F. Smee, surveyor and valuer (of Messrs. Bradshaw, Brown & Co.), as to valuation.

Mr. Henry Sherley Price, member of the Institute of Mechanical and Electrical Engineers, said he averaged two millions a year in valuations of engineering works. He put the damage on loss of trade consequent on disturbance of the business at £2,000, and considered that it would take at least three months to re-organise, remove into the new premises, and get to work on the same basis as at the present moment. During that three months the whole of the establishment charges would be running, whether any work was done or not. He had taken the gross profits according to the 1897 balance-sheet, and divided them by four, producing £870 as part of the expenses that would run on during the three months. He had written to the Council asking them not to stop the business, but they would make no offer.

Some discussion arose as to the agreement which had been come to with regard to the fixtures, Sir William Marriott stating that the County Council had offered the company the whole plant and materials. Ultimately the Under-Sheriff took a note that the arbitrators were to assess the value of all the fixed plant and loose tools belonging to same, all tenants' fixtures and improvements, and the damage to machinery in course of removal. Part of the business could not be carried on at one place while the machinery was being removed.

Mr. F. Charrington and Mr. F. H. Nalder gave corroborative evidence that the business would be practically stopped for three months.

Sir Wm. Marriott, opening the case for the County Council, said the jury had nothing to do with the removal of the fixed plant and machinery, and would only have to decide the value of the lease and the loss of business. As a matter of fact, the premises were let in 1890 at £180 per annum, whereas it was contended on behalf of the claimants that they were now worth £275, which was a very considerable difference.

Mr. Wm. Dalton, of the Surveyor's Department, Scotland Yard; Mr. Andrew Young, F.S.I., valuer to the County Council; Mr. James F. Field, F.S.I. (Messrs. Field & Sons); Mr. Wm. Eve, F.S.I.; and Mr. Henry Stock, F.S.I., gave evidence for the defendants as to the questions of value and convenience.

Prof. Robinson, professor of civil engineering at King's College, was of opinion that the claimant's business could be re-established within two months.

After counsels' speeches and the Under-Sheriff's summing up, the jury gave a verdict for £1,450, divided as follows: £350 for the value of the lease; and £1,100 as loss of trade.

The parties agreed that Mr. F. Terry Horsey, F.S.I., of 11, Billiter Square, E.C. (Messrs. Fuller, Horsey, Sons & Cassell), should be appointed by the Court as umpire in the two heads of claim set aside.

Holophane, Limited, v. The Stewart Electrical Syndicate, Limited.

In the Chancery Division on Saturday, before Mr. Justice North, Mr. Swinfen Eady, Q.C., said he had a motion to restrain the infringement of the Holophane patents and from passing off. The defendants appeared, and asked time to answer evidence, and had agreed in the meantime to keep an account.

Mr. Neill, for the defendants, said the patent was a singularly complicated one, and its validity was disputed. It seemed to him a very inconvenient course to try a case of this kind in motion, and he suggested it should stand till trial or further order, he undertaking in the meantime to keep an account.

Mr. Eady said he could not agree to that, as there was a question of passing off. He thought, after hearing the evidence, that his Lordship would grant an injunction even as regarded the patent itself.

Mr. Neill said that really it was pure and simply a patent action.

Mr. Eady: I cannot accept that.

Mr. Neill said that the validity of the patent would shortly come before Mr. Justice Kekewich in an action which was pending.

Mr. Eady said he could not accept an undertaking until the trial, but only until the motion was disposed of.

Mr. Neill said he would give an undertaking until the motion was disposed of.

GLASGOW TELEPHONE INQUIRY.

Sheriff Jameson's report, from which we extract the following, has been placed before the Glasgow Corporation. After referring to the number of witnesses called (84), the Commissioner states that he considered he was not entitled to allow an inquiry into the cost of working. He then gives a detailed description of the exchange system in Glasgow district, and proceeds to answer *seriatim* the question to which his attention had been drawn in his instructions.

(1) Is the Service, As Far As It Goes, Efficient?

He was of opinion that it was not. This was due, directly or indirectly, to the want of a metallic circuit, but a considerable proportion of the enormous number of complaints was not referable to that cause alone, and might have been remedied by more thorough supervision in the central and junction switch rooms, by more care in connection with wires in contact, more prompt attention to complaints against operators, and other precautions. In support of this he refers to the numerous complaints which the correspondence showed had not been manufactured for the occasion.

(2) Is the Service Adequate, and are there a Sufficient Number of Call Offices?

Dealing with this question, he says that no witness was adduced who complained of being deterred from joining the exchange system on any condition as to way-leave or otherwise, and he does not think it is at all unfair in a person who uses the telephone himself being requested to give facilities for the extension of its use to others. In regard to the five years' condition, he says it seems not unreasonable that the company should decline the expense of putting up a wire in connection with their exchange without some security that the expense will not be practically thrown away by a subscriber leaving his premises at the end of a short period. He holds that the number of call offices is sufficient to meet the reasonable requirements of the public.

(3) Is the Price Charged for the Service Reasonable?

After stating the rates, he says: "It appears to me that these rates are not unreasonable, except in some outlying districts, such as Bearsden, Pollokshaws, and others, in which case, I think, they ought to be reduced. But speaking generally, I may say that the rate is what is called the £10 rate for places of business within a half-mile of the Exchange, which was the Post Office telephone rate for distance between a quarter and a half mile up till October 1st last, when a reduction took place to £8. Comparing the rates charged by the Telephone Company in Glasgow with the table of rates in foreign countries, I do not consider that they are excessive. The example which all the Corporation witnesses took as a comparative example was Stockholm. They assume that Stockholm is comparable with Glasgow, and that the rates there should rule the rates in Glasgow. For my own part, I can hardly imagine two more dissimilar places in almost every conceivable respect. It is, moreover, noticeable that a great number of the witnesses who were called for the discontented subscribers said they would not object to the £10 rate if the service was efficient, and if it be the case, as proved by Mr. Gaine, that each message in Glasgow costs 0·57 of a penny, or practically a halfpenny a message, I do not think it can be said that the price is not reasonable."

(4) Is the Inefficiency Due to the Refusal of Facilities by Glasgow Corporation, and is such Refusal Reasonable?

"I am of opinion that the main cause of inefficiency of the present telephone exchange service in Glasgow is, that it is worked by an overhead single-wire system, with an earth return, in a city where there is an enormous amount of concentration of wires to one point greater than even to one point in London, and where, owing to the system of electric lighting in one of the underground railways, an overhead system is peculiarly liable to be rendered inefficient. These objections will be got over by the company making an overhead twin-wire system, but I think it would be most unreasonable to require them to do so. The National Telephone Company resolved, in February of last year, to introduce the metallic underground system in Glasgow, and on February 26th, 1896, applied to the Corporation for assistance, which was refused. My opinion, accordingly, is, that the continued inefficiency of the present telephone exchange service in Glasgow is, in a great measure, due to the refusal of facilities to the Telephone Company by the Corporation of Glasgow for constructing an underground metallic circuit system. The Sheriff examines the evidence given by the representatives of the Corporation on that point, and gives his conclusions as follows:—It humbly appears to me that this evidence is self-condemned (1) so far as the inconvenience of the public is concerned, the inconvenience of the Corporation laying an underground system for themselves, and the National Telephone Company laying an underground system under the supervision and control of the Corporation, would be in identically the same position. Beyond this, the objections seem to me to be purely of a sentimental and fanciful kind. The objection to giving leave to the Telephone Company because it is a dividend earning company, appears to me quite absurd, when it is considered that the operation proposed is really for the benefit of the public, and will, in that view, cause the company a large expenditure of money; and, further, that the company are willing to pay the Corporation a sum in respect of the leave to be given under their streets. I may remark that the way in which some members of the Corporation speak of the streets as the patrimony of the city of Glasgow is absurd, whether regarded from the point of view of law or of fact. My inference on the whole evidence is, that the true cause of the refusal of the Corporation of Glasgow to allow the Telephone Company wayleave under their streets is that they are resolved if possible to establish a telephone system of their own by means of which they would be able to extinguish the National Telephone Company altogether, so far as Glasgow is concerned, and supply a better and cheaper service to the inhabitants of the present Glasgow district telephone area. My answer to this question accordingly is, that the continued inefficiency of the telephone service in Glasgow is, for the most part, due to the refusal of the Corporation of Glasgow to allow the National Telephone Company to construct a metallic underground system underneath the streets of the city; and I am further of opinion that such refusal is not reasonable or justifiable on grounds of policy or otherwise, unless it be thought that the Corporation are justified in their refusal because they desire to establish a telephone system of their own, and to place the National Telephone Company at an enormous disadvantage in competing with them for the patronage of the public."

(5) Is it Expedient to Grant the Glasgow Corporation a License?

The Sheriff answers this question at length, and concludes as follows:—

"In these circumstances, and apart from the difficulty of the situation, which I shall hereafter advert to, I should have been prepared to state as my opinion that it is not expedient that the Corporation of Glasgow should obtain a license to carry on the business of telephony within the present Glasgow district area, and that for these reasons:—

"1. A telephone service in this country does not exist for the benefit of all classes of citizens, but for that of a limited number. It is therefore not an object to which the "Common Good" of a burgh ought to be applied.

"2. Whether the foregoing proposition be correct or not, it is my opinion that the Corporation of Glasgow are not at present entitled to apply the burgh funds or funds raised on the security of the burgh "Common Good" to the establishment and maintenance of a telephone system outside of the burgh boundaries. To enable them to do so, a special Act of Parliament would be necessary, and it seems inappropriate for the Postmaster-General to grant the license to do something which at present it is otherwise illegal for the Corporation to do. Perhaps this might be got over by the license being given under the condition that it should not be available beyond the boundaries of the City of Glasgow till Parliament has sanctioned the proposed action of the Corporation.

"3. On general grounds of public convenience it is inexpedient to have two telephone systems or two telephonic authorities within the same area, as this leads to the necessity of members of the public subscribing to both systems, or suffering from delay in the transhipment of messages from one system to the other.

"4. Because the establishment of a second telephone system may render the acquisition of the telephones in Glasgow by the Government at the end of 1911 more difficult and expensive.

"5. Because up till this time the Corporation have not produced satisfactory evidence that they could successfully finance and work the proposed system without the risk of putting a new and serious burden on the ratepayers of Glasgow.

"In my opinion the reasonable solution of the matter would be that the Corporation should grant to the National Telephone Company the same facilities for laying a metallic circuit system underground as the large English municipalities have already done, and under similar safeguards.

"But the Corporation of Glasgow at present state that they will never consent to the National Telephone Company being allowed to lay an underground system in Glasgow, and it is clear that unless this is done, the telephone service in Glasgow will continue to be inefficient, which is a state of matters that ought not to be allowed to continue.

"The question therefore arises whether, excepting the present situation, it would not be expedient, notwithstanding all the objections I have above pointed out, that the license they now ask should be granted to the Corporation, throwing on them the whole responsibility of their proposed undertaking.

"One way out of the difficulty would be for the Post Office to establish a telephone exchange in Glasgow themselves, with an underground metallic circuit system of wires. To do so would seem to be authorised by clause 18 of the agreement between the Postmaster-General and the National Telephone Company, dated March 25th, 1896.

"If this course does not recommend itself to Her Majesty's Government, then, in the interests of the public who use the telephone in Glasgow and district, I am of opinion that it would be expedient to grant to the Glasgow Corporation the license they have now requested, provided that they are able to satisfy the Postmaster-General that financially their scheme is sound, and that they have the means of carrying it out."

The following correspondence has passed between the Secretary of the Post Office and Sir James Marwick:—

"General Post Office,
"*March 16th*, 1898.

"The Town Clerk, Glasgow.

"Sir,—I am directed by the Postmaster-General to forward to you, for the information of the Corporation of Glasgow, the accompanying copy of the report which was made to the Lords Commissioners of Her Majesty's Treasury by Mr. Sheriff Jameson after his recent inquiry into the telephone exchange service.

"The Duke of Norfolk understands that the Corporation have arrived at the conclusion that they could not confine to their own municipal area the operations of the telephone exchange system which they desire to establish; and he agrees with the Corporation in thinking that there would be grave public inconvenience in instituting an exchange system confined to the area of the municipality alone, and which would exclude from its operation many neighbouring districts in which citizens of Glasgow reside or carry on their business. It is evident, however, to his Grace that, outside the limits of their own jurisdiction, the Corporation might encounter the same difficulties of obtaining wayleaves for the necessary underground wires which have hitherto embarrassed the efforts of the National Telephone Company to make their own system efficient in Glasgow itself.

"Whether this is so or not, however, the Postmaster-General is advised that the Corporation in the present state of the law has no power to carry on the business of a telephone exchange, either within or outside the limits of the municipality, and in these circumstances he is precluded from assenting to the wishes of the Corporation by issuing a license.—I am, Sir, your obedient servant,

S. Walpole."

"City Chambers, Glasgow,
"S. Walpole, Esq., Secretary, "*March 19th*, 1898.
"General Post Office, London.

"Sir,—I beg to acknowledge receipt of your letter of 16th instant, enclosing copy of the report which has been made to the Lords Commissioners of Her Majesty's Treasury by Mr. Sheriff Jameson, and intimating the views of His Grace the Duke of Norfolk upon the applications by the Corporation for a telephone license.

"I have submitted your letter and Sheriff Jameson's report to the committee of the Corporation.

"The committee have not had time to consider the report in detail, but they observe that Sheriff Jameson states, in concluding it, that if the Government do not see their way to establish a telephone exchange in Glasgow, with an underground metallic system of wires, he is of opinion 'that it would be expedient to grant to the Glasgow Corporation the license they have now requested, provided that they are able to satisfy the Postmaster-General that, financially, their scheme is sound, and that they have the means of carrying it out.' The Corporation will be glad to have an opportunity of satisfying His Grace upon both these points.

"In reply to your letter, I am instructed to beg his Grace to give consideration to the following statement:—

"1. The Corporation have not arrived at the conclusion that the operations of the Telephone Exchange system which they desire to establish, can not be confined to their own municipal area. The fact is simply this—after ascertaining that the authorities of the various burghs adjoining the city were anxious that the Corporation's exchange, if instituted, should include their burghs, the Corporation, on September 24th last, made an application for the wider area, and they believe it is in the public interest that their exchange should include that area. But they are convinced that, should his Grace unfortunately be unable to grant the license for the larger area, a great public advantage would be secured if the Corporation obtained a license for the municipal area. In that view they desire to remind his Grace that their application of August 12th, 1893, for a license for that area, has never been withdrawn, and is still before him.

"2. The fact that the Corporation made an application in 1893 for a telephone license for the municipal area, and have since frequently, till last autumn, pressed upon successive Postmasters-General the desirability of granting it, is, the Committee trust, sufficient evidence that the Corporation can not concur with His Grace in thinking that there would be grave public inconvenience in instituting an exchange system confined to the area of the municipality. They believe, on the contrary, that a larger number of persons would benefit by a license covering the extended area, and that the public interest would be promoted by the granting of a license for that area. At the same time they believe that the trade and commerce of the city would be greatly benefited by the institution of a municipal service, though its operations were confined within the city boundaries, which extend to 12,000 acres, and embrace a population of upwards of 700,000. Even were the suburban districts excluded from the advantages of the proposed new system, the telephonic facilities which these districts at present possess would not thereby be taken away or diminished. The committee believe that, if the applications which they have made were granted, one result would be to place telephonic facilities for business purposes within the reach, for the first time, of a body of citizens exceeding in number those who at present use the telephone. But the conferring of that advantage could in no degree subject the present subscribers to inconvenience.

"3. The fact that the municipal authorities of the burghs surrounding Glasgow have come forward to ask that the application of the Corporation, extended so as to include those burghs, should be granted, indicates very clearly that no difficulty in connection with wayleaves in those burghs need be apprehended. The Corporation at present supply those burghs with gas, water, and tramway facilities, and their water and gas pipes and tramway lines are laid in and on their streets, yet no friction has ever arisen regarding these matters. The committee do not entertain the slightest doubt that they could, as in the case of their other extensive undertakings, carry on a telephone exchange as efficiently in the suburban burghs as within the city.

"4. The Corporation cannot admit for one moment that the efforts of the National Telephone Company to make their system in Glasgow efficient have been embarrassed by difficulties in obtaining wayleaves for underground wires. It was not till long after the Corporation, induced by the complaints of the citizens, had applied to the Postmaster-General for a license, that the company even asked such wayleaves. It is to be observed, moreover, that the company has never sought to take advantage of the railways and underground tunnels within the city.

"5. The Corporation are aware that they have no statutory power to carry on the business of a telephone exchange, but, in the event of the Postmaster-General granting them a license, they would be in a position to press upon the Government the desirability of bringing in a public Bill to give corporations the requisite powers; or, if the Government were unable or unwilling to do so, they would themselves promote a private Bill in the next session of Parliament to obtain those powers. The Postmaster-General will not fail to see that, unless the Corporation were able to satisfy Parliament and its officers that a license was actually available, it would be inexpedient in the highest degree for them to incur trouble and expense in asking Parliamentary powers to do what, without the license sought, they could not possibly do.

"As his Grace has been so good as to indicate the grounds on which he has arrived at the opinion intimated in your letter, and as these grounds involve an entire misapprehension of the position which the Corporation has consistently held since 1893, and also of the conditions on which the Corporation could apply for the necessary Parliamentary powers to establish local telephones, I have been instructed to beg that his Grace may be pleased to reconsider their application in the light of what is now stated.

"I have the honour to be, Sir, your obedient servant,

"J. D. Marwick, *Town Clerk*."

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending March 22nd, 1897.

	£	s.
Adelaide	12	0
Amsterdam	90	0
Barcelona. Teleg. cable	359	0
Brisbane	100	0
" Teleg. mat. ...	211	0
" Iron teleph. poles	4,735	0
Calcutta...	134	0
Cape Town. Teleg. mat.	160	0
Colombo	43	0
Delagoa Bay	205	0
Demerara	32	0
Durban	95	0
East London	198	0
Flushing	26	0
Fremantle	31	0
Gibraltar	10	0
Hamburg. Teleg. mat ..	20	0
Malta	14	0
Mauritius. Teleg. mat.	29	0
Mossel Bay. Teleg. mat.	30	0
Odessa	35	0
Port Elizabeth	30	0
Singapore	40	0
Sydney	1,269	0
Terneuzen	22	0
Yokohama	443	0
Total ...	£8,373	0

Week Ending March 22nd, 1898.

	£	s.
Alexandria. Teleph. mat.	212	0
Amsterdam	160	0
Antwerp. Elec. fuses...	151	0
Barcelona. Teleg. wiro	46	0
Boulogne	22	0
Brisbane	138	0
Buenos Ayres	65	0
Cadiz	20	0
Calcutta...	1,158	0
Cape Town	1,285	0
Colombo	92	0
Copenhagen	12	0
Delagoa Bay	27	0
Durban	145	0
Flushing	31	0
Fremantle	7,201	0
Genoa	55	0
Gothenburg	341	0
Hong Kong	180	0
Jaffa	20	0
Liban	243	0
Madras. Teleg. cable...	8,200	0
Ostend	53	0
Port Elizabeth... ...	1,616	0
Reval	1,200	0
St. John's, N.B. ...	172	0
St. Petersburg	20	0
Singapore	16	0
" Teleg. mat.	66,280	0
Sydney	82	0
Wellington	75	0
Total ...	£89,318	0

Foreign Goods Transhipped.

	£	s.
Barbadoes. Teleph. mat.	18	0

Announcement.—The proprietors of *Trade and Industry* inform us that they have secured the services of Mr. John Strahan Smith as the editor of *Trade and Industry*. They also announce that *Aluminium and Electrolysis* and the *Journal of Acetylene Gas-lighting and Carbide of Calcium Review* will be published in future, on behalf of the proprietors at the offices of *Trade and Industry*, 161, Strand, W.C.

Best & Lloyd.—It is announced that for personal and private reasons the firm of Best & Lloyd has been registered as a limited company, taking possession of the Birmingham works and the business on March 31st, 1897. All debts owing by, and all accounts due, will be paid and received by Best & Lloyd, Limited. The *personnel* of the management will be as hitherto.

Birmingham Electrical Exhibition.—On Monday last an Electrical and General Trades Exhibition was officially opened at Bingley Hall.

Books Received.—"Commercial and Domestic Telephony," (A popular guide). By M. Byng, M.I.E.E., and F. G. Bell. Published by General Electric Company and Whittaker & Co.

"Treatise on Chemistry," Vol. II. The Metals. By Profs. Roscoe and Schorlemmer. Published by Macmillan & Co., Limited. 31s. 6d.

Catalogues.—The London Smelting and Refining Syndicate, of 39, Victoria Street, S.W., has issued a pamphlet, illustrating and describing the various descriptions of machinery, materials and chemicals for the electro-deposition of metals supplied by it. This syndicate also undertakes the complete equipment of plating, electrotyping and refining plants. In looking through the list, we observe lead-lined vats, and vats for differential or localised electro-plating, rocking or sliding frames for vats, scouring trough, burnishers, vats for quickening solution, filtering frames, brushes, and a variety of accessorial and other apparatus and fittings. There is a number of interesting illustrations showing some of the operations, and at the end of the pamphlet are general remarks regarding iridium, and on the electro-deposition of cadmium.

Messrs. Geo. Richards & Co., Limited, of Broadheath, Manchester, have issued new illustrated catalogues of their machine tools and appliances, and wood-working machinery. Both lists are dated January, 1898. The machine-tool list describes the firm's planing machines, standard lathes, giving sketches of the various parts, drilling, tapping, slotting, boring, milling, grinding and other machines. The wood-working machinery catalogue deals with band and circular sawing machines, planing wood-turning lathes, boring stand, saw sharpening, moulding, mortising, and various other machines for wood-working.

From Messrs. Francis & Spilsbury, of 20, Bucklersbury, E.C., we have received a copy of Mr. A. P. Lundberg's catalogue which we reviewed last week. On this list Messrs. Francis & Spilsbury's name is printed as London and south country agents. The firm is also agent for Heaton & Smith's patent switches, a list of which is included.

Change of Address.—Mr. Robert Hammond has removed from Ormond House, Great Trinity Lane, E.C., to 64, Victoria Street, Westminster, S.W.

Church Lighting.—The National Electric Free Wiring Company, Limited, have just completed the installation of the electric lighting in the Palace Gardens Church, Notting Hill.

The order for installing the electric light in St. Barnabas Church, Kensington, has been placed in the hands of the same company. The company's patent system of wiring is being used in both cases.

Cowper-Coles's Parabolic Reflectors.—We are informed that the offices of the Reflector Syndicate, Limited, have been removed from 2, Carteret Street, to 39, Victoria Street, Westminster, S.W.

Dissolutions of Partnerships.—Messrs. H. Nunns and E. Sykes (Messrs. Nunns & Sykes, electrical engineers, South Parade, Halifax) have dissolved partnership by mutual consent.

Messrs. P. S. Brook and J. A. Hirst (Brook, Hirst & Co.), electrical engineers, Northgate Electrical Works, Victoria Road, Chester, have dissolved partnership by mutual consent. Mr. P. S. Brook attends to debts.

For Sale.—The Southampton Corporation invite offers for the purchase of a loco. boiler and a slow speed (Robey) horizontal engine now at the electricity works. See our "Official Notices" this week for particulars.

Laying New Mains.—The London County Council is at last taking steps in order to minimise the traffic disturbances, due to the constant breaking up of the streets. In two cases on Tuesday the Council, in sanctioning the laying of new mains by, among others, the Charing Cross and Strand, and the Metropolitan Electric Supply Companies, stipulated that in the main thoroughfares concerned, the work, when once commenced, should be carried on continuously, both by day and night, until completed.

L.C.C. Highways Committee.—The following were elected members of this committee, who are concerned with tramways, telephones and electric lighting, at Tuesday's meeting of the London County Council:—J. A. Baker, J. W. Benn, T. L. Corbett, W. H. Dickinson, J. S. Fletcher, E. A. Goulding, W. Haydon, N. W. Hubbard, Sir John Hutton, W. O. Johnson, R. Parker, R. C. Phillimore, Lieut.-Col. C. Probyn, P. J. Rutland, J. Thornton. It will be noted, with much regret, that the name of Earl Russell is excluded from the list. The noble earl made an eloquent statement on his own behalf, but this was of no avail, and the loss of his services on the committee will be a loss to London as a whole.

Liquidation Notices.—A general meeting of the Electrical Advertising Syndicate will be held at 164, Gresham House, E.C., on Tuesday, April 19th, at 3 o'clock, to hear an account of the winding-up operations from Mr. J. W. Jefferies (liquidator).

The British Electric Installation Contractors, Limited, will hold a meeting on May 2nd at 50, Foregate Street, Worcester, to hear an account of the winding-up operations from the liquidator, Mr. W. J. Hill.

Lists.—From the International Trading Company, of 35, Queen Victoria Street, E.C., who are the sole agents for the Chemnitz Electrical Company, Limited, we have received illustrated price lists, Nos. 1, 2, and 4. These deal with continuous current dynamos and motors; rails, regulators, and resistances; and arc lamps, lanterns, &c. A variety of types of motors and dynamos are shown by means of good illustrations, tabulated figures and prices being given. In List 2, regulating resistances, magnetic switches, motor starting apparatus, automatic current regulator, reversing and starting apparatus, sliding rails, and belt tighteners are detailed. List 4 contains description of the "Chemnitz" arc lamps, for continuous and alternating currents, stage projectors, lanterns, ornamental and otherwise, for arc lamps and lamp accessories.

Ozonisers.—The Electric Ozone Syndicate, Limited, of 5, New Union Street, Moorgate Street Station, is now manufacturing Mr. Andreoli's commercial ozone generators, which are entirely made of aluminium. The advantages claimed for these improved apparatus are the following:—The yield of ozone is large (about 100 grammes per horse-power-hour). There is no rise of temperature in these ozonisers which may damage them, or cause a loss of ozone. These ozone generators can be worked in a continuous manner, and can be made of any size to produce from 100 grammes to 1,000 grammes and more per hour. The syndicate already has several large ozonisers on order.

Personal.—Mr. E. J. Clarke announces that he has severed his connection with the Electrical Power Storage Company as assistant works' manager and works' foreman, after 13 years service, to undertake the management of the "Hart" Secondary Battery Company, Limited, at Crispin's Wharf, Stratford, E. We extend our best wishes to Mr. Clarke for success in his new venture.

Russia.—A company has just been formed with a capital of £50,000, to be known as the Allgemeine Electricitäts Gesellschaft, St. Petersburg. The Allgemeine Company of Berlin is interested in the new concern.

Synagogue Fittings.—The *Jewish Chronicle* contains an article regarding the formal inauguration of the electric light in place of gas at the St. John's Wood Synagogue. The fittings, consisting of 20 3-light electroliers, 10 3-light brackets, four 10-light electroliers, four 3-light candelabras, and two 5-light candelabras, were supplied by the Edison & Swan United Electric Light Company, Limited, and are of unique design, harmonising well with the general character of the interior of the building. They are in the Moorish style, generally resembling Moresque candelabras and lamps. The "Mogan David" has been utilised as an ornament in the design which is pierced in stout brass metal, being solely hand made. The great centre candelabra and 3-light pendants, suspended between the arches of the ladies' galleries, which to heighten the design have been studded with coloured cut-glass gems, give a very pretty effect. The whole of the fittings are of a special and very handsome design.

Telephones in Hospitals.—In our issue of November 12th last, we noted that the Private Wire and Telephone Installation Company's tender for fitting telephones in Guy's Hospital had been accepted. The same company has now been ordered to extend its system all over the premises.

ELECTRIC LIGHTING NOTES.

Aberdeen.—Prof. Kennedy has submitted his notes on the report of Messrs. Smith & Blackman on the proposed electric lighting extensions to the west end and other points. He considers the proposal a wise one. He agrees with the engineers that it is advisable as far as possible to supply current for all purposes in Aberdeen from one station, and concurs with them that it would be better to adopt a high tension continuous current system of feeders, with rotary transformers, than to use low tension feeders working at so small a current density as 500 amperes per square inch. If the increased plant at the electric station will give a pressure of 550 volts, the delivery of the 400 kilowatts to consumers at the west end would require two pairs of cables, each having an area of 0·67 square inches, and all that the Corporation would have to provide would be these cables without any other apparatus either inside or outside the station. In working the station they would simply have to arrange that one of the higher voltage machines should always be working on the west end feeder. The cost of this arrangement would be £5,750. Whether it would be best for Aberdeen to adopt the simple feeder system with the drop of 110 volts, or to adopt the booster system, must depend upon the time at which they expect to be able to deliver current to the west end and the rate at which they expect the demand to come on. As to these points the resident engineers must speak. But the professor advises the Council most distinctly that he should prefer either of these arrangements to the system with 2,000 volts, as he believes it would be not only considerably less in capital cost, but also more efficient in transmission. Electric traction and dust destructor schemes are also considered by the professor.

Arbroath.—The public library buildings are lighted electrically. The plant put down by Messrs. W. Dixon & Co., of Glasgow, comprises a 14 H.P. Crossley gas engine, E.P.S. accumulators, &c. Arc lamps are in the picture galleries, and incandescents in other parts.

Bath.—The Electric Lighting Committee presented a 43-page report at the last Council meeting.

Birkenhead.—The street lamps along the Approach to Woodside Ferry are now lighted by electricity.

Cardiff.—The borough electrical engineer has reported that during February the income was £664 6s. 7d., which was an increase on the amount reported in February of last year. The number of lamps now is nearly 16,000, and 1,420 are about to be added.

Chester.—Mains for the supply of public and private lighting are to be laid in a number of streets at a cost of £950.

Croydon.—The Croydon County Council has requested Prof. Kennedy to report upon the proposed acquisition of the works under the Crystal Palace Electric Lighting Orders, having in view the provision of a supply of current to the South Norwood district as well as Upper Norwood. Prof. Kennedy is also to report upon the cost and best mode of an extension up the London Road as far as Thornton Heath pond.

Dingwall.—The Town Council has agreed not to insist on the production of the specification of the electricity works until the proposed public electric company is formed.

Garston.—The Urban Council on the 17th inst. resolved on the recommendation of the General Purposes Committee to erect a refuse destructor and electricity station on St. Austin's Mount, Garston Old Road, at a total cost of £25,000. Mr. F. H. Medhurst was appointed electrical engineer.

Gourock.—A report on electric lighting has been presented to the Burgh Commission. The estimated cost of an installation would be about £8,600, including plant sufficient to light the whole of the burgh and for the erection of 16 arc lamps for street lighting.

Hackney.—The Vestry had a discussion in committee last week with reference to the proposal of the Electric Extension Company, Limited. The matter was again adjourned.

Hampstead.—The Vestry will apply to the London County Council for sanction to borrow £51,500 to meet the expenditure on the electric lighting capital account up to the 25th inst., instead of £50,000 as previously agreed upon. Another loan of £18,000 to meet the expenditure on the new plant to be laid down before next winter is to be applied for. The Lighting Committee recommended that Wright's patent demand indicators be fixed on all consumers' premises present and future. The recommendation was referred back to the committee for further consideration and explanation. The same committee also reported that, with reference to the letter from Messrs. Ferranti, Limited, on the subject of their contract for the supply of new plant at the central station, they had instructed the Vestry Clerk to inform Messrs. Ferranti that the plant is not at the present time running satisfactorily; that the Vestry is not prepared to fall in with their suggestion that the periodicity of the present machines should be increased; and, further, that the late engineers' strike had nothing whatever to do with the completion of the first contract. Approved.

High Wycombe.—Messrs. Hodges & Todd have been appointed by the Town Council to inspect and report upon the works of the High Wycombe Electricity Supply Company until same are completed.

Horsham.—At the last District Council meeting, a special committee which had made investigations and visited Tunbridge Wells recommended that an application be made for a provisional order, and that Mr. Hawtayne be engaged to prepare a scheme. The report was adopted.

Huddersfield.—The Corporation has appointed a subcommittee to confer with the Elland Council with respect to its application for a supply of electricity for Elland from the Huddersfield works. This month's returns show that there are 43,295 lamps connected at Huddersfield, an increase of 729 over the previous month.

Islington.—Residents in Highbury New Park are asking for the electric light.

The Vestry is to lay mains along a considerable portion of St. James's Road for the purpose of lighting Liverpool Road; to continue the mains and erect lamps throughout this thoroughfare; to lay conduits and mains on one side of the road, and to erect 13 arc lamps (cost £1,260), also to extend the arc lighting through Parkhurst Road, thus completing the line of lighting direct to Holloway Road. Conduits and mains will be laid both for public and private supply on both sides of the road, and 13 arc lamps erected, the total estimated cost of the work being £2,200.

Leamington.—In view of the favourable report made by Mr. Robert Hammond the supply of electricity in the borough is to be undertaken by the Corporation. In their provisional order there will be a clause providing for taking over that portion of the undertaking of the Midland Electric Light and Power Company, Limited, which would be of use to the Corporation.

Leeds.—A Local Government Board inquiry relative to the application of the Leeds Corporation for a provisional order to enable them to issue stock for the purchase of the undertaking of the House-to-House Electricity Company, Limited, will be held at the Town Hall on 31st inst.

Leicester.—At last week's Council meeting Alderman Lennard presented the half-yearly statement of the Electric Lighting Committee, ending December 31st, from which it appeared that the result of the working to the date named, after paying interest on capital, and £581 17s. 4d. on account of sinking fund, was a profit of £449 5s. 10d. Deducting that amount from £1,819 3s. 6d. loss to June 31st last, showed a net loss of £1,369 17s. 8d. The total amount which had been paid on account of sinking fund was £3,741 5s. 6d. The committee also reported that good progress had been made with the apparatus in connection with the works, and it was anticipated that the extension would be completed in good time to meet next season's requirements. With regard to the revenue account, their total receipts were £3,654, as against £3,068 for the corresponding half of the previous year, showing an increase of about £566. In the corresponding half they were charging 6d. per unit, while in the present balance-sheet it was 5d. per unit; that meant a loss to their revenue account of £664. On the expenditure side they had a total expenditure of £1,897, as against £1,436, an increase of £461. The total profit on the profit and loss account was £1,757 for the half-year, as against £1,631 for the corresponding half of the preceding year, so that while their business had increased something like 15 per cent. they had only a net increased profit of £126; after paying interest and sinking fund charges they only had a net profit of £449 as against £457. The net result up to date was that whereas at the end of June they stood with a debit balance on revenue account of £1,819, they now deducted £449, net profit, leaving the debit balance £1,370, and their sinking fund now stood at £3,741.

London.—The Works' Committee of the St. Luke's Vestry has recommended that the principal thoroughfares of the parish—City Road, Finsbury Pavement, Old Street, Golden Lane, &c., be electrically lighted. The matter was by consent referred back.

London County Council.—The gas plant at the Crossness outfall has become worn out and inadequate for lighting the works during next winter. The Main Drainage Committee recommends that the Council agree to the installation of electric light at the Crossness outfall in accordance with the drawings presented to the Main Drainage Committee, at an estimated cost of £7,000; and that tenders be invited for the supply and fixing complete of the dynamos, engines, switchboard, and principal mains, and also for the supply and fixing of the service mains, wiring and fittings.

Lynn.—Prof. Robinson's report estimates the cost of an electric lighting plant for the district at about £15,000.

Marylebone.—The Vestry has instructed the Special Committee to enter into negotiations for the acquisition of a site for a dust destructor and electric lighting station.

Newington.—The Vestry has decided to open a separate account with the treasurer for the electric lighting undertaking, and his offer to place £5,000 at the disposal of the Vestry pending the completion of a loan has been accepted.

Northampton.—The directors of the Northampton Electric Light and Power Company have informed the Town Council that they do not feel in a position to name a price for the sale of their undertaking.

Partick.—The Board of Trade have had under their consideration the application of the Kelvinside Company for a provisional order to light the burgh with electric lighting. The application was opposed by the Commissioners of the burgh and Glasgow Corporation, and the Board of Trade has decided not to proceed with the application.

Portsmouth.—We learn that a number of the leading tradesmen here have sent a petition to the Council against the Electric Lighting Committee's proposal to give facilities to the Free Wiring Company. We are informed by a correspondent that those interested in the local electrical trade look upon this in the light of unfair competition.

Saltburn.—The District Council is giving its consent to the Cleveland and South Durham Assets Company's application for permission to erect poles, &c., in certain streets for electric lighting.

Shoreditch.—The present cable from Great Eastern Street sub-station through Leonard Street is too small and a ·75 cable is to be at once substituted, the cost of the work being about £390. Larger cables are also to be substituted for those at present laid in Great Eastern Street, Paul Street, Curtain Road, Old Street, and other streets where the chief engineer has advised such substitution.

Southport.—A Local Government Board inquiry was held last week into an application by the Council for power to borrow £21,178 for electric lighting purposes. The electric light extensions consist of the erection of a 600-unit engine and alternator combined, the laying down of two main cables, and various other works. There has been a rapid increase in the demand for electricity, and it is estimated that the proposed extensions will meet the requirements of the town for 18 months or two years.

Spain.—Messrs. W. Baird & Co., of Glasgow, who are working the iron ore mines of the Pedroso Company in the Province of Seville, have put down an electric lighting plant at their wharf on the Guadalquiver, at Seville, in order that the loading of ore into the steamers may be carried on both day and night.

Stirling.—The Police Commissioners have asked Mr. R. F. Yorke to give them a report on the water power available at their reservoirs for the electric lighting of the town.

Sunderland.—In the new workhouse infirmary being erected for the Board of Guardians (cost £20,000) provision is to be made for installing the electric light.

Swansea.—Mr. Manville has made his report on the lighting question. The borough surveyor is reporting on dust destructors. The two reports will be discussed in committee shortly.

Tottenham.—The Tottenham and Edmonton Gas Company has withdrawn the electric lighting clauses from the Bill before Parliament.

Walsall.—The Electric Lighting Committee reports a further increase in the number of consumers, and that after paying interest on loans and providing sinking fund, there is a deficiency of £531 17s. 7d. on the past year's business, making with the previous year's loss the total deficiency on the undertaking up to December 31st last, £977 1s. 5d.

Watford.—The Board of Trade has approved of the Council's electric lighting scheme.

Withington.—The District Council on 17th inst. discussed the terms offered by the Manchester Corporation for the supply of electricity. A sub-committee from Withington will confer with the Manchester Electricity Committee.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Barking.—Mr. Crooks will bring forward at the next L.C.C. meeting a proposal to refer it to the Highways Committee to consider and report as to the practicability of the Council laying and itself working a tramway along the top of the northern outfall sewer embankment from Stratford to Barking; and also what system of traction would be the most suitable and economical for such a tramway.

Bradford.—The Tramways Committee has appointed Mr. C. F. Spencer, of Walsall, manager for the Bolton Road and Great Horton electric trams, at a salary of £150 a year.

Bristol.—The thirty-eighth ordinary general meeting of the Imperial Tramways Company was held at Bristol on Monday, and Mr. George White, the chairman, in his speech referred to the electrical prospects on several lines. The London United Tramways, Limited, was the one undertaking not actually worked by the company; they had, however, an investment in it, and it was making great strides. The Acton, Brentford, Hounslow, and Hanwell councils had all approved of the proposed new electric tramways. He was personally looking forward to very important results from the development of the United system, inasmuch as they had since received memorials from other districts adjacent to their lines begging them to apply at once for light railways to be worked by overhead electricity, and to connect up with their general system. The small tramway at Darlington, the directors were working on much the same lines as of old, but they would have to apply their minds to substituting electricity in the town also. The Middlesborough, Stockton, and Thornaby electric tramway had proceeded under the able guidance of the managing director and engineer, Mr. Clifton Robinson, and had been completed in so expeditious a manner, that he believed it formed a record piece of tramway work in the United Kingdom. He knew of no previous instance where 15 miles of the best form of concreted and forked tramway had been laid in six months. The power station was well on the way to completion. Electrical arrangements was also in an advanced state, and there could be no doubt the works would be opened in the current half-year, and when finished, would certainly be one of the most complete in this country, or indeed, he might say, in the world. The power house would be a model of its kind.

City and Brixton Electric Railway.—The Bill for the construction of this new electric railway from Brixton to the City, with stations at Brixton Hill, Lorne Road, Kennington Oval, Kennington Cross, Lambeth, St. George's Circus, and King William Street, which the City and South London Company, which will have connections at the Oval and at King William Street, have agreed to work in perpetuity, came last week before a committee of the House of Commons. Mr. Littler, Q.C., in opening the case for the promoters, said the scheme was originally threatened with considerable opposition, but the London County Council, the London, Chatham and Dover Railway Company, and the Lambeth Vestry were apparently satisfied that they would not be injuriously affected, as they were not represented by counsel. The only active opposition came, says the *Times* report, from the St. Saviour's District Board of Works, who raised points as to the depth of soil that ought to be maintained between the tunnels and the roadways, the possible interference with a lavatory, and other small matters. The construction would be carried on by the shield system which had been so successfully adopted in the case of the Central London Railway and elsewhere throughout the metropolis. He mentioned incidentally that the City and South London Company were now constructing a new tunnel under the Thames in connection with their Islington extension, and that consequently they intended to abandon their original London Bridge tunnel, which would now be available for the growth of mushrooms in the same way as the Waterloo tunnel at Edinburgh, where these succulent fungi are cultivated with considerable success. Mr. Mott, chairman of the City and South London Railway, gave evidence to the effect that there would be no difficulty in raising the capital of £1,200,000 necessary for constructing the railway, along with the stations and other incidental works. After hearing engineering evidence from Sir Benjamin Baker, the committee decided to pass the Bill, subject to the insertion of clauses which are now in course of arrangement with the St. Saviour's District Board of Works.

The City and Brixton Railway Bill, the preamble of which was passed last week, came before the Select Commons Committee on the consideration of clauses the other day. Amendments having been made to meet the objections of the local authorities, the Bill, as amended, was ordered to be reported for third reading.

In regard to Mr. Littler's statement respecting the London Bridge tunnel, the *Pall Mall* has inquired of Mr. Jenkin, the general manager of the C. and S. L., and finds that the facts are as follows:—The London Bridge tunnel forms part of the line from Stockwell to King William Street, which was opened in 1890. It is now proposed to hand over this tunnel to the new Brixton line, to bore another tunnel on the other side of London Bridge, and extend the line to Lombard Street, Moorgate Street, and then on to Islington. The deviation from the present line will be made a short distance from the Borough Station on the City side.

The same Committee also had before them the City and South London Railway Bill, which proposed to authorise the construction of sidings at Clapham, the acquisition of lands for the purposes of the company, and an extension of time in connection with the undertaking, and to empower the sale of a portion of the line to the other company—the City and Brixton. The Bill was ordered to be reported to the House.

Charing Cross and Hampstead Underground Electric Railway.—The Bill promoted by the Charing Cross, Euston and Hampstead Railway Company came before a Select Committee of the House of Commons the other day, but the threatened opposition having been withdrawn, the Bill was referred to the Unopposed Bill Committee.

Clontarf.—A successful trial trip was made on this electric tramline on 17th inst, by the contractors' representatives. Public service was commenced this week.

Coatbridge and Airdrie.—The Light Railway Commissioners will hold an inquiry at Coatbridge on Tuesday, March 29th, into the application of the British Electric Traction Company to lay a light electric railway between these two towns.

Dublin.—The Dublin United Tramways Company have lodged a memorial with the Lord Lieutenant for an Order in Council authorising the extension and doubling of the lines of their system in various districts in the city. The total proposed expenditure amounts to £74,858.

Dudley.—A special meeting of the Town Council was held on Tuesday for the purpose of again considering the tramways question which has been engaging their attention for some time. It may be remembered that the Council opposed the scheme of the British Electric Traction Company when the Light Railway Commission sat at Dudley, because the Council desired to have the tramways in their own hands. The tramway which has given rise to the discussion is the portion of the Dudley and Stourbridge line that runs from Dudley Station to the borough boundary at Hart's Hill; but it is proposed to construct a new line from Queen's Cross, at Dudley, to Bishton's Bridge, at Netherton, that will tap the thickly populated district of Netherton, and provide a means for the Old Hill and Cradley Heath people getting to Dudley. These are the tramways within the borough at the present time. The British Electric Traction Company have an order to construct a line from a place called the "Deck Hole," Dudley, to Kingswinford, and thence to Stourbridge, and the company will also have the portion of the Dudley and Stourbridge line from Hart's Hill to Stourbridge. Whether the British Electric Traction Company should have the whole tramway section has been a subject keenly discussed. The Council have consulted Mr. Reginald P. Wilson, and his report has been submitted to the Council. He strongly recommends the Council to acquire the portion of the Dudley and Stourbridge line to Hart's Hill, and the construction of the new line to Netherton. He considers there are some thousands of pounds of profit in it to the town if electric traction is employed. Using the very best rails, and constructing the line on the best methods, he estimates that the cost of putting the Hart's Hill track in order for electric traction will be £13,150, and the cost of constructing the new line to Netherton at £11,452. He estimates the total capital expenditure to be £50,000, and after allowing for interest and sinking fund, he is of opinion that there will be a net profit of nearly £4,000 per annum, providing that the cost of current is at 2½d. per unit. If the Council should first acquire the tramways, and then agree to lease them to an outside company, then he suggests that the company should pay 2½d. per unit for the electric power, 5½ per cent. on the capital expended, and 15 per cent. on all tickets sold over the Council's sections of the lines. Even then, he thinks, the company would make the handsome profit of not less than £2,300 on a capital of less than £10,000. The Light Railway Commissioners being in favour of giving to the British Electric Traction Company the right to construct the line to Cradley Heath, and the Council having preserved the right of appeal to the Board of Trade, he advises the Council to oppose the decision of the Commissioners before the Board of Trade. The Council has passed a series of resolutions to the effect that Mr. Wilson's report be adopted; that the Council should construct, and as soon as circumstances allow, electrically equip the branch tramway or light railway to Cradley, with the consent of the Rowley District Council, or, in case that authority should object, to the boundary of the borough in that direction, that the Council oppose the application of the British Electric Traction Company for powers to construct the branch line above mentioned; that the Corporation electric lighting scheme be carried out without delay. The Railway, Tramway and Electric Lighting Committee will carry matters through. This means that the Dudley tramways scheme is to be municipalised, and the initial expenditure is estimated at £50,000.

The Finchley Electric Line Rejected.—The Light Railway Commissioners resumed and concluded last Saturday, at the Hampstead Vestry Hall, a three days' public inquiry into the scheme for connecting Finchley and Hendon with Hampstead by means of an electric tramway. We have already mentioned that there was a determined opposition from the local authorities. The promoters were Mr. J. T. Firbank, M.P., and Mr. Murphy, and the engineers Sir Douglas Fox and Mr. Wragg. In the result the Commissioners said that the necessity for the "light railway" had not been proved, and they therefore declined to grant an order for its construction.

Great Orme.—The unopposed Bill for the construction of a tramway from Llandudno up the Great Orme was before the House of Commons Committee last week. The line would be about a mile long and would cost £20,000.

Halifax.—Major Cardew has been holding a Board of Trade inquiry respecting an application by the Corporation to borrow £20,000 for electric tramway purposes.

The two routes of tramways which are in course of construction will, it is expected, be opened for traffic at Whitsuntide.

Hastings.—The borough engineer has presented a very lengthy report on the tramways question, in which he states that after obtaining information from numerous towns regarding systems, he has come to the conclusion that the overhead electric trolley system is the most suitable for Hastings. Routes are suggested and general considerations are discussed. Single lines, 3 feet 6 inches gauge, with frequent passing places, are recommended. The lines would be 2 miles 1 furlong and 2 miles 7 furlongs long. The cost of construction is given as £7,263 per mile, and the cost of working £6,356 per annum; income £8,424. The committee recommended that the various suggestions made as to the construction and working by the Corporation of the two main lines be adopted; that power be also sought to construct and work the branch lines suggested; that the overhead electric system of traction be used throughout, and that a special committee of seven members be appointed to determine and carry out the details of the scheme. These recommendations have been adopted by the Council, and a special meeting of the Council is to be held on April 20th next.

Ilkeston.—The Council (sitting as General Purposes Committee) has passed a resolution in favour of tramways for the borough, steps to be taken by the Council in that direction. The Town Clerk is to collect details as to the working of tramways at Dover and elsewhere.

Leicester.—The Town Council has appointed a special committee to consider the advisability of purchasing the tramways, and also to report on a suitable system of traction.

Manchester Underground "Electric."—A *Manchester City News* writer has seen plans of an underground electric railway for Manchester, "which only await the capitalist in order to be carried out." The first part of the scheme is to connect the various railway stations by means of an inner circle in the city—a length of 3½ miles. The second part of the scheme would be an outer circle 8 miles in length.

The Metropolitan Underground.—The Great Western Railway Company, which runs 17 trains per day over a part of the lines of the Metropolitan, has raised objection to the Bill applied for by the company authorising electrical equipment. The objections came before the Court of Referees at the House of Commons on Monday. The Great Western trains running on the line are necessarily subject to the Metropolitan Company's approval, and the Great Western appears to think that when the line is electrically equipped they also may be compelled to change their system to electricity.

Paisley.—The British Electric Traction Company, which has made a conditional agreement with the Paisley Tramways Company, has laid its proposals before the Town Council. It is proposed to extend in the direction of Johnstone in the west, Glasgow boundary in the east, Renfrew in the north, and Potterhill in the south, electricity being, of course, employed. A lease of at least 28 years is suggested, and the company offers to negotiate for the supply of electrical energy from the Corporation works when put down. Mr. Teague has the letter in hand for report. The tramways company transfers its undertaking as at January 1st, 1898, the price being £18,591 odd.

Plymouth.—The Plymouth Corporation will oppose the Devonport, Plymouth, and Stoke Tramways Bill.

Riesengebirge.—The whole Silesian slope of the Riesengebirge, including the Upper Iser, belongs to the Warmbrunner line of the Schaffgotsch. The managers of this property have decided, as much in their own interest as in that of the tourist, to consider the question of opening up the Riesengebirge by a Kamm railway and a Schneekoppe railway. The building of the lines will commence as soon as possible, and it has been decided to work them by electricity. The immense energy of the larger streams, which descend the Riesengebirge, is to be utilised for generating the electricity, and in two or three years a network of light electric railways will render all important points of the Riesengebirge accessible; at the same time, the exploitation of the vast forest lands will be facilitated by this system of railways, which will be an immense improvement on previous methods of transport. The new network of railways will be connected to existing lines at six points; in the west at Warmbrunn, Hermsdorf and Petersdorf, and in the east at Schmiedeberg, Arnsdorf and Krummhübel. The Koppe and Kamm line will connect on to the branch line, Tillerthat, Krummhübel, mount in bold curves, past Quersiffen, to Brotbaude, run past the highest houses on the beautiful Brückenberg, to Kirche Wang, then wind past the Schlingelbaude and the "Eyes of the Mountain" to Hamppelbaude, and, finally, in serpentine windings, mount the last slope of the Kamm, and reach a station near the Reisenbaude. From this the line will run round the steep Schuttkogel of the Schneekoppe, in a double spiral, up to the Koppe houses. May we be spared this trip!

St. Helen's.—Having regard to the changes to take place in the immediate future in the method of traction, in the character of the service generally, and the consequent outlay required by the company, no dividend is to be paid by the St. Helen's Tramway Company for the last half-year.

Whitley and North Shields.—It is proposed by the British Electric Traction Company, Limited, which has lately taken over the North Shields and Tynemouth tramways, to build a light electric railway along the coast road between Whitley, Tynemouth and North Shields.

TELEGRAPH AND TELEPHONE NOTES.

Cable Communication to Australia.—According to a *Pall Mall Gazette* correspondent "A Departmental Committee, including representatives of the Colonial Office, the War Office, the Admiralty, and the Colonies, is now sitting under the presidency of Sir William James Lloyd Wharton, K.C.B., Hydrographer of the Navy, to consider the proposal of the Eastern Telegraph Company to lay an all-British cable connecting London with the Cape, Natal, Mauritius, and Australia, as an alternative scheme to the proposed Pacific cable from Vancouver to Australia and New Zealand. The Imperial representatives regard the two lines chiefly from the strategic standpoint, and it is understood that there is almost a consensus of opinion in favour of the Cape-Australian scheme, especially if a connection be established with India and Ceylon. There is a division of opinion in the Australasian colonies, the eastern provinces favouring the Pacific project as supplying an entirely new line with extensive commercial possibilities in the near future, and the western colonies being more in sympathy with establishing a direct connection with South Africa and the Mauritius. The cable companies require an extension of the existing subsidy of £32,500 a year for a fresh term of years in the event of their incurring the very considerable cost of constructing the new line. New Zealand, as well as the eastern colonies of Australia, object to this guarantee, and would prefer that any fresh financial responsibilities should be in connection with a trans-Pacific route. It is doubtful, however, if the Imperial Government will be disposed to contribute a third of the cost of that line at present. Hence it may be somewhat difficult to reconcile the conflict of interests."

The Iceland Cable.—In regard to the scheme of the Iceland Cable Company the *Standard* remarks that the Danish Government is willing to guarantee £5,000 a year for 20 years, and the British Government is to be asked to guarantee £3,000 a year for a similar period. Mr. Doughty, the member for Grimsby, intends to bring the question before the attention of Parliament; and it is also to be discussed at a meeting of the Sea Fisheries Association, at the Fishmongers' Hall, on March 31st. It is expected that the Government will show some unwillingness to subsidise a foreign company.

Interruption of the Cape Cables.—We have again to add to the long list of interruptions and delays which have occurred from time to time in the telegraph communication with the Cape. On the 17th current we were officially informed by the Berne Office that "the St. Thomé-Loanda cable will be interrupted intermittingly during the next three or four days for renewal purposes, traffic will be forwarded by the East or West Coast routes when necessary, without alteration of rates." Two days later we heard from the same source that the Lorenzo-Marques-Durban cable was interrupted, that the repairs to the St. Thomé-Loanda cable were not yet completed, but "communication with South Africa is maintained by the Portuguese landlines from Lorenso Marques to Transvaal." It will thus be seen that both the East and West Coast routes were interrupted, and our communication with Cape Town was entirely depending on the some 1,000 miles of landline, the greater part of which passes through foreign territory. Although this state of affairs did not last long, for later in the day the St. Thomé-Loanda cable was repaired (thus restoring the West Coast route), it proves once more the absolute necessity of laying another cable to the Cape, and, as we have previously pointed out, the cable company who is, and has been since its existence, in receipt of large subsidies from the English, Cape of Good Hope, Natal and Portuguese Governments, should be quite able to carry out the work without further "privileges" for doing so.

Interruptions to Australian Landlines.—Referring to the list of interruptions to the Australian trunk landlines recently published by us, we are able to furnish our readers, from Australian papers just to hand, with a little more information on the subject, and the following extracts from the Australian press will show that there is every cause for the general dissatisfaction which has been expressed, both in England and Australia, with the existing system of telegraphic communication between the great commercial centres of both countries:—

February 8th.—"The Postmaster-General, Adelaide, advises:—'Port Darwin line still interrupted. Our West Australian lines are working badly owing to thunderstorms. Very little prospect of getting cable business through.'"

No cablegrams from London were received in Sydney on February 8th.

February 10th.—"The Postmaster-General at Adelaide advises:—'The Port Darwin line is interrupted north of Woodnadatta since 11.30 p.m., Wednesday. Probably caused by floods.'"

No cablegrams from Europe were published in Sydney on February 11th, so we presume that the West Australian line was also interrupted.

February 11th.—"Adelaide. The Postmaster-General reported this morning: —'Fault removed between Oodnadatta and Charlotte Waters, 9.5 a.m. Line still interrupted between Barlow and Tennant's Creeks since 5.35 p.m. yesterday.'"

Later.—"Communication restored Port Darwin line at 2.15 p.m."

In the same paper we read:—"Port Darwin, Friday, February 11th:—'The Cable Company's steamer *Recorder* has been here for some days past repairing the cable.'"

February 14th.—"Perth, Saturday (February 12th). Great dissatisfaction is expressed here at the unsatisfactory working of the Inter-Colonial Telegraph line on the South Australian side. Many messages are 24 hours late, and there is great difficulty in obtaining share quotations. The local exchanges are completely paralysed. For several nights lately the lines have failed altogether, or else worked very badly."

It will be seen that the scanty information we are able to make known is only gathered from such particulars as appear from time to time in the Australian press. As we have frequently pointed out, it is seldom, if ever, that any notice of interruption to the Australian trunk landlines is furnished by the Bureau International des Administrations Télégraphiques. It will be noticed that what information is published in Australia emanates from Sir Charles Todd, the Postmaster-General of South Australia, yet that gentleman, in answering a protest from the London Chamber of Commerce towards the end of last year concerning the delays in the transmission of cable messages to and from South Australia, says that "delays have rarely occurred," and that he does not "anticipate any further complaints." We do not see how that statement can be reconciled with the following extracts from letters in the Australian papers we are now dealing with:—

"During the past six or seven months the interruptions of the overland telegraph line to Port Darwin have been sufficiently frequent to cause very serious inconvenience to business people. On every such occasion the utter worthlessness of the Roebuck Bay line as an emergency one has been fully demonstrated. It would therefore seem that the Eastern colonies must look to a Pacific cable if they desire an alternative service of any value, and free from the misleading information supplied too frequently from Adelaide."

Another writer says:

"The increasing frequency of the interruptions to the cable service to Europe, both as regards the submarine system and the landlines, would, one might imagine, be sufficient to draw serious attention to the faultiness of the present means of communication much more strongly than it appears to. To many business men it must mean immense loss."

In commenting on Sir Charles Todd's reply to the secretary of the London Chamber of Commerce, the writer continues:—

"If delays are occasionally due to heavy business, it is clear that the lines are insufficient for the purpose for which they are designed, and therefore should have their carrying powers increased. When the West Australian landline was connected from Roebuck to Adelaide, it was intended as an attempt in this direction; but it has proved utterly unreliable, being more often out of order than not."

The same correspondent goes on to show that an alternative line for telegraphic communication between England and Australia is a necessity, and says:—

"Such a route would be offered by the Pacific cable. In the event of war being declared, the Pacific cable would in all probability be worth many times the sum we seem so reluctant to grant, even if it only remained open sufficiently long to give us warning."

We have for years advocated the laying of the Pacific cable, so that the principal centres of population in Australasia might be entirely independent of the two unreliable lines which run across that vast continent to meet the submarine cables; besides which it would be invaluable for strategic purposes, and we trust, that now the Australian Governments are reported as willing to take action in this direction, some definite movement may soon be made.

The Telephone Service.—In the Commons last week, Sir Mark Stewart asked the Secretary to the Treasury, as representing the Postmaster-General, whether it was the practice of the Post Office to substitute a telephone for a telegraph where the guarantors have signed an agreement with the Post Office for a telegraph service; and if it were so, would he state the reasons. Mr. Hanbury, in reply, said it has been judicially decided that the definition of telegraph includes a telephone. In agreements of the kind referred to there is no provision as to the particular form of instrument to be used. The guarantee for a telegraph extension is based on the most suitable method of serving the office, and if a telephone is used it is because it offers advantages over other forms of telegraph apparatus, either in regard to initial cost, maintenance, or working.

The Association of Chambers of Commerce meeting in London last week, passed a resolution pressing upon the Telegraph Department of the Government the necessity of promptly increasing the telephone trunk line service between mercantile centres.

The Huddersfield Corporation has had a discussion *re* telephone matters, particularly regarding rates. The Telephone Company is substituting underground for overhead wires, and reconstructing the plant on the twin-wire system. The North Staffordshire Chamber of Commerce has also been discussing the inefficiency of the service and the high charges. Mr. Gaine and Mr. Coleman met the Chamber the other day, and it was explained that there was no prospect of reduced charges, as the plant was to be constructed on the twin-wire system in order to improve the service.

The Pacific Cable.—The British Empire League meeting at Ottawa on 10th inst., passed a long resolution regarding the Pacific cable scheme, urging the Government and Parliament of Canada to continue such action as may be necessary to secure the early commencement of the cable. A committee was appointed consisting of Sir Sandford Fleming, Colonel Denison, Messrs Casey, M.P., Hughes, M.P., and Principal Grant, to wait upon the Government for the purpose of presenting the resolution and urging prompt action.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1898 ...	...
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	
Paramaribo-Cayenne ...	Jan. 27th, 1898 ...	March 19th, 1898.
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Cable beyond Obidos ...	March 9th, 1898. ...	...
Cyprus-Latakia	Feb. 10th, 1898 ...	...
San Thomé-Loander... ...	March 17th, 1898 ...	March 19th, 1898.
Gibraltar-Tangier	„ 19th, 1898 ...	...
Lourenco Marques-Durban...	„ 19th, 1898 ..	...
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Cartagena-Barranquilla ...	July 4th, 1896 ...	...
Bolinao-Manila-Laminos ...	March 9th, 1898 ...	March 21st, 1898.
Saigon-Bangkok	„ 15th, 1898 ...	March 16th, 1898.
„ „	„ 18th, 1898 ...	„ 19th, 1898.
Majunga-Tananarive ...	„ 15th, 1898 ...	„ 16th, 1898.
Fao landlines...	„ 21st, 1898 ...	„ 22nd, 1898.

The Telegraph Clerks.—The London committee of the Postal Telegraph Clerks' Association issued last week a statement in reply to the circular of March 15th issued by the Postmaster-General. The association states that many points are not yet dealt with, and pressing grievances remain unredressed. As examples they particularly draw attention to two points—classification and holidays.

FORTHCOMING EVENTS.

1898.

Friday, March 25th, at 8 p.m.—The Institution of Civil Engineers (students' meeting). "Internal Governor Friction," by H. O. Eurich, Stud.Inst.C.E.

At 5 p.m.—Physical Society at the rooms of the Chemical Society, Burlington House. (1) "On the Circulation of the Residual Gaseous Matter in a Crookes Tube," by Mr. A. A. Campbell Swinton. (2) "On some Improvements in the Roberts-Austen Recording Pyrometer, and Notes on Thermo-electric Pyrometers," by Mr. A. Stansfield.

At 8 p.m.—Electro-Harmonic Society. Last Smoking Concert of the season at St. James's Hall Restaurant.

Monday, March 28th. Last day for Darwen Corporation electric light plant tenders.

Wednesday, March 30th, at 8 p.m.—Society of Arts. Prof. S. P. Thompson, on "Telegraphy Across Space." Mr. J. W. Swan, F.R.S., will preside.

Royal United Service Institution. Captain J. N. C. Kennedy on "Wireless Telegraphy."

At 7.30 p.m.—Institution of Electrical Engineers. Students' meeting. Paper on "Electrical Instruments," by M. R. Gardner, Student.

Thursday, March 31st.—Last day for Hampstead extension plant tenders.

Royal Institution of Great Britain. Prof. J. A. Fleming, M.A., D.Sc., F.R.S., M.R.I., on "Recent Researches in Magnetism and Dia-magnetism." (Lecture V.).

At 3 p.m.—Chemical Society, Burlington House. Annual general meeting.

Friday, April 1st, 8 p.m.—Institution of Junior Engineers at the Westminster Palace Hotel. Paper on "Mechanical Refrigeration," by Mr. J. T. Burrell, of Peterborough.

Saturday, April 2nd, 11 a.m.—Visit of the Institution of Junior Engineers to the Thames Iron Works, Blackwall.

Tuesday, April 5th, at 8 p.m.—Röntgen Society, at 11, Chandos Street, Cavendish Square, W. Paper by Mr. James Wimshurst upon "The Influence Machine and its Advantages for lighting X-Ray Tubes."

CONTRACTS OPEN AND CLOSED.

OPEN.

Ashton-under-Lyne. — April 5th. The Corporation invites tenders from firms willing to undertake the free wiring of premises in the Borough. Consulting engineers, Messrs. Lacey, Clirehugh & Sillar, 78, King Street, Manchester. See our "Official Notices."

Belgium.—March 30th. Tenders are being invited by the municipal authorities of Ghent for the supply and erection, &c., of a complete installation for the electric lighting of the town dock. Particulars may be obtained from, and tenders to be sent to, l'Hotel de Ville, Ghent, Belgium.

Belgium.—April 1st. The Municipal Authorities of Seraing are inviting tenders for the concession for the supply of electrical energy in the town for public and private lighting purposes during a period of 30 years. Particulars may be had from, and tenders to be sent to, the College des Bourgmestre et Echevins, Seraing, Belgium.

Bournemouth.—The Corporation wants tenders for the electric lighting of the pier and pleasure grounds. Particulars *re* plant, &c., are given in our "Official Notices" March 18th. Borough engineer, Mr. F. W. Lacey.

Bournemouth.—April 4th. The Corporation wants tenders for motor vehicles for the collection of house refuse, &c. Borough engineer, Mr. F. W. Lacey. See our "Official Notices" March 18th.

Darwen.—March 28th. The Corporation wants tenders for the supply of steam engine and dynamos, piping, accumulators, switchboards, mains, arc lamps, pillars, &c. See our "Official Notices" March 11th.

Denmark.—March 30th. Tenders are being invited until the 30th inst. by the Danish Telegraph Department in Copenhagen for the supply of 56 tons of copper-bronze wire, 4 mm. diameter, and 42 tons of copper-bronze wire, 3½ mm. diameter. Particulars may be obtained from, and tenders to be sent to, Die Telegraf-directorale Tekniske-afdeling, Copenhagen.

Derby.—April 12th. The Corporation wants tenders for the electric wiring of its Ford Street yard and premises. See our "Official Notices" March 18th.

Derby.—April 11th. The School Board want tenders for the electric wiring of the Traffic Street Board School, Derby. Particulars from Mr. J. E. Stewart, Corporation electrical engineer. See our "Official Notices" last week.

France.—March 30th. Tenders are being invited by the municipal authorities of Paris for the supply of the electrical conductors, required in connection with the electric lighting of the Square Vaugirard. Particulars may be had on application, and tenders to be sent to, l'Hotel de Ville, Paris.

France.—March 31st. Tenders are being invited by the Municipal Authorities of Saint Chamond (Loire) for the concession for the lighting of the public streets of the town, either by gas or electricity. Particulars from, and tenders to be sent to, La Mairie de Saint Chamond (Loire).

Hampstead.—March 31st. The Vestry wants tenders for the supply and erection of one or two steam alternators, switchboard panels, two induced draught wet back boilers, feed water heater, steam and exhaust pipes, feed pumps, 50 kw. exciter, and a feed water softener. See our "Official Notices" March 18th for full particulars.

Leyton.—April 4th. The District Council wants tenders for the supply of two dynamos, one transformer, two gas engines and connections, and switchboards for extension of the electricity works. Electrical engineer, Mr. H. C. Bishop. See our "Official Notices" March 18th.

Manchester.—April 4th. The Lancashire and Yorkshire Railway Company is inviting tenders for various stores. The following are a few of the items:—5. Copper; 7. Copper tubes for boilers; 8. Copper tubing; 29. Signal and telegraph fittings; 30. Signal, telegraph and electric light wires. Samples may be seen and forms of tender and further particulars obtained at the Stores Department, Osborne Street, Manchester.

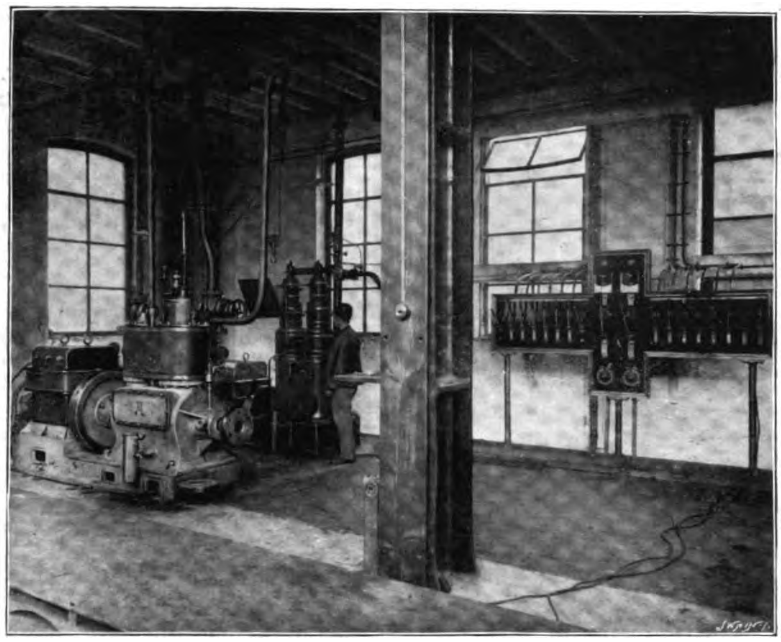
Shoreditch.—April 12th. The Vestry want tenders for the supply and erection of arc lamps and accessories, also for electric cable. Electrical engineer, Mr. C. N. Russell. See our "Official Notices" this week.

(*Continued on page* 409.)

MESSRS. MAVOR & COULSON'S WORKS, GLASGOW.

THE new works of Messrs. Mavor & Coulson, Limited, have been recently opened, and as they are equipped with the most modern plant some details of them may be interesting. The works are erected on ground purchased by the company from Messrs. Clark & Co., Limited, who formerly used the site for their Mile End Thread Works. The works are $1\frac{1}{2}$ miles distant from Glasgow Royal Exchange, and are within three minutes' walk of the Bridgeton Cross Stations of the North British and Caledonian Railways.

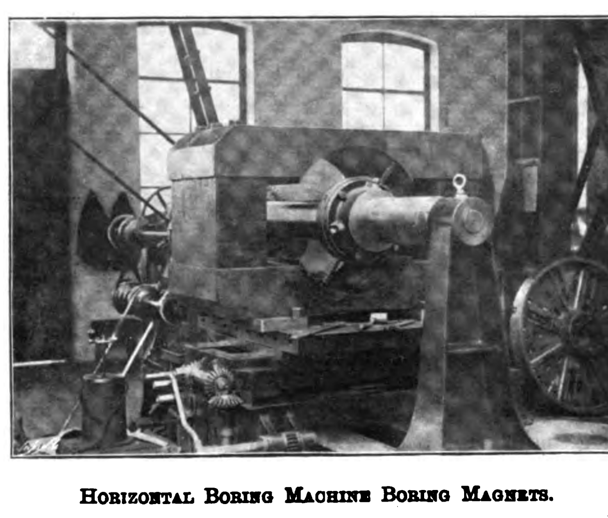
The company's manufacturing business was formerly carried on in their premises in Orr Street, Bridgeton, which premises together with the machine tools there were held on lease. During the company's tenancy of these works patterns were developed and standardised, and methods of production systematised. At the expiry of their lease last year the company was therefore in a singularly favourable position to undertake the design and equipment of a new factory for their specialities in electrical machinery and accessories. In the general arrangement of the works and selection of machinery, the directors have had the advantage of an intimate knowledge of the most recent American and Continental practice, and of their own special requirements. The result has been the building and equipping of a factory, which is the only one of its kind in Scotland, which provides facilities for the rapid, economical, and accurate production of high-class electrical machinery, and is probably not surpassed by the best and most recent factories in the country. The establishment of this new factory for the extensive manufacture of electrical plant in Glasgow is an important addition to the long and varied list of industries which have been located in and around the city.



GENERATING PLANT FOR SHOP DRIVING.

The existing buildings formerly used for the thread factory and stores have been partially utilised for the new factory. The ground formerly occupied by the engine and boiler house, wood stores, bobbin shop, packing case warehouse, &c., has been cleared, and a spacious new shop and smithy, brass foundry and moulding shop have been erected. The machine shop is 160 feet long by 75 feet wide, and is covered by a single span steel roof, glazed all over and supported by 14-inch brick walls, and cast-iron columns carrying the crane girders which are spaced at 40 foot centres. The lofty roof gives a spacious and airy workshop, while its steel and glass structure and the side windows in the walls provide exceptionally good and uniform lighting. The heating is effected by cast-iron pipes supplied with exhaust steam from the engines. On either side of the space swept by the crane is erected a gallery, which will be used on the one side by the pattern making and carpentry department, and on the other by the store department for finished stock. The design is to ultimately use these galleries for light machine tools, and accommodate elsewhere the two departments mentioned. The large centre bay is floored with granolithic, and the two side bays under the galleries are floored with double pine planking laid on joists. The machinery in this department is driven by 10 electric motors. None of the shafting is driven direct from the steam engine, with the exception of a short length on the testing engine. It is hardly necessary to point out the advantages gained by the use of electric motors in this department.

A special feature in this department is the extensive use of milling machines and other special appliances for labour saving. While special appliances do not in any sense dispense with the necessity for skill on the part of the workman, they permit of the use of a class of labour more easily available than that of a fully trained and equipped all round tradesman. The machines and tools are arranged with a view to the utmost accuracy in work without the necessity for individual measurements by the operator, the machines themselves being provided with measuring devices in which dimensions can be read off with ease and accuracy down to $\frac{1}{1000}$th of an inch. The use of such machinery necessitates a separate department, with special appliances for making new tools and for keeping the working tools in order. This is provided in the tool room in the north-west corner of the main shop, where a staff of skilled men are constantly employed in these operations. The antiquated practice of keeping a machine standing while the operator is grinding his tools or awaiting their formation by the tool smith is thus entirely abolished. It is found that the use of highly finished and accurately made machinery is a valuable education to the men operating it. The tendency being to assimilate the character of the work produced to that of the machinery producing it, and to keep the shop and all its surroundings up to a high standard of cleanliness and order. These tendencies inevitably reflect their characteristics upon the finished product.



HORIZONTAL BORING MACHINE BORING MAGNETS.

The electric crane, which sweeps the whole of the centre bay of the shop, is capable of lifting about 10 tons, and can traverse the whole length of the shop from start to stop in one minute. It is fitted with a motor for each motion, and is controlled by a man who sits in a cage under one end of the crane girder. The controlling gear consists of three liquid switches, which give command over all the required motions, and which enable the driver to operate any motion at any speed, either simultaneously or independently of the

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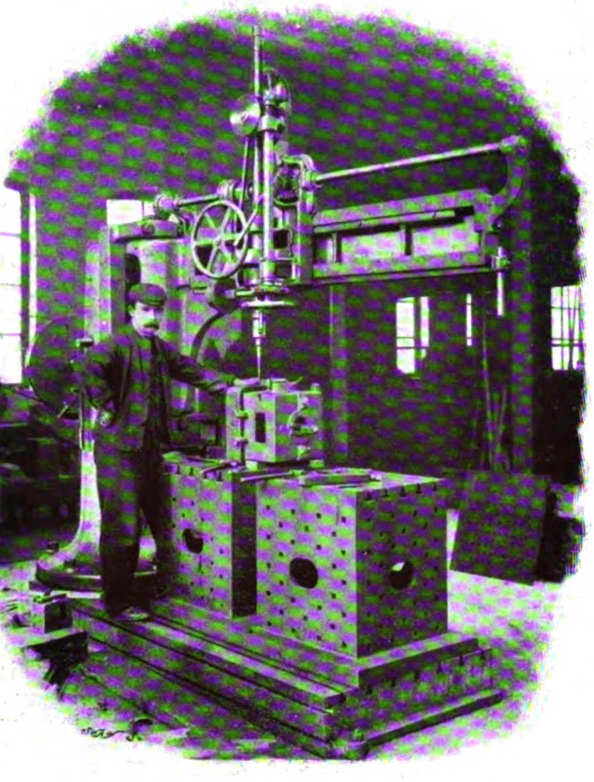
other motions. The entire absence of reversing clutches and other complicated mechanism renders the crane exceedingly easy to manipulate. An ordinary mechanical labourer



Radial Drill.

after one day's instruction can readily handle the crane, and expertness is soon acquired. The power required to work this crane is insignificant as compared with that required for square shafting or rope-driven cranes, and the power is only absorbed for actual work; there are no "stand-by" losses. The electric current is carried to the crane by a No. 4 copper wire, supported on insulators attached to the main girder on the east side of the shop. A rubbing contact attached to the cage picks up the current from this conductor, whence it is led by cables to the controlling switches. The crane girders themselves are fitted with conductors for carrying the current to the hoisting and across traverse motors, the current being picked up by rubbing contacts on the crab. The long traverse is driven by a light spur gear, and the cross and hoisting by special wormgears running in oil boxes.

Entering from the fitting shop is the smithy and boiler-house. In the smithy is fitted one 3-cwt. steam hammer and three forges, the forge blower being driven by an electric motor.

The brass shop occupies the ground floor of the portion of the building facing King Street. It is fitted out with turret lathes, milling machines, multiple drills, &c., for the production of large quantities of brasswork for use on switchboards, and on the various appliances connected with the wiring and installation of electric light and power. In this department, as in the machinery shop, advantage has been largely taken of the most modern improvements in American machine design, and the result is an immense improvement in the economy and accuracy of the product.

The winding shop is accomodated in the same building as the brass shop, but on the upper floor. Into this department are delivered the armature cores and magnet formers to be wound with copper conductors. There is little machinery in this department, the greater part of the work being performed by hand. The magnet wire is wound on the formers on a group of lathes driven by an electric motor. A light overhead travelling crane, operated by hand, is provided for handling parts in process of manufacture. It is capable of lifting two tons, and sweeps the whole length of the shop. After completion of the winding the armatures and magnet coils are lodged in a drying stove until the moisture is thoroughly expelled from the insulating materials. This stove is situated over specially constructed flues between the main boilers and the chimney.

In the machine shop are also placed the steam boilers, engines and dynamos for the production of electric current for lighting the works and driving the machinery. The electric lighting installation for the works and offices consists of 230 16-C.P. lamps, 30 Sunbeam 150-C.P. lamps, and six arc lamps of 2,000-C.P. each. There are in all 15 motors, of 85 aggregate horse-power. Two boilers generate steam at 160 lbs. pressure. The smaller boiler is just capable of overtaking the present work, but a Babcock & Wilcox boiler, evaporating 2,280 lbs. of water per hour, has been recently added to provide for extensions. The electric current is generated by two dynamos, each mounted on the same bed-plate with and coupled direct to a high speed single acting engine. The output of each combined set is 40 electrical horse-power. From the steam dynamos the conductors are led to the main switchboard, from which point the whole of the distribution is carried out on the company's well-known "C.C." Concentric System of wiring, in which the positive or live conductor is entirely enclosed in the negative conductor, which is uninsulated and connected to "earth." The lighting and power are supplied from the same system, but on different circuits. Each circuit is controlled by a switch on the main switchboard, on which are also placed ammeters and voltmeters to indicate the amount of power being used at any instant. Adjoining the steam dynamos is the testing table, on which all machines are temporarily run before being despatched.

Test Room.

In the brass foundry, which forms another department, are made all the brass and a few light iron castings required for the various manufactures carried out in the works. It is provided with six moulding furnaces and a core drying oven. For cleaning and cutting off the castings a group of cutting-off saws, emery grinders, and scratch brushes are driven by a $4\frac{1}{2}$ horse-power electric motor, coupled direct to a short counter-shaft. A "Cyclone" dust collector with fan driven by a motor is arranged to draw the dust from the emery grinders and deposit it in a receiver. The men are thus saved from breathing the metallic particles, and the metal is saved for re-melting. Plate moulding has been recently introduced to this department with very successful results.

While the excellence of the manufactures has secured for the company a large share of English and foreign work, and important contracts for Government departments, municipalities, and public bodies, the directors, in the design and equipment of the new factory, have kept prominently in view the large and increasing demand for electric machinery, especially for power purposes, in this district. The directors believe that there is no more promising field in the whole world for the introduction of the applications of electricity to industrial purposes than that embraced by a circle of 10 miles' radius round the city of Glasgow, and they are of opinion that the existence of these works in Glasgow will give an important stimulus to the adoption of electrical plant in Scottish industries.

THE RELATIONS BETWEEN CUSTOMER, ENGINEER AND MANUFACTURER.

In continuation of this subject, on which we published a leading article in our issue of February 11th, Mr. S. Dana Greene considers the tests and guarantees prescribed in specifications. Tests may be classed under the few heads of efficiency, heating, regulation, sparking, and insulation—he is speaking, of course, of electrical machinery particularly, and is of opinion that there should be standard tests which would simplify matters all round. Such uniform tests, moreover, would place a consulting engineer in a very strong position, for his duty would simply be to see a certain standard worked up to, and he would not then be exposed to the possibility of having to withdraw or alter unworkable clauses of his own drawing up. He advises, for America, that such standards should be drawn up by the Institute of Electrical Engineers, and why should not the same duty be undertaken by the English Institute for England. Frequently there are misconceptions as to the proper definition of efficiency—commercial or electrical. The former alone interests the customer, and for want of the proper understanding of this, we may see huge extravagancies in all sorts of practice.

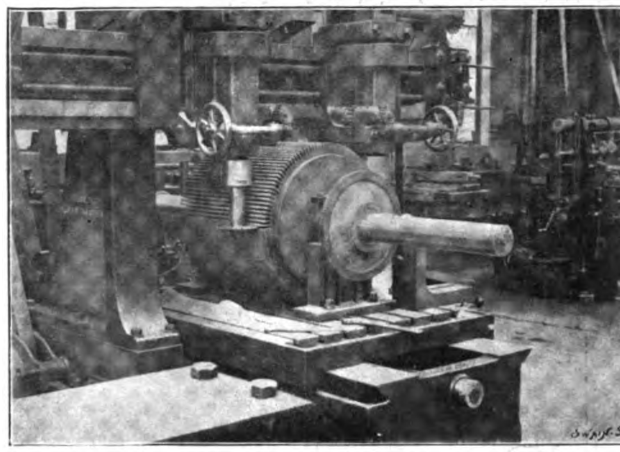
Thus, as recently pointed out by Mr. Raworth, the pursuit of the item of small fuel consumption per I.H.P. may have caused Lancashire mill owners to overlook an economy of first cost which would have been better appreciated if brake horse-power had been the datum line.

All electrical manufacturers have their own figures for the difference between carbon and copper brushes in efficiency and between different voltages, and so on, and it ought not to be difficult to form intelligent general rules.

Mr. Greene objects to the demand made upon the electrical manufacturer to guarantee the combined efficiency of engine and dynamo. Overload guarantees are sometimes required, ranging from 25 to 100 per cent. This often means increasing the capacity of a machine as surely as if it had been asked for in the specifications. Unreasonable demands for overload amount to an attempt to buy big machines at the price of small ones.

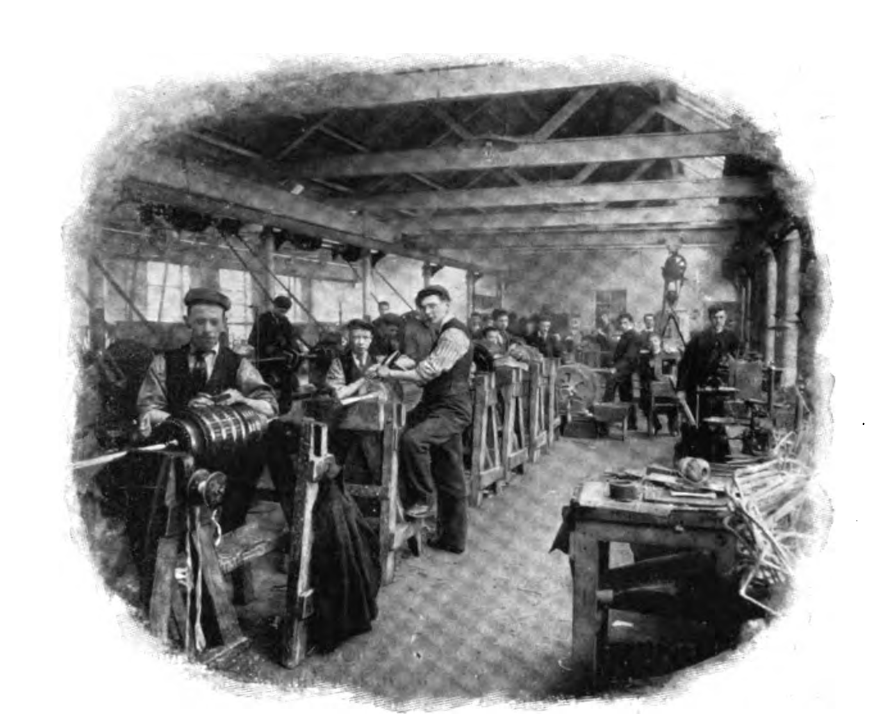
Impossible demands often specified are the straight line compounding curve, practically unattainable until we discover a magnetic material with a straight line saturation curve and a drop of 2 per cent. in speed of lighting generators not to affect the E.M.F. more than 2 volts, also impossible even with separate exciting.

In testing for insulation, because a 5,000-volt test is correct for a 1,000-volt machine, it does not follow that a 10,000-volt machine should be tested to 50,000 volts. The



Mavor & Coulson's.—Duplex Milling Machine Slotting Armature Cores.

proper method is to consider jointly the duration of test, current frequency, and voltage. As the latter rises, the margin between it and the test voltage necessarily decreases, because of the risk of injury to insulation from excessive voltage. All these things might properly be standardised, and excessively drawn specifications, leading to distorted designs and special apparatus, put a load on the customer's purse in the long run, for manufacturers do not for ever work at a loss, and the eccentric engineer becomes shunned by the best manufacturers, and is generally looked on with suspicion.



Mavor & Coulson's.—Armature Winding Shops.

Often a contractor, working for a penalty date, and paying expensive overtime, finds himself with the stuff on his hands for weeks after it should have been paid for. This sort of thing is very unfair. It is bad for workmen who have been pushing a job, to see their finished work lying ready for shipment for weeks. They invariably let the fact influence them when the next push job comes to hand, and the demoralisation perhaps makes a really urgent job late. Where there is a penalty for delay, it is urged there should be a bonus for prompt readiness to date. Again, the self-appointment of a consulting engineer as sole judge, is considered unfair; and though probably it could not be enforced at law, there ought to be provision for a third party.

Generally, Mr. Greene's paper was suggestive, and met the cordial approval of his hearers, who invite the American Institute of Electrical Engineers to consider some comprehensive plan for such standardisation of apparatus for electric light and power.

Writing on the other side of the question from that taken by Mr. Greene, Mr. White-Fraser looks on the consulting engineer as a safeguard to the honourable manufacturer—protecting him from the unscrupulous maker of inferior goods. Mr. Fraser also rather deprecates standardising as likely to hinder engineering progress. But Mr. Fraser writes as though Mr. Greene had asked for the abolition of the consulting engineer, for he refers to alternate and direct current machinery, and the pushing of one or the other by the manufacturer, where the consulting engineer would, unbiassed, be able to advise which was the better system. But Mr. Greene did not wish to abolish the engineer so much as to curb him, and restrain the tendency to design new plant when equally good things are to be bought in open market. It is in selecting systems that the value of the consultant should come in; in giving out orders that his knowledge of manufacturers should prove valuable; in passing work as sound, that his technical knowledge should avail him. There is indeed plenty for him to do in applying his knowledge and making general arrangements. As we write these lines we have in mind a large pair of steam engines which, though only performing an ordinary factory duty, were built from entirely new patterns to a design got out in a consulting engineer's office. They are wasteful and extravagant, and probably cost over double what any good firm of engine builders would have charged for far better designs of standard type. Americans are well to the fore in many respects in this matter of standards. Parts of railroad cars are standardised, and we don't know that this fact has done much to prevent progress and change along proper lines of development. We have no such progress-stopping standards on English railroads, yet who will deny that there are vehicles running on the South-Eastern Railway that are of the type of 50 years ago, if not themselves 50 years old? Americans have tried to standardise cement tests. Here every little architect or engineer who calls for the use of a bag of Portland cement must write out a wordy specification for a product of which he has no technical knowledge. Yet every one knows that Portland cement could be standardised under three classes—some men would say one class would cover everything—and might be classed as A, B, or C, and so specified. The question for the consulting engineer himself to determine is how far he is to carry out his own personal supervision. There is a point somewhere between a mere outline of a building and a specification and drawing of the floor brads, at which an architect has to draw the line. It is only a question of degree, and how far we are to go in the direction of designing our own details. In Mr. Fraser's opinion the chief objectors to consulting engineers are the manufacturers of everything; the special manufacturers who make one thing, and that perfect, look on him as a friend. They ought to be able to do so, if only he will do his duty as a selective agent.

Mavor & Coulson's: Machine Shop, West Bay.

In further correspondence on this subject, a Mr. F. J. Johnston implies that consulting engineers have been, at times, poorly informed men. He instances where one electrical engineer in a responsible position sent a flagman to a distance of 1,000 or 1,500 feet with a flag which he was to drop on receiving an electrical signal at a device placed by him. The engineer pressed the button and timed between the pressing of the button and the fall of the flag. The idea of the test was to *determine how long the current required to travel the 1,000 or 1,500 feet!!!*

Mr. Johnston points out that customers select their engineers and place them to overlook contractors, yet customers are no more competent to select engineers than the ordinary layman is competent to select a specialist physician.

Generally, there seems to be an opinion abroad that contractors are very much in the hands of engineers who arrogate to themselves the sole right of judging questions of materials and workmanship, and have the power to hinder work and to throw all kinds of expensive delays in the way of the contractor for which he can make no charge. In fact, the contractor is looked upon as though he were making a huge fortune and is expected to stand all manner of extortion. If engineers will be so extravagant in the demands they make for recognition, they might at least be fair enough to protect the contractor from robbery. Engineers are occasionally far too apt to give ear to any tittle tattle which brings them lying reports of bad work. Such are the views of contractors; to the other side we may next give attention.

CONTRACTS OPEN AND CLOSED.

OPEN.

(*Continued from page* 404.)

Spain.—March 29th. Tenders are being invited by the municipal authorities of the town of Zafra (Badajos province) for the concession for the electric lighting of the public streets during a period of 20 years. Particulars and conditions may be obtained from, and tenders to be sent to, El Secretario del Ayuntamiento de Zafra (Badajoz), Spain.

Switzerland.—April 30th. Plans and estimates are being invited, says the *Contract Recorder*, by the Government authorities of Fribourg, Switzerland, until April 30th next, for a projected electricity generating station to be established at Hauterine. Water-power is to be utilised, and the station will have a capacity of about 6,000 H.P. A premium of £120 will be awarded to the three schemes submitted which are considered to be the best. Plans and estimates are to be sent to the Department des Travaux Publics, Fribourg, Switzerland, from whence full particulars of the competition may be obtained.

The War Office.—April 27th. The Secretary of State for War is prepared to receive offers, competitive designs and specifications for the supply of portable electric search light apparatus. Particulars from the Director of Army Contracts, War Office, Pall Mall, S.W. See our "Official Notices" February 4th.

Victoria.—June 24th. The Council of the city of Hawthorne (Colony of Victoria, Australia) is inviting tenders for the supply and erection of buildings, boilers, engines, dynamos, transformers, mains, meters, arc lamps, poles; also running the plant for three years. See our "Official Notices" March 11th.

CLOSED.

Glasgow.—On 17th inst. the Corporation adopted the recommendations of the Electricity Committee accepting the following offers:—(1) The offer by Messrs. Laing, Wharton & Down, for one engine and dynamo of 700 horse-power at the price of £5,064; (2) the offer by Messrs. Mirrlees, Watson & Yaryan Company, Limited, for one engine and dynamo of 400 horse-power at the price of £1,970; (3) the offer by Messrs. Mavor & Coulson for one engine and dynamo of 900 horse power at the price of £5,775; and (4) the offer by Messrs. Mirrlees, Watson & Yaryan Company, Limited, for one engine and dynamo of 200 horse-power at the price of £1,265. An offer obtained from Messrs. Babcock & Wilcox, Limited, to provide and erect at the new generating station, Port Dundas, two of their patent boilers of about 1,000 horse-power each, with relative superheaters, at the price of £2,020 for both boilers and superheaters was also accepted. Bailie Maclay, in moving the minutes, explained that the engines, dynamos and boilers, contracts for which were thus recommended, represented 2,200 horse-power. They took it that these engineers were bound to deliver the plant by a certain date, somewhere about the end of August. They hoped to have the new works in operation immediately thereafter, and in that way they would be ready to supply current from their two works against the increased demand of next winter. There was urgency in the case, and they were going ahead with the business as quickly as possible. All the engines are Scotch, with the exception of one, which is American.

Salford.—The following is a list of the firms who tendered for the supply of electric cables for the Corporation:—The British Insulated Wire Company (high tension); The Callender Cable and Construction Company, Limited; The Western Electric Company; W. T. Glover & Co. (low tension); W. T. Henley's Telegraph Works Company; Siemens Bros. & Co. The tenders of the British Insulated Wire Company and Messrs. W. T. Glover & Co. were accepted.

West Derby (Lancs.).—For the electric lighting of the Mill Road Infirmary the Board of Guardians have, according to *Daily Tenders and Contracts*, accepted the tenders of the following:—

Boilers.—Messrs. Fawcett, Preston & Co., Liverpool	£1,075
Engine House Plant.—Messrs. Scott, Anderson & Beit, Sheffield	2,085
Batteries.—The Chloride Electrical Storage Syndicate, Manchester	440
Wiring Buildings.—Messrs. W. & J. Robinson, Limited, Bootle	1,411

Mr. T. L. Miller, M.I.E.E., is consulting engineer.

GLASGOW TELEPHONE INQUIRY.

The report of Sheriff Jameson is an example of the disadvantage of government by commission and of the proverbial infelicity of giving reasons for decisions.

The delay in the publication of the report after the taking of the evidence, though considerable, is not so great as to necessitate here a recapitulation of the circumstances under which Sheriff Jameson's inquiry was undertaken. Upon the evidence submitted to him, he finds that the telephone system in Glasgow is not efficient, the inefficiency being mainly due to the refusal by the Corporation of underground facilities to the Telephone Company, but he thinks that the company's service might be improved by a more thorough supervision of the switch room and other improvements; he is more than usually emphatic in expressing his opinion that the comparisons which were introduced with a view to showing that the company's charges were excessive, are altogether outside the circumstances of the case. With regard to the license, he gives reasons for recommending that a license be not given to the Corporation, whilst, in the concluding paragraphs, he suggests that, notwithstanding all the objections he has pointed out, the license should be granted to the Corporation, "throwing on them the whole responsibility of their proposed undertaking," if the Post Office does not itself start a telephone exchange, and provided the Corporation is able to satisfy the Postmaster-General that financially its scheme is sound, and that it has the means of carrying it out.

In forwarding the report the Secretary to the Post Office states that the Postmaster-General is precluded from assenting to the wishes of the Corporation by issuing a license, because in the present state of the law the Corporation has no power to carry on the business of a telephone exchange. Sir J. D. Marwick, the town clerk of Glasgow, in acknowledging Mr. Walpole's letter, takes advantage of the fact that His Grace the Duke of Norfolk "has been so good as to indicate the grounds on which he has arrived at his opinion," and discusses them in some detail, finally concluding with the intimation that if the Post Office will give them a license, they will take the necessary steps to obtain the legal powers.

Thus it will be seen that instead of the question being finally settled upon grounds of public policy, it has been settled in such a way as to invite further argument and agitation. Sheriff Jameson was, doubtless, under the impression that throwing the whole responsibility of their proposed undertaking on the Corporation might act as some deterrent, but the nature of the evidence brought before him should have sufficed to show that the advocates of a municipal service are either insufficiently acquainted with the responsibility, or are willing to undertake any sort of risk with a view to adding a telephone service to their other enterprises. We have on so many occasions pointed out that the decision on telephonic policy must be come to by those who have had proper opportunities for studying the question, and some responsibility in the settlement of it, that we need now only point out how the decision in this case has finally rested with the Post Office. Efforts will undoubtedly be made either to over-ride this decision, or to impugn the motives underlying it. It is certainly to be hoped that neither the Treasury nor Parliament will be coerced or cajoled into removing the decision from the hands of those who have knowledge and a sense of responsibility—the two essential elements needed for a decision on this important question.

Ceylon Technical College.—An Indian paper says that the staff of the Ceylon Technical College has been strengthened by the addition of Mr. Thomas Cockerill, who takes up the post of Instructor of Telegraphy and Electrical Engineering. Mr. Thomas Cockerill, who recently went out to India from this country, is a Fellow of the Chemical Society and an A.I.E.E. He was trained at Owen's College, Manchester, and at the Manchester Technical School. He was lecturer and head of the Electrical Departments at the Bolton Technical Schools and at the Halifax Technical Schools.

NOTES.

Obituary.—It is with great regret that we have to chronicle the death of Col. Dyer, which took place on the 21st inst. at his residence in Manchester. We fear that the arduous and anxious time passed through by him during the recent long strike must have been largely accountable for the accentuation of the organic trouble of the heart which seems to have finally caused his death. As head of the Employers' Federation, he was in the forefront of the battle, and the credit of victory is largely with him, and his sudden death will come as a great blow to the Federation. The incidents and causes of the strike are too fresh for comment to be necessary, but we believe all admit that he was animated by a desire for his country's welfare, and in no way can he be accused of harshness in his dealings with the conquered, whose defeat was, after all, much better for themselves than a victory could have been. Colonel H. C. S. Dyer was a director of Sir W. G. Armstrong, Whitworth and Co., Limited. He joined the Royal Artillery at the age of 18, and saw active service in the Crimea and in India. On retirement as lieutenant-colonel he became assistant superintendent of the Enfield Factory, whence he transferred to Sir Joseph Whitworth, of Manchester, and subsequently to the Elswick Works, which he was instrumental in amalgamating with those of Whitworth, knowing the two places so well. The colonel was of fine and commanding appearance, and in losing him England has lost a representative man of the best type of national character. Born in 1834, he has died at what is now the very early age of 64.

The funeral, which took place on Wednesday at Manchester, was an imposing ceremony, the carriages forming a line more than a mile in length. A large number of the members of the Employers' Federation assembled in the drawing room at Appleby Lodge, Rusholme, the residence of the deceased gentleman. These included Sir Benjamin Browne, Mr. Henderson, Mr. Platt, Mr. Coventry, Mr. Brooks, Mr. Browett, Mr. Alexander Siemens, Mr. Lindley, Col. Peacock, Mr. Sinclair Scott, Mr. Slater Lewis, Mr. Baldwin, Mr. Eddison, and many other gentlemen who took an active part with Col. Dyer in the recent dispute. The utmost sympathy was expressed on all sides, and there was a general feeling that the master engineers had been bereft of a brave and able champion of their cause in the loss of Col. Dyer.

The last issue to hand of Chicago *Electrical Engineering* has a long obituary notice of the late Dr. V. Weitlisbach, who died in November, 1897, in his 43rd year. Dr. Weitlisbach was born in Switzerland, and in the seventies studied under Helmholtz at Berlin. He was manager of the Zurich Telephone Company from 1880 to 1884, and was then appointed chief engineer to the Swiss Telegraph Administration in Berne, under the title of first secretary to the Technical Department. That position he held at the time of his death. Telephone work claimed Dr. Wietlisbach more than anything else, and he has been a frequent contributor to the Berlin and Berne technical press on telephone questions. Dr. Weitlisbach had, at the time of his decease, nearly completed a large and thorough treatise on telephony.

Lectures.—Mr. J. E. L. Barnes lectured at the Birkenhead Town Hall on 16th inst. on "Electric Traction."

Before the Aberdeen Mechanical Society at Gordon's College, on the 18th inst., Mr. Wm. Pickersgill, G.N.S.R. locomotive superintendent, read a paper on "The Economic Use of Electricity for Power Purposes in Railway Workshops."

Mr. Roger W. Wallace, Q.C., chairman of the British Aluminium Company, read a paper before the Society of Chemical Industry on 14th inst. on "Electrical Industries at Foyers."

At the Birmingham Municipal Technical School Engineering Society last week a paper on "The Making and Laying of an Atlantic Cable," was read by Mr. William Smith, the electrical engineer of the Technical School.

At the Royal Scottish Society of Arts meeting on 14th inst. Dr. R adman, F.R.S.E., read a paper on "The Electric Furnace, and Some of Its Uses."

Magnetism and Diamagnetism.—Prof. J. A. Fleming, F.R.S., gave the third of his course of lectures on "Recent Researches in Magnetism and Diamagnetism," at the Royal Institution on Thursday last week, the special subject being the properties of the diamagnetic group of bodies. An experiment was first shown, says the *Times* report, illustrating a method employed by Quincke for measuring the magnetic susceptibility of paramagnetic and diamagnetic liquids. An inverted syphon containing the liquid to be tested, and having one leg much thinner than the other, had its narrow tube placed between the poles of a magnet, when the liquid, if paramagnetic, was drawn up into the field, and if diamagnetic, depressed in the tube. Numerous experiments were then performed with a large electro-magnet, constructed for Tyndall, to show that paramagnetic bodies held in the interpolar field set themselves along the lines of force, whereas diamagnetic ones placed themselves across in the equatorial position. Illustrating Faraday's observation that all substances were affected in one way or the other by a powerful magnetic field, Prof. Fleming caused some amusement by showing that such familiar objects as bread, apple, cold mutton, and tobacco were acted upon by a strong magnet. The influence of the medium surrounding a substance in determining its action in the field was demonstrated by means of other interesting experiments. The peculiar behaviour of crystals called by Faraday magnecrystallic action was then explained, and attention was called to Tyndall's important investigations, during which he discovered that structural changes such as those produced by compressing a substance in any direction greatly affected its magnetic susceptibilities. This fact was demonstrated by means of a piece of bread, which, although diamagnetic, simulated the behaviour of a paramagnetic body after being squeezed, because the line of compression became an axis of greater diamagnetic action. Turning to the action of diamagnetic bodies on light, the lecturer exhibited Faraday's classical experiment, in which a block of magnetised heavy glass (silico-borate of lead) was proved to rotate the plane of a polarised light, and concluded with a reference to the more recent work of Verdet, Kundt and others on magneto-optic effects.

Ward's Omnibus Tests.—There are apparently some errors in the volt readings in the report of these tests, from the 55th minute to the 65th. Amperes 32 and volts 224 may be right; but at the 65th minute, while still 32 amperes, the volts are given 244. Either one or the other must be wrong. At the 95th minute we notice a reading of 40 amperes and 216 volts, and the last reading is 40 amperes and 220 volts. If these figures were correctly noted, it would seem that the battery must have been charging up during the last 10 minutes! The difficulties in reading instruments on board an omnibus may account for a good deal, and the figures can only be taken as a rough approximation, near enough to obtain an idea of the power required. It would be interesting to try how many bus horses would haul that bus home if the battery ran down.

Personal.—We are informed that on February 9th, 1898, Lord Salisbury appointed Mr. Geo. Herbert Bailey Assistant District Commissioner in the Niger Coast Protectorate by telegram. Besides his judicial duties, no doubt when the state of the country under the sphere of influence involved renders it practicable, advantage will be taken of Mr. Bailey's experience of matters telegraphic in connecting up the capital of the Protectorate (Old Calabar) with the African cable system and the establishment of inland telegraphs.

Mr. Lycett is resigning the position of clerk to the Kingswinford Rural District Council, and has become district manager to the British Electric Traction Company.

Mr. R. S. Portheim, of Messrs. D. Bruce Peebles & Co., engineers, of Edinburgh, is sailing for the States on the 26th inst. per ss. *St. Louis*, and will investigate the latest American practice in electric transmission of power.

Will.—The estate of Lord Sackville A. Cecil, whose connection with the telegraph world we referred to in our notice of his lordship's death, is sworn at £249,388.

Municipal Electrical Association.—At a meeting of the Council of the Municipal Electrical Association held at the Westminster Palace Hotel, London, on March 15th, it was resolved to call a general meeting of the Association to be held at the Westminster Palace Hotel, London, on April 19th, at 8 p.m. The following applications for membership were considered and approved. Members:—W. H. Chambers, Gibraltar; C. F. Parkinson, Morcambe; J. K. Brydges, Wakefield; the E. L. Committee, Barrow-in-Furness; the E. L. Committee, Darwen; Stanley Clegg, Darwen. Associates:—S. E. Andrew, Leytonstone; J. C. Vaughan, Leytonstone; T. D. Clothier, Hull; A. N. Puszet, Brighton; N. McLean, Harrogate.

Royal Institution.—The Friday evening lecture arrangements for after Easter include the following:—April 29th, Prof. Andrew Gray, M.A., LL.D., F.R.S., "Magneto-Optic Rotation and its Explanation by a Gyrostatic Medium," (with experimental illustrations). May 6th, Edward A. Minchin, Esq., M.A., Fellow of Merton College, Oxford, "Living Crystals." May 13th, Prof. W. A. Tilden, D.Sc., F.R.S., "Recent Experiments on Certain of the Chemical Elements in Relation to Heat."

Prof. Dewar will deliver the weekly discourse on April 1st. His subject is "Liquid Air as an Analytic Agent."

The Northampton Institute.—Great men are, like the *Daily Mail*, often in advance of the Times, so was last week's *Engineering*. We were under the impression that the Lord Mayor's state visit to the Northampton Institute—to which we refer at length in another column—took place last Friday evening. Our contemporary, however, says the ceremony occurred on the Wednesday previous, so that we and the 2,000 or more who were present on Friday—including the Lord Mayor and Lady Mayoress—arrived just 48 hours behind time!

Technical Education.—The presentation of certificates to art, science and domestic economy scholars, under the Technical Education Board of the London County Council, was made by the Right Hon. Sir Bernhard Samuelson, Bart, F.R.S., at the Northampton Institute, St. John Street Road, E.C., last night.

The Successor of Prof. Galileo Ferraris.—An American exchange says that Prof. Luigi Lombardi has been appointed Professor of Technical Physics at the Industrial Museum of Turin to fill the chair which was left vacant by the death of Prof. Galileo Ferraris.

Mechanical Engineering in Germany.—It is stated by H.M. Ambassador at Berlin that no further applications for admission to the Mechanical Engineering Department of the Technical High School at Charlottenburg, near Berlin, can be received after April 1st next from persons not of German nationality, as the increase of students in that department has been so great that the accommodation is overtaxed.

Damages Awarded.—At the Brompton County Court on Monday, Mr. John Price, an excavator for the new Central London Electric Railway, was awarded, by agreement, £300 and costs, under the Employers' Liability Act. In November last a heavy quantity of earth fell on him, causing motor paralysis of both legs.

Appointment Vacant.—The British Electric Traction Company, Limited, is wanting an electrical engineer to design and construct power houses, and to undertake the electrical equipment of tramways, including rolling stock, but not permanent way. See our "Official Notices" this week.

The Wonders of the Telegraph.—The following marvellous instance of what the electric telegraph is now capable of doing appeared in yesterday's *Standard*:—

HARDING.—On March 19th, at Chefoo, China, the wife of John Reginald Harding, M.I.C.E., of a son. (By telegram).

Private Bills.—The General Power Distributing Company Bill, Central Electric Supply Bill, Chelsea Electricity Supply Bill, and the Metropolitan Electric Supply Bill passed the second reading on Tuesday.

West Ham Wiring Tenders.—Messrs. Allingham and Fennell say that in a published list of tenders for the wiring of the public buildings at West Ham their name is omitted, although a tender was submitted by them for carrying out the work on their "Nomorfyre" system for the sum of £1,139 15s. The town clerk informs them that their tender is being considered with the others.

The Parliamentary Committee.—The House of Commons representatives on the joint committee on electrical energy, generating stations and supply, are Mr. Ashton, Lord Balcarres, Mr. Kimber, and Sir Leonard Lyell.

The Electro-Harmonic Society.—To-night's Concert brings the 1897-98 season of this Society to a close, and it will be pleasant to see a large gathering of members and friends. Classical chamber music is worthily represented by Haydn and Schubert, while piano and violin solos will be represented by compositions of Chopin and Vieuxtemps. Mr. James Gawthrop and Mr. Robert Hilton, whom everybody will be pleased to see again, will sing ballads. The humorous element will be supplied by Mr. W. G. Churcher, and Mr. W. Carlton Smith, and the small string orchestra, which has added so much to the enjoyment of these monthly meetings, will again discourse sweet sounds.

Torquay Municipal Lighting.—The municipal electricity works were formally inaugurated last Friday by the Mayoress of Torquay. In a subsequent issue we shall describe the principal features of the system.

NEW COMPANIES REGISTERED.

London and District Mutoscope Company, Limited (56,367).—Registered March 4th with capital £75,000 in £1 shares, to adopt an agreement with the Mutoscope and Biograph Syndicate, Limited, for the acquisition of a license to use certain patents, to manufacture, sell and deal in mutoscopes, biographs, photographic apparatus, and to carry on the business of electricians, and electrical and mechanical, metallurgical and chemical engineers. The subscribers (with one share each) are:—E. Baker, 29, Cornhill, E.C., secretary; M. J. M. Campbell, Orleans Club, King's Street, W., gentleman; E. J. Nicholas, 29, Cornhill, E.C., secretary; W. Johnson, 8, Shalcombe Street, Chelsea, S.W., clerk; G. Beeson, 2, Clarendon Terrace, W., clerk; S. E. Newman, 72, Romilly Road, Finsbury Park, N., clerk; R. Humphreys, 23, Digby Road, South Hackney, N.E., clerk. The number of directors is not to be less than two nor more than seven. The subscribers are to appoint the first. Qualification, 100 shares; remuneration, £1,000 per annum, and a percentage of the profits divisible. Registered office, 29, Cornhill, E.C.

Phoebus Solder and Electric Soldering Fluid Company, Limited (56,373).—Registered March 4th with capital £4,000 in £1 shares, to acquire and carry on the business of solder, soldering fluid and alloy manufacturers carried on as the "Phoebus Solder and Electric Fluid Company" at 5, York Grove, Peckham, S.E. The subscribers (with one share each) are:—E. E. Bailey, 69, Kilmoirie Road, Forest Hill, S.E., engineer; L. C. J. Graper, 3, Harman Street, Kingsland, N., traveller; J. R. Woodley, Hopton Road, Streatham, S.W., accountant; H. H. Champness, 42, Huddlestone Road, Tufnell Park, N., gentleman; C. G. Cheverton, 43, Breakspears Road, St. Johns, S.E., gentleman; A. H. White, 26, Rosenthal Road, Catford, stockjobber; F. D. Sandell, 12, Ravensbourne Road, Catford, accountant. Table "A" mainly applies. Registered office, 5, York Grove, Queen's Road, Peckham, S.E.

Electric Lighting and Fittings Corporation, Limited (56,379).—Registered March 5th with capital £50 000 in £1 shares to carry on the business of electrical and mechanical engineers, and manufacturers of and dealers in electric, magnetic, telegraphic, telephonic, and other appliances, and steam, hydraulic, pneumatic, and other engines. The subscribers (with one share each) are:—A. Cross, 2, Balliol Road, Bootle, timber merchant; J. A. Dargue, C.E., 175, Bedford Street, Liverpool; J. B. Hepburn, 21, Brasenose Road, Liverpool, engineer; L. Hughes, 23/31, Hatton Garden, Liverpool, merchant; T. H. W. Walker, 41, North John Street, Liverpool, architect; H. Isaac, 23, Great Charlotte Street, Liverpool, fishmonger; C. Birchall, Egremont, Chester, shipowner. The number of directors is not to be less than three nor more than seven; the first are the first five subscribers; qualification, £200; remuneration as fixed by the company. Registered by Cameron, Kemm & Co., Gresham House, E.C.

Best & Lloyd, Limited (56,397).—Registered March 8th with capital £50,000 in £10 shares, to acquire and carry on (1) the business of a manufacturer of, and dealer in, chandeliers and electric and gas fittings carried on by R. H. Best, at Handsworth, Staffordshire, as "Best and Lloyd," and (2) the business of a manufacturer of and dealer in red lead carried on by R. H. Best at Handsworth, Staffordshire, as "J. and H. Lloyd," and to adopt two agreements with the said vendor. The subscribers (with one share each) are:—R. H. Best, Cambray Works, Handsworth, manufacturer; W. R. Nicholl, Northleigh, Olton, near Birmingham, accountant; J. Pinckston, Stowe Villa, Albert Street, Handsworth, manager; G. Vale, Lauriston, Rookery Road, Handsworth, manager; Miss E. H. Best, 23, Radnor Road, Handsworth; Miss L. H. Best, 23, Radnor Road, Handsworth; Mrs. E. M. Best, 146, Hamstead Road, Handsworth. The number of directors is not to be less than three nor more than five; the first are R. H. Best (chairman, with £1,000 per annum); W. R. Nicholl, G. Vale and J. Pinckston; qualification, 50 shares; remuneration, £100 per annum. Registered by Waterlow Bros. & Layton, Limited, Birchin Lane, E.C.

British Electric Meter Company, Limited (56,408).—Registered March 8th with capital £5,000 in £10 shares, to acquire and turn to account a sole selling agency and an option for an exclusive manufacturing license in the Bastian electrolytic meter, and prepayment attachment, and to adopt an agreement with the Tourtel Gas and General Engineering Company, Limited. The subscribers (with one share each) are:—A. V. Askham, 41, Clifford Gardens, Kensal Rise, W., secretary; J. M. Tourtel, 35, St. Luke's Road, Westbourne Park, W., gentleman; C. E. Smith, 1, Wedmore Gardens, Upper Holloway, foreman; J. B. Birnbaum, 2, Long Acre, W.C., merchant; A. Laurmon, 39, Westbourne Street, Sloane Square, S.W., clerk; O. G. Peterson, 82, Weed Vale, Forest Hill, S.E., clerk; W. H. Carlisle, 54, Margravine Gardens, West Kensington, clerk. The number of directors is not to be less than two, nor more than five. The first are: A. F. Davies and J. M. Tourtel. Remuneration, two guineas each per board meeting attended. Registered by Devonshire & Co., 1, Frederick's Place, Old Jewry, E.C.

Costa Rica Electric Light and Traction Company, Limited (56,447).—Registered March 10th with capital £130,000 in £1 shares, to adopt an agreement with M. C. Keith to carry on the business of electric lighting in the Republic of Costa Rica or elsewhere, and to carry on the business of tramway and light railway proprietors, common carriers, electricians, mechanical engineers, &c. The subscribers (with one share each) are:—R. Killman, 14, Sunnyside Road, Ilford, accountant; T. S. Cocks, 71, College Street, Putney, clerk; F. Chipperfield, 179, Choumert Road, Peckham, S.E., clerk; J. C. Holliday, 9, New Broad Street, E.C., clerk; F. H. Firth, Copthall, Twickenham, gentleman; H. W. White, Sydney House, Barrow Road, Streatham, clerk; W. H. Avery, Clareville, Sutton, secretary. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first. Qualification, £250; remuneration, £150 each per annum, and £200 for the chairman. Registered by Ashurst & Co., 17, Throgmorton Avenue, E.C.

Premier Electricity Meter Company, Limited (56,448).—Registered March 10th with capital £25,000 in £5 shares, to carry on the business of electric meter manufacturers and dealers, and electricians. The subscribers (with one share each) are:—J. Atherton, 11, Charing Cross Road, W.C., manufacturer; C. M. Downie, 24, Newman Street, Oxford Street, W., electrical engineer; J. Downs, 8, Marlborough Villas, Wimbledon, clerk; W. M. M. Forwood, 15, Union Court, Spl., solicitor; C. O. Grindrod, 11, Knowsley Road, Rock Ferry, Cheshire, gentleman; A. E. Haptie, 5, Durham Road, Seaforth, near Spl., cashier; A. Ruckley, 8, York Road, Seacombe, Cheshire, clerk. The number of directors is not to be less than three nor more than seven. The subscribers are to appoint the first. Qualifications, £100; remuneration as fixed by the company. Registered by T. T. Hull, 22, Chancery Lane, W.C.

Shirras, Laing & Co., Limited (3,793).—Registered at Edinburgh March 10th with capital £30,000 in £1 shares, to acquire the business of Shirras, Laing & Co., ironmongers, blacksmiths, electrical and heating engineers, 46—52, School Hill and Harriet Street, and Back Wynd, Aberdeen, and to carry on and develop the same. The subscribers are:—J. Murray, 28, St. Nicholas Street, Aberdeen, publisher, 300 shares; D. Smith, 27, Argyll Place, Aberdeen, farmer, 400 shares; J. Taggart, 92, Great Western Road, Aberdeen, granite merchant, 200 shares; H. Mortimer, 143, Union Street, Aberdeen, solicitor, 200 shares; G. Shirras, School Hill, Aberdeen, ironmonger, 1,000 shares; R. Haley, School Hill, Aberdeen, ironmonger, 1,000 shares; J. Stephen, 3, Corridean Wynd, Aberdeen, engraver, 250 shares. The directors are to be afterwards appointed. Qualification, 200 shares. Registered by Simpson and Warwick, W.S., 18, Heriot Row, Edinburgh.

Love's Electric Traction Company, Limited (56,471).—Registered March 12th with capital £20,000 in £1 shares to acquire the letters patent for the United Kingdom and various countries other than the U.S.A. and Spain in respect of Love's system of electric traction, to adopt an agreement with J. C. Love and J. E. Hodges, and to carry on the business of electrical and general engineers, machinery manufacturers, tramway and railway proprietors and suppliers of electricity. The subscribers (with one share each) are:—P. W. Goldring, 20, Abchurch Lane, E.C., law student; W. E. Elmslie, 20, Abchurch Lane, E.C., solicitor; H. J. Church, 15, Bendrell Road, Brockley, S.E., clerk; J. Perry, 175, Essex Road, Islington, clerk; J. L. Cooper, 6, Union Road, Tuffnell Park, N., accountant; H. J. Bethell, 128, Beresford Road, Hornsey, N., clerk; A. E. Seamer, 7, Park Place Villas, W., clerk. The number of directors is not to be less than three nor more than seven. The first are:—J. C. Love, J. E. Hodges, W. C. Slaughter, and C. L. Philips; qualification £200; remuneration as fixed by the company. Registered by Goldring & Philips, 20, Abchurch Lane, E.C.

Mid-Air Bulletin Syndicate, Limited (56,507).—Registered March 15th with capital £6,500 in £1 shares, to acquire, own and work certain letters patent granted to S. Crandall, for "improvement in electric signalling and other apparatus," and to adopt a certain agreement. The subscribers (with one share each) are:—F. Brown, Walsall, electrical engineer; J. E. Sheldon, Stafford Street, Birmingham, manufacturer; L. S. Crandall, 62, Moor Street, Birmingham, inventor; W. H. Ryle, 35, Temple Street, Birmingham, land agent; H. A. Pepper, 14, Temple Street, Birmingham, chartered accountant; E. M. Rudland, 14, Temple Street, Birmingham, chartered accountant; J. S. Remington, 97, Castleford Road, Spark Hill, Birmingham, secretary. W. H. Ryle is the first chairman and director. Registered by C. Doubble, 14, Serjeant's Inn, E.C.

Hart Secondary Battery Syndicate, Limited (56,511).—Registered March 15th with capital £5,000 in £1 shares, to adopt an agreement with W. Hart and E. J. Clark, and to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity, and electrical apparatus manufacturers. The subscribers (with 150 shares each) are:—G. W. Kidd, 229, Romford Road, E., licensed victualler; L. W. Spratt, 369, Romford Road, E., draper; J. G. Locks, Lemna Road, Leytonstone, newspaper proprietor; J. G. Abraham, Craiglands, Stroud Green, surveyor; M. Allcock, 97, Clapton Common, N.E., gentleman; G. Hay, 61, Broadway, Stratford, confectioner; S. W. Hart, Oak Dene, South Woodford, surveyor. Registered, without articles of association, by E. Andrew White, 27, Clement's Lane, E.C.

H. M. Salmony & Co., Limited (56,530).—Registered March 16th with capital £25,000 in £1 shares (5,000 5 per cent. cumulative preference), to acquire the business of H. M. Salmony and Co., to adopt an agreement with H. M. Salmony and E. Rosenberg, and to carry on the business of electrical and mechanical engineers, manufacturers of, and dealers in, electrical apparatus, and contractors for the supply of electricity. The subscribers (with one share each) are:—G. S. Hein, 71, Lombard Street, E.C., bank manager; F. Salmony, 166, Finchley Road, N.W., stock jobber; T. J. Digby, 30, Princess Road, South Norwood, electrical engineer; F. H. Minn, 77, Grange Park Road, Leyton, E., electrical engineer; J. Hart, 69, Linden Gardens, W., electrical engineer; H. M. Salmony, 26, Winchester Road, Swiss Cottage, N.W., electrical engineer; E. Rosenberg, 34, Dryden Chambers, Oxford Street, W., electrical engineer. The number of directors is not to be less than four nor more than six; the first are H. M. Salmony, E. Rosenberg, and H. Schwabe. Qualification, £250 debentures, or £100 shares; remuneration as fixed by the company. Registered by M. Abrahams, Sons and Co., 80, Old Jewry, E.C.

Direct Telephone Exchange Syndicate, Limited (56,542).—Registered March 17th with capital £5,000 in £1 shares, to adopt an agreement with H. Leupold & Vautin, and to carry on the business of a telephone, telegraph, electric light, heat and power supply company. The subscribers (with one share each) are:—P. H. Gardner, 47, Burnam Road, Tollington Park, N., accountant; J. E. T. Wells, 13, Knoyle Street, New Cross, S.E., clerk; J. T. Hayter, 8, Mehetabel Road, Hackney, N.E., writer; C. H. Weeks, 60, Foxham Road, Tufnall Park, N., solicitor; C. Hof, 52, Leadenhall Street, E.C., merchant; B. Steinert, 218, Winchester House, E.C., gentleman; H. Leupold, 20, Grange Road, Norwood, S.E., gentleman. Table "A," mainly applies. Registered by A. Maxwell, 41, Bishopsgate Street, E.C.

The National Engineering Supply Company, Limited (3,808).—Registered at Edinburgh March 18th with capital £2,000 in £1 shares, to carry on the business of steam and electrical engineers, machinery and metal merchants, and agents. The subscribers (with one share each) are:—T. McStraith, 70, Wellington Street, Glasgow, accountant; M. Brown, 5, Hayfield Terrace, Glasgow, merchant; W. Thorn, 14, Scott Street, Bridgeton, Glasgow, clerk; J. Smith, 70, Wellington Street, Glasgow, engineer; A. Paterson, 109, Bath Street, Glasgow, writer; G. Chapman, 109, Bath Street, Glasgow, writer; J. McTaggart, 78, Kelvin Street, Glasgow, builder. Directors are to be afterwards appointed; qualification, 100 shares. Registered by Breeze, Paterson & Chapman, 109, Bath Street, Glasgow. Registered office, 312, Argyle Street, Glasgow.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Headland's Patent Electric Storage Battery Company, Limited (45,524).—This company's annual return was filed on January 18th, when 19,665 shares were taken up out of a capital of £20,000 in £1 shares. 14,993 are considered as paid, £1 per share has been called on seven, and 10s. per share on the remainder. £2,389 10s. has been received, which includes £50 paid in advance.

Harp Arc Lamp Syndicate, Limited (41,057).—As this company is not doing any business, the secretary has requested that its name be erased from the Register of Joint Stock Companies.

Buenos Ayres Electric Light Company, Limited (16,057).—This company's annual return was filed on January 1st. The capital is £100,000 in 9,986 shares of £10 each, and 70 founders' shares of £2 each. All the latter have been subscribed for, but no calls have been made.

CITY NOTES.

Hanley Corporation Accounts.

NOTWITHSTANDING the short period for which the loans in the case of Hanley have been granted, the electricity works are rapidly arriving at a profit-earning stage, after paying contributions to sinking fund and interest on loans. The following paragraphs from the engineer's report are worth quoting:—

"The total expenditure was £4,000 7s. 8d., and the total receipts were £6,520 1s. 7d., according to the Board of Trade returns, leaving £2,519 13s. 11d. as the gross profits of the undertaking to be carried to the net revenue account. This amount represents a profit of 4·88 per cent. on the capital expended. The receipts do not show such an increased consumption as was hoped for by the reduction in price from 6d. to 5d.; in fact, the customers who formerly paid 6d., taken collectively, and of course including corporation buildings, have consumed less current in 1897 than in 1896. This seems conclusively to point out that a much greater inducement was necessary to bring in long-hour consumers, and this has now been given; but owing to hesitation on the part of intending customers, the good results may not come immediately. The lowering of the price, particularly to private houses and to shops having long hours should, however, during the ensuing few years, prove to be a wise and sound course, unless Hanley is to be different from all other places.

"It will be noted that notwithstanding the reduction in price, the very great addition to the sum required to be paid to the sinking fund and the large sums expended in maintenance, rates and taxes, that the deficiency is so small an amount as £188 11s. 1d. on a gross income of £6,520. A very few additional customers would have converted that amount into a net profit, in fact, the new connections made already more than warrant the belief that such a sum will be cleared off in the first half-year. The effect of the new optional charges is, of course, a distinct matter. If the price had remained at 6d. and the same quantity sold, the income would have been £1,000 more. On the other hand, the lowering of the price has undoubtedly brought new customers in, and it is only reasonable to estimate that the loss caused by the new charges during the first half of this year will be balanced by the gain in the second half."

The following table shows the increase in the various items:—

INCREASE.

Capital expenditure.	Output in units.	Working expenses.	Revenue from sale of current.
£7,491	3,881	£1,400	£1,930

The following table gives the cost per unit:—

	1897.	1896.
Total capital expended	£51,684	£44,143
Number of units sold	351,762	247,881
Number of lamps connected	—	—
Revenue from sale of current	£6,292	£4,362
Net revenue	£2,520	£1,791
Average price obtained per unit	4·2d.	4·5d.

Cost of production.	£		Per unit.	1896.
Coal	1,003		·68d.	·73d.
Oil, waste, water, and engine room stores	226		·15d.	·19d.
Salaries and wages at generating station	887*	Works' cost 2·07d.	·60d.	·57d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	992*		·67d.	·50d.
Rent, rates and taxes	357		·24d.	·15d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	535		·36d.	·38d.
Depreciation of buildings and plant account	—		—	—
Renewal fund account	—		—	—
Total	£4,000		2·70d.	2·52d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	6,292	0	0	4·2d.
Meter rents, &c.	150	0	0	—
Supply of steam	—			—
Transfer fees	—			—
Other items	78	0	0	—
Total	£6,520	0	0	4·2d.

* Attending and repairs of arc lamps (£295) added to these two items.

Total cost per unit (exclusive of depreciation and renewal accounts), 2·67d.; works' cost, 2·07d.

The Hove Electric Lighting Company.

THIS company continues to make substantial progress, and though it has, during the past year, made a considerable reduction in the price charged for electricity, there is every reason to anticipate an increased *clientèle* from that cause alone. There is a marked decrease in the cost of production, the most striking being in the repairs and maintenance account, which stands at £209, against £340 last year. Considerable extensions to the company's systems have taken place, and probably the next accounts will demonstrate the benefits arising from enlarging the scope of the company's operations.

The increase in the various directions are indicated below:—

INCREASE.

Capital expenditure.	Output in units.	Working expenses.	Revenue from sale of current.
£4,874	67,681	£262	£677

The following table gives the cost per unit:—

	1897.	1896.
Total capital expended	£66,896	£62,022
Number of units sold	268,243	200,562
Number of lamps connected	27,777	21,794
Revenue from sale of current	£6,839	£6,162
Net revenue	£3,602	£3,114
Average price obtained per unit ...	6·11d.	7·39d.

Cost of Production.	£		Per unit.	1896.
Coal	805		·72d.	·79d.
Oil, waste, water, and engine room stores	119		·11d.	·16d.
Salaries and wages at generating station	785		·70d.	·88d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	209	Works' cost 1·72d.	·19d.	·41d.
Rent, rates and taxes	184		·16d.	·27d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges and insurance	1,172		1·04d.	1·28d.
Depreciation of buildings and plant account	—		—	—
Renewal fund account	—		—	—
Total	£3,274		2·92d.	3·79d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	6,839	0	0	6·11d.
Meter rents, &c.	—			—
Supply of steam	426	0	0	—
Transfer fees	4	0	0	—
Total	£7,269	0	0	6·11d.

Total cost per unit (exclusive of depreciation and renewal accounts), 2·92d.; works' cost, 1·72d.

The Electric Installation Company, Limited.

THIS company has been formed for the purpose of making installations of electric plant for lighting or other purposes in public institutions, hotels, mills, factories, collieries, warehouses, shops, &c., on the hire-purchase system or on a rental. It is not proposed that the company should manufacture the different appliances required in such installations, but that its revenue should be derived from payments to be made for the hire and rental of electric plant. Generally, arrangements with customers would be such that all claims against them would be satisfied after the rental had been paid for 10 years. It is obvious that such a scheme calls for heavy expenditure, and it is not surprising, therefore, to find that the capital of the company which is courageous enough to embark upon such an enterprise is £100,000 in £1 shares. The immediate call is for 2s. 6d. on application and 2s. 6d. on allotment. In a sense, the company may be considered a Manchester one. The directors are mainly Manchester merchants, the offices of the company are in Manchester, and the consulting engineer is Mr. F. F. Bennett, of Manchester. No doubt Lancashire and the north country generally presents a very favourable field for the operations of the company, and we see little reason why it should not meet with some success. It is exceptional, not to say remarkable, that in this company no promotion money will be paid; there are few electrical companies that can say the same.

Brockie-Pell Arc Lamp Company. The report of this company, covering a period of 17 months, has just been issued, but it is impossible in this issue to do more than make a few extracts from it. Profit and loss account show on the debtor side, £7,737, the principal items of which are, directors' fees, £1,676; and salaries, £3,257. The credit side shows manufacturing gross profit, £2,085, and royalties nearly £1,000, there being practically a loss of £4,590 on the 17 months' working. According to the report, this is mainly due to the time taken in equipping the works with the various machines for the making of the lamps. The first 100 lamps, made entirely at the company's factory in Tabernacle Street, were not completed till the end of July last, so that the business has only been in full swing for a period of from five to six months. Orders for lamps received from month to month, show a steady increase. A contract has been signed for the disposal of the French and Belgian patents for £3,000, of which £500 has been received on account.

Chelsea Electricity Supply Company, Limited.

Mr. J. Irving Courtenay presided at the general meeting of this company held last Thursday, and said it was a pleasure to him to be able again to report a continual improvement in the results obtained. The £60,000 ordinary share capital subscribed in 1896 did not rank with the ordinary capital previously subscribed until 1897, and, notwithstanding this additional capital, the increase in the business had enabled them to show a profit which would allow of 6 per cent. being paid on the ordinary shares, as compared with 5 per cent. on the smaller capital of previous years, carrying forward a balance of £1,652 4s. 1d. to meet contingencies. That the public was now fully alive to the value of the electric light was amply demonstrated by the substantial addition to their circuits of over 16,000 lamps during the year, and the large increase in the use of the light generally throughout the metropolis and in the provinces. That fact was of itself an explanation of the necessity for the expansion in capital expenditure, and so long as this expenditure brought an increasing return, none would have cause to complain. They had added a valuable security to the property in the form of freehold land, and substantial buildings on this land, to the extent of over £20,000, and had increased the plant, machinery, mains and meters by nearly £35,000. The progress during the year had been continuous and steady, and it really seemed as if an average of 16,000 or 18,000 lamps annually would continue to be added. They must, however, make provision for somewhat larger additions, because it frequently happened that a new estate would be completed, and shops and offices all opened at once; constant care was exercised by the staff in watching the progress of the various estates. The new sub-station in Pavilion Road was of sufficient capacity to cope with the maximum demand ever likely to arise in its neighbourhood. They had laid, during the year, about 9¼ miles of casing, which was capable of accommodating about 36 miles of conductor, and had actually drawn in during the year some 16½ miles of conductor into the ways just mentioned. There were added during the year 16,178 lamps, or their equivalent in the 12 months, so that the total number of lamps on December 31st was 96,758, since which they had passed the hundred thousand. The chairman then referred to the compulsory purchase of property adjoining, and in the neighbourhood of, their works in Chelsea, for which a Bill had been promoted in Parliament. The cost of production had been slightly reduced, and, from the character of their district, the improvements introduced in their machinery, and the indications in the present accounts, they might fairly expect progressive improvement in the return on capital. In regard to vibration troubles, their works were now equipped with the most recent type of plant, and every precaution that the best practical experience could suggest had been taken, and as they had, in addition, made a careful inspection of the property in the neighbourhood, they had no fear of the ultimate issue of any complaints that may be made against the company.

The report and accounts were then adopted.

South London Electric Supply Corporation.

The ordinary general meeting of the South London Electric Supply Corporation, Limited, was held on Monday last at Winchester House, E.C., Mr. George Ellis, J.P., presiding.

The Chairman said: Steady progress was being made in all directions. Most new undertakings suffered from delays; theirs, so far, had not been very serious, and had been amply compensated for by the acquisition of the site which they had succeeded in obtaining after lengthy negotiations. It was practically in the centre of the area of supply; it required no clearing and hardly any levelling, and the three acres of freehold land cost under £10,000; a better site for the operations there could not be. Referring to the accounts, a certain proportion of the administration expenses had been allocated to the cost of land, buildings, machinery, plant and mains. It had been stated that no dividend could be paid till the cost of the order and expenses, amounting to £47,000, had been paid off. This was not true; the expenditure could be placed to a suspense account. The Board of Trade would allow a dividend to be paid so long as a suitable amount was set aside for the extinction of the item. No doubt some of them had been told that £47,000 was a large sum for this order and the expenses. On the face of it, it does seem large, but it is not so in fact. The Board of Trade insisted upon the capital being underwritten to the extent of £200,000 before they would let this company have the order, and that in itself, with the brokerage, absorbed £24,000 of the amount. He should like to compare the expenditure with that of two other large companies in London—namely, the Westminster and the St. James's Companies—and to say that their order had not cost them one-half of what theirs had cost them, because in one case they had had to redeem their founders' shares at a cost of £120 000, and in the other case he believed at £150,000, whereas £47,000 was the absolute cost to them of this order. With regard to the issue of the balance of the share capital, the facts of the case are these: the shares subscribed for gave them a little over £200,000 to fulfil contracts and carry out works involving an expenditure of about £300,000. In July last they could not get more capital, as the shares were considerably below par, and it was illegal to issue shares at a discount. Any offer to the shareholders which it had been suggested should have been made, would still further have depreciated the shares and have thus added to the difficulties. The board had many serious consultations, and at last most reluctantly instructed their engineer to cut down the contracts; but then arose an unforeseen difficulty. They were under an obligation to the Lambeth Vestry to build a dust destructor capable of burning a certain number of tons of refuse per annum, so that this, the largest contract, could not be reduced. They, however, arranged to cut down the engines, cables, and other machinery by one-third, but they did this only as a last resource, as they knew full well that this meant doing away with any possibility of early dividends; but there was, at that time, no other course open to them. However, on July 29th, Mr. Cook, a gentleman whom the board knew to be connected with a strong group of financiers, called on the board and offered to take the 1,530 shares necessary to obtain a Stock Exchange quotation, at par—although shares could be purchased in the open market at a considerable discount—conditionally upon giving him an option at par for the balance up to December 1st. Mr. Cook told them in the most straightforward manner that he was representing some financial gentlemen of considerable means, and the inference they drew from this statement was that it was almost certain the option would be exercised, and that the necessary funds for carrying out the scheme in full were sure to be provided. Mr. Cook, however, found some difficulty at the outset in making his arrangements, as so many people had left London for the holidays, and at the next board meeting he asked for a month's grace. This was agreed to, and at the end of that time the cheque was forthcoming, and application for a Stock Exchange quotation was duly made and granted. Subsequently Mr. Cook transferred his option to Mr. Atherton, the gentleman who had some months previously promoted the company, and he at the expiration of the option at the end of November, came to the board and offered to take up and pay for the whole of the shares covered by it if the board so desired. He, however, made another proposal, to the effect that he should then only take up and pay for 12,500 shares out of the 21,659, leaving the balance—namely, 9,159—over until March 1st, and paying to the company interest at the rate of 4 per cent. on the £18,318. The board thereupon considered which of these two offers would be most beneficial to the company, and came to the conclusion that Mr. Atherton's second proposal was the better. They had read Mr. Wheelock's circulars, and he (the chairman) had told them the facts. As directors, they had only to consider the true interests of the company. With no quotation, with shares at a discount, and insufficient capital at their command to carry out their programme, the directors were satisfied that in placing the balance of capital as they did, they acted as men of business in the interests of the shareholders. None of the directors had any interest in the allotment made to Mr. Atherton, either directly or indirectly. In order to show that they had not allowed the work to lag, he might mention that the local authorities had represented that the progress in laying the mains was somewhat too rapid to enable them to keep pace with the company in the work of reinstating the streets, a compliment which was most satisfactory. The chairman then moved the adoption of the report.

Mr. Brooke-Hitchin seconded the motion.

Mr. A. Brooke moved the following amendment: "That the report be received but not adopted, and that a committee of five shareholders be appointed, with power to add to their number, to inquire into the formation and past management of the company, and the relations between the board and the promoter, and with power to call for books and documents, and to obtain such legal and professional assistance as may be necessary, such committee to report to a meeting to be called for Monday, April 18th, 1898."

After some discussion the amendment was negatived, only four votes being recorded in its favour, and the report and accounts were adopted.

The Direct Spanish Telegraph Company, Limited.

The report and accounts of the directors for the year ended December 31st, 1897, to be presented at the yearly general meeting of shareholders, to be held on Tuesday, March 29th, 1898, states that the accounts for the year ended December 31st, 1897, show, after providing for interest on, and redemption of, debentures, a balance to the credit of revenue of £12,975 6s. 4d. After adding the usual sum of £5,000 to the reserve fund, the balance will amount to £7,975 6s. 4d., and the directors recommend the declaration of dividends for the year 1897, of 10 per cent. on the preference shares, and 4 per cent., free of income-tax, on the ordinary shares, absorbing £5,486 4s. Half of this amount was distributed on October 1st, 1897, as an interim dividend in respect of the half-year ended June 30th, 1897.

The traffic receipts show a decrease of £2,927 3s. 11d., as compared with the year 1896, when, as stated in last year's report, the increase was due to exceptional circumstances. The reductions of rates, and the mode of counting the words in telegrams, adopted at the Buda-Pesth Conference, came into force on July 1st, 1897, and have, as was expected, adversely affected the company's receipts.

The working expenses are £223 8s. 11d. in excess of those for the year 1896. The company's cables and land lines in connection with them have continued in good working order throughout the year. In the report of the directors of September 11th, 1894, it was stated that the construction of a new breakwater at Bilbao placed the company under the necessity of removing the shore end of the Falmouth-Bilbao cable to a point outside the new breakwater, and that the cost of this removal was chargeable to the harbour authorities at Bilbao.

The directors regret that the liability of the harbour authorities was not admitted by the Spanish Courts. The cost of the removal of the shore end, amounting to £3,514 5s. 2d., has, therefore, been debited to the reserve fund, and it is proposed that the balance of the revenue account, amounting to £2,489 2s. 4d., be transferred to the reserve fund towards the payment of this amount, and that the £1,025 2s. 10d., required to make up the cost of the removal, be repaid to the reserve fund out of future revenue. The reserve fund now amounts to £44,769 11s. 2d. The directors report, with extreme regret, the death of Mr. Edmund Etlinger, who had been a director of the company since its formation in 1872. The directors have filled the vacancy so caused by the appointment of Mr. F. Alexander Johnston.

In commemoration of Her Majesty's Diamond Jubilee, the directors have granted a bonus to all employés in the company's service.

Mr. F. Alexander Johnston is the director retiring by rotation, and offers himself for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths & Co., retire, and offer themselves for re-election.

Willans & Robinson, Limited.

The eighth half-yearly report of the directors, to be submitted at the ordinary general meeting of the company, to be held at the City Terminus Hotel, Cannon Street, London, at 3 p.m., on Wednesday, March 30th, 1898, states that the accounts for the half-year ended December 29th, 1897, are submitted herewith. After writing off as depreciation from plant, patents, &c., the sum of £5,277. 8s. 4d. (against £4,162 11s. 2d. last half-year), and paying interest upon debenture stock, the balance to the credit of profit and loss account for the half-year (including £1,859 13s. 7d. brought forward) is £16,053 0s. 10d. Out of this the directors propose that dividends be paid at the full rate of 6 per cent. per annum upon the preference shares, and at 8 per cent. per annum upon the ordinary shares, together amounting to £8,707 17s. 7d. The amount payable to the original directors, in accordance with the articles of association, is £1,832 5s., leaving a balance of £5,512 18s. 3d. From this the directors propose to carry £2,000 to the debenture redemption fund, and £1,500 to the reserve fund (against £1,000 last half-year), leaving a balance of £2,012 18s. 3d. to be carried forward. The directors feel that the satisfactory results of the half-year's trading, achieved under circumstances not altogether favourable, coupled with excellent prospects for the future, justify them in recommending a moderate increase of dividend.

In accordance with the announcements made in the last report, applications have been invited from the shareholders for the balance of the unissued shares, viz., 3,000 preference and 3,000 ordinary shares.

As required by the articles of association, two of the directors, viz., Mr. Robinson and Capt. Sankey, retire, but are eligible, and offer themselves for re-election.

The auditors, Messrs. Cooper Bros. & Co., also retire, but are eligible for re-election.

Hastings Electric Light Company.

The annual meeting was held last week at the Queen's Hotel. Mr. F. A. Langham presided.

The Chairman, in moving the adoption of the report and balance-sheet, said they had to work for three years under a losing contract. It was difficult to say how much they lost, but certainly several hundreds a year, through being originally misinformed as to the cost of producing the light. They had had to feel their way, and unfortunately they had to pay for it. Now that was at an end it was evident they had a good and prosperous concern, and he thought nothing showed it more than the figures which they had alluded to in their report, comparing the receipts for the light supplied as against the cost of production. For his own part, and on the part of the directors, he must say they were deeply indebted to Mr. Andrews and to those who were working under him for the pains they had taken to obtain the result of economy which was shown in that report. He thought it did great credit to their staff that with increased receipts and increased working, although they had been able to earn about £1,600 more, it should have been done at an additional cost of under £200. Their receipts had been steadily increasing for the past three years. In 1895 they were £6,090; in 1896 they had increased to £7,086, and in 1897 they rose to £8,734; therefore, it was a regularly increasing business. They were taking more money each year, and they had fair grounds for supposing, with contracts in hand, and the orders given to them, that that state of things would extend to the present year also. Their working expenses in 1896 to earn £7,086, were £5,164, whereas in earning £8,734 in 1897, their expenses were only £5,361, so that in earning £1,600 or £1,700 more, they expended something under £200 more in the working. It was very agreeable to them to find that the popularity of the light was increasing, and that they got new customers, because, of course, as soon as they ceased to supply the town—which they were still doing, although on more remunerative terms—they would have spare light for private customers. As they knew, since their last annual meeting, they had had a special general meeting, at which the shareholders unanimously adopted the suggestions of the board, that the contract with the Corporation should be entered into. That contract was accordingly entered into; but at present nothing further had been done, because the Corporation were seeking to obtain their provisional order, without which they could not take the works over. They, at present, were still lighting the front line under arrangement with the Corporation from month to month, until the Town Council were able to supply light for themselves. But they did not anticipate, even when they lost this lighting, that they would sustain any loss, because they had considerable demands for private lighting, which they could carry out, but which they had been afraid to add to the burden on the machinery already taxed with the public lighting.

Mr. A. Bray seconded the motion, which was adopted.

The Metropolitan Electric Supply Company, Limited.

The report of directors to be presented at the ordinary general meeting next Tuesday at Winchester House, states that the directors submit a statement of the company's accounts for the year ending December 31st, 1897, prepared in the form prescribed by the Board of Trade under the provisions of the Electric Lighting Acts, 1882 and 1888.

The capital expenditure, which at the end of 1896 amounted to £757,035 13s. 11d., has now reached a total of £850,831 10s. 9d., the increase during the year having been £93,795 16s. 10d. The principal items are mains and apparatus, and the purchase of a site for future extensions. The balance of capital in hand at the end of the year was £29,597 18s. 10d. The gross revenue for the year amounted to £138,267 14s. 6d. against £116,459 4s. in 1896, being an increase of £21,808 10s. 6d. The cost of generation, which in 1896 was £52,619 4s. 9d. amounted in 1897 to £58,604 5s. 4d., or an increase of £5,985 0s. 7d.

The balance to the credit of the revenue account, before providing for depreciation, is £58,721 10s. The directors have set aside £15,000 as an addition to the depreciation account carrying to the credit of the net revenue account, the sum of £43,721 10s. which, with the balance brought forward from last account and other receipts, makes a total of £46,917 3s. 6d. After deducting debenture and share interest and other charges, there appears a balance of £22,989 6s. 6d. An interim dividend of 5s. per share on the ordinary share capital was paid on October 15th, 1897, amounting to £12,475, and the directors recommend that a further dividend of 7s. per share on such shares be now paid, making a total distribution of 12s. per share for the year, or 6 per cent. on the capital. The dividend upon the new shares being for six months only, will be 6s. per share, or one-half the total amount of dividend upon the original shares. This will absorb a further sum of £21,215, and leave a balance of £1,774 6s. 6d. to be carried forward to the next account.

The number of 8-candle-power lamps supplied by the company increased during the year 1897 from 308,000 to 360,000. The present number of lamps connected is 374,000, and the applications show no signs of decrease. A report from the company's engineering director is appended, showing that the satisfactory condition of the stations, machinery, and plant has been maintained.

In accordance with the articles of association, the following directors, viz :—Admiral of the Fleet Lord John Hay, G.C.B., W. Harrison Cripps, Esq., and John Birkbeck Lubbock, Esq., retire from the board, and are eligible for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths & Co., also retire, and are eligible for re-election.

Sheffield Electric Light Company.

The annual meeting of the company was held on Monday last at the Cutler's Hall, Sheffield.

The Chairman of the Board (the Lord Mayor, Alderman Franklin) presided at the ordinary meeting, and in moving the adoption of the report, congratulated the shareholders upon the sound financial position of the company, and in several ways pointed to unmistakeable proofs of progress. In 1893 the revenue from the sale of current was £3,555, and it increased year by year until in 1897 it reached £14,318. The profits had increased in the same way, and for the past year amounted to £11,392, out of which it was proposed to pay a dividend of 12½ per cent., and carry forward £902. The output was 747,067 units, against 483,427 units in 1896 and 288,406 in 1895. The greatest percentage of increased output was in 1896, when the increase was 67 per cent., against 54 per cent. last year, but the reason of that was that owing to the impossibility of getting additional machinery, chiefly in consequence of the engineering dispute, the company declined to receive new customers for several months. He alluded to, and laid stress upon, the decreased cost of production, stating that in 1893 the cost of production was 5·44d. per unit, in 1894 3·8d., in 1895 3·6d., in 1896 2·23d., and in 1897 1·56d. Within a period of 15 months the directors had brought down the cost of production from 2½d. per unit to about 1½d. The directors were convinced they had a valuable property, and they were well satisfied with the progress which had been made.

Alderman Gamble seconded, and the report was adopted, as was also one declaring a dividend of 12½ per cent.

A special meeting followed, to approve the sale of the undertaking to the Corporation of Sheffield.

The Chairman moved the formal resolution, agreeing to sell to the Corporation, and the resolution was unanimously carried.

Manchester Electrical Works, Limited.

The following report and balance-sheet have been sent out to the shareholders of the Manchester Electrical Works, Limited (successors to Woodhouse & Rawson): —

"147, Leadenhall Street, E.C., *March 9th*, 1898.

"Sir or Madam,—Your directors have not considered it necessary to call a general meeting of shareholders during the past year, because they prefer to have some definite proposals to place before you regarding the disposal of the works, which they have been endeavouring to bring about on behalf of the shareholders. Negotiations for the sale are still pending, and as soon as a firm offer can be secured at a sufficient price, a meeting of the shareholders will at once be called to confirm the sale. In the meantime the money that you have subscribed is secured by a charge on the plant and stock, and carries with it 5 per cent. interest until such time as it is repaid. Your directors beg to forward balance-sheet, showing the financial position on December 31st, 1897. You will notice that the total expenditure for salaries and office expenses since the incorporation of the company amounts to £153 2s. 6d. There has been, and will be, no further addition to this item, and your directors will continue, as in the past, to waive their fees.

"Yours faithfully,

"Willoughby Wallace, *Chairman*."

The British Insulated Wire Company, Limited.

The first ordinary general meeting of this company was held last week at the Exchange Station Hotel, Liverpool, Mr. W. Marriner Brigg, chairman of the board of directors presided. There were also present Mr. E. K. Muspratt, Mr. S. Z. de Ferranti, Mr. J. B. Atherton, and Mr. J. E. Pearson, directors; Mr. F. J. Leslie, solicitor; Mr. Edward Tracey, secretary, and a considerable number of shareholders.

The report, which was for the first eight months of the company's working, ending December 31st last, stated that the net profits for that period were £33,281, which the directors regarded as very satisfactory, being in excess of the estimate in the prospectus. They recommended a dividend at the rate of 15 per cent. on the ordinary shares.

The Chairman, in moving the adoption of the report and accounts, expressed the pleasure of the directors at meeting the shareholders under such happy circumstances. They had already found it necessary to enlarge their working premises, and further buildings were in progress, in order to enable them to keep pace with the orders in hand. Fortunately their area of land at Prescot was large enough for the extensions required, and already a competent authority had informed him that they had the most complete and best laid out works in the country. When the new company took over the business they had £200,000 worth of orders on hand. The figure now stood at £300,000, and personally, he felt confident that ere long they would require a further issue of capital in order to keep pace with the demands upon them. He was satisfied that they could employ a very much larger capital profitably. He, therefore, felt entitled to congratulate the shareholders, both as to what they had already done and on the excellent prospects before them.

Mr. Berry seconded the motion, which, after a brief discussion, was unanimously adopted, and a dividend was declared as recommended.

On the motion of Mr. Muspratt, the retiring directors, Messrs. W. M. Brigg and Ferranti, were unanimously re-elected, and Messrs. Chalmers, Wade & Co. were re-appointed auditors.

A hearty vote of thanks to the chairman and directors concluded the proceedings.

Norwich Electricity Company.

The ordinary general meeting of the shareholders was held last week. The chairman, Mr. F. W. Harmer, presided.

The Chairman said he trusted that the report which they held in their hands would be looked upon as satisfactory. The most interesting item of the report was the balance, either to the debit or credit of the account, and the amount which was allotted for the purpose of dividend. They had never had a debit balance yet, and he hoped that they never would have. At the end of the first year's working they had declared a modest dividend of 3 per cent., and they had been able to make it a little better each year. 1897, he was glad to say, was the best they had had. He hoped the shareholders would think that the 5½ per cent. now declared was very fair for a young company like their own, and it was especially gratifying because, as they knew, 12 months ago the price of current had been reduced 12½ per cent. Owing, however, to economy in working, and to the fact that they had acquired a large number of new customers the result of the year's working was even more than that of 1896. The directors were increasingly satisfied that they had adopted the right system of producing electricity, and that was a very important matter. As to economy of working they might compare with the best companies in England. The price at which they were making electricity was considerably below the average of the whole country, even including those of the Midland counties where coal was much cheaper than it was in Norwich. The capital account had been kept down to the lowest possible figure, and, compared with the revenue they obtained for it, was below the average. The most interesting feature which he had to report was that they did not seem to be getting to the end of their prosperity. They were acquiring new customers at this moment as fast as they were last year at this time, or, indeed, at any period in their history. They had lately adopted a system of free wiring, which would probably bring them a considerable amount of new business, which they could not have obtained in any other way. The directors had not only put aside this year a certain amount for depreciation, but also another sum as reserve. Machinery was constantly wearing out, and it was not so valuable at the end of a year's working as at the beginning. The company had been applied to to supply electricity in Thorpe, and they were now applying to Parliament for an Act to enable them to do so.

The report, after some discussion, was adopted.

Brush Electrical Engineering Company.—The interim report of the directors of the Brush Electrical Engineering Company for the six months ending December 31st last states that the works at Loughborough have been fully employed, and the volume of orders received during the half-year has been above the average of the past few years. In consequence of the increasing demand for the company's manufactures in connection with electric traction, the directors are largely extending the capacity of the works for the output of motors and cars. Other extensions of the works at Loughborough, rendered necessary by the development of the company's general business, are in progress. A final settlement of the matters in dispute with the City of London Electric Lighting Company has been effected. An interim dividend for the half-year at the rate of 6 per cent. per annum has been declared on the company's preference shares.

Stock Exchange Notices.—Application has been made to the Committee to appoint a special settling day in, and to grant a quotation to, Westminster Electric Supply Corporation, Limited—£200,000 3½ per cent. first mortgage debentures.

The Committee has appointed Tuesday, March 29th, a special settling day in W. T. Henley's Telegraph Works Company, Limited —Further issue of 2,500 ordinary shares of £10 each, fully paid, Nos. 10,001 to 12,500; and ordered the undermentioned to be quoted in the Official List:—St. James's and Pall Mall Electric Light Company, Limited—Further issue of 12,000 ordinary shares, Nos. 40,081 to 52,080; W. T. Henley's Telegraph Works Company, Limited—Further issue of 2,500 ordinary shares, Nos. 10,001 to 12,500.

Costa Rica Electric Light and Traction Company, Limited.—The share capital of this company, which has been formed to supply electric light and operate electric tramways in San José and Cartago and to take over existing works, is £130,000, in £1 shares, which are taken by the vendor in part payment of the purchase money, £130,000 5 per cent. first debentures being offered for subscription at the price of 90. These are repayable at par on January 1st, 1948, and may meanwhile be redeemed at six months' notice at 105 per cent.

Central London Railway.—A special meeting of this company was held last Saturday for the purpose of authorising an increase in the number of directors, and for the election of Sir Henry Oakley as a director. The motion was adopted, and subsequently Sir Henry Oakley was elected chairman of the company.

Metropolitan Electric Supply Company.—The ordinary general meeting will be held on 29th inst., at noon, at Winchester House. The transfer register of the ordinary and new ordinary shares will be closed from 19th to 29th inst., both days inclusive.

Bournemouth and Poole Electricity Supply Company.—The first ordinary general (statutory) meeting will be held at Winchester House, Old Broad Street, E.C., on the 28th inst., at 2 p.m.

Eastern Telegraph Company, Limited.—The usual interim dividend of 2s. 6d. per share on the ordinary shares, free of tax, in respect of the quarter ended December 31st, is announced.

Brockie-Pell Arc Lamp, Limited.—This company notifies that the transfer books of the company will be closed from March 22nd to April 4th, 1898, both days inclusive.

TRAFFIC RECEIPTS.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending March 18th, 1898, were £2,503 8s. 4d.; corresponding period, 1897, £2,053 7s. 5d.; increase, £449 15s. 11d.

The Cape Electric Tramways.—The receipts for February were: Cape Town, £8,600; Port Elizabeth, £2,275.

The City and South London Railway Company.—The receipts for the week ending March 20th, 1898, were £1,030; week ending March 21st, 1897, £1,012; increase, £18; total receipts for half-year, 1898, £12,826; corresponding period, 1897, £12,818; increase, £8. Miles open, 3½.

The Dover Corporation Electric Tramways.—The receipts for the week ending March 19th, 1898, £117 17s. 5d.; total receipts to March 19th, 1898, £1,166 8s. 11d.

The Dublin Southern District (Electric) Tramways Company.—The receipts for week ending Friday, March 18th, 1898, were £403 4s. 6d.; corresponding week last year, £363 15s. 4d.; increase, £39 9s. 2d.; passengers carried, 68,513; corresponding week last year, 59,721; aggregate to date, £4,378 17s. 11d.; aggregate to date last year, £4,669 13s. 10d.; decrease to date, £290 15s. 11d.; mileage open, 8 miles.

The Liverpool Overhead Railway Company.—The receipts for the week ending March 20th, 1898, amounted to £1,316; corresponding week last year, £1,360; decrease, £44.

The Western and Brazilian Telegraph Company, Limited.—The receipts for the week ending March 18th, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,933.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, March 16th.	Closing Quotation, March 23rd.	Business done during week ended March 23rd, 1898. Highest.	Lowest.
137,400*l*	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	..	...	100 - 104	100 — 104	...	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	7 — 8	7 — 8	...	...
125,000	Do. do. 5% Debs. Red.	100	...	...	...	93 — 96	93 — 96	...	...
923,960*l*	Anglo-American Teleg., Ltd.	Stock	£2 9s.	£2 13s.	3 %	59 — 61	59 — 62	59½	...
3,038,020*l*	Do. do. 6 % Pref.	Stock	£4 18s.	£5 6s.	6 %	108½ 109½	109½ - 110½	110½	109
3,038,020*l*	Do. do. Defd.	Stock	...	...	...	11½ — 12	11¾ — 12¼	12 5/16	11 15/16
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	...	...	16¾ — 17¼	16¾ — 17¼	16¾	...
75,000*l*	Do. do. 5 %, Debs., 2nd series, 1906 ...	100	5 %	...	...	112 — 116	112 — 116	112½	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	4 %	4 %	...	3 — 3½	3 — 3½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	...	187 — 192	187 — 192	...	...
918,297*l*	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	106 — 108	106 — 108	106¾	105¾
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	2 %	...	1/16 — 3/16	1/16 — 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	9 %	8 %	...	6½ — 7½	6½ — 7½	7	6¾
6,000	Do. 10 % Pref.	10	10 %	10 %	...	14½ - 15½	14½ — 15½	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 11	10 — 11	...	...
30,000*l*	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	4½%	103 — 106%	103 — 106%	...	...
60,710	Direct United States Cable, Ltd.	20	2½%	2½%	...	10¾ — 11¼	10¾ - 11¼	11¼	10⅞
120,000	Direct West India Cable 4½% Reg. Deb	100	...		...	98 — 101	98 — 101	...	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	...	17¾ - 18¼	17¾ - 18¼	18 3/16	17⅞
70,000	Do. 6 % Cum. Pref.	10	6	6%	...	18½ — 19½	18½ - 19½	18¾	...
89,900*l*	Do. 5 % Debs., repay. August, 1899	100	5 %	5%	...	100 - 103	100 — 103	...	...
1,302,615*l*	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4%	...	128 — 131	128 - 131	...	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7%	...	18¾ — 19¼	18¾ -- 19¼	18⅞	...
25,200*l*	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5%	...	99 103	99 - 103	101	...
100,500*l*	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5%	...	100 - 103	100 — 103	...	...
320,000*l*	Do. 4 % Deb. Stock	Stock	4 %	4%	...	128 - 131	128 — 131	128	...
35,100*l*	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5%	...	99 - 103	99 — 103	...	...
46,500*l*	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5%	...	100 - 103	100 — 103	...	...
300,000*l*	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1900	100	4 %	4%	...	102 - 105	102 — 105	...	...
200,000*l*	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4%	...	108 - 111 %	107 — 110%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	...	11¾ - 12¼	11¾ — 12¼	12⅛	11 13/16
180,042	Do. do. 6 % Pref.	10	6 %	6%	...	17½ — 18	17½ — 18	17⅞	17 9/16
150,000	Great Northern Teleg. Company of Copenhagen	10	10 %	10%	...	29 — 30	29½ — 30½	...	...
160,000*l*	Do. do. do. 5 % Debs.	100	5 %	5%	...	100 — 103	100 — 103	...	...
97,000	Halifax and Bermuda Cable Co., Ltd., 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	95 — 100	95 — 100	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10%	...	52 — 55	52 — 55	...	...
100,000*l*	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6%	...	106 — 109	106 — 109	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	...	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5½%	5½%	6 %	6½ - 6¾	6½ — 6¾	6¾	6½
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 18	16 — 18	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5¾ - 6¼	5¾ — 6¼	5 13/16	5⅝
1,329,471*l*	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	102 — 107	102 — 107	104½	103½
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	⅝ — ¾	⅝ - ¾	...	...
100,000*l*	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	...	105 — 108	105 — 108	...	..
11,839	Reuter's Ltd.	8	5 %	5 %	...	8 — 9	8 — 9	...	...
3,381	Submarine Cables Trust	Cert.	..	...	...	139 - 144	140 — 145	143½	...
58,000	United River Plate Teleph., Ltd.	5	4 %	...	...	4 — 4½	4 — 4½	...	...
146,733*l*	Do. do. 5 % Debs.	Stock	5 %	...	...	106 — 109	105 — 108	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	nil	...	4 — 5	3½ - 4½	4½	...
213,400*l*	Do. do. do. 5 % Debs.	100	5 %	5 %	...	101 104	101 - 104	...	...
64,269	Western and Brazilian Teleg., Ltd.	15	3 %	2 %	...	11½ - 12	11¾ 12¼	12 1/16	11 11/16
33,129	Do. do. do. 5 % Pref. Ord ..	7½	5 %	5 %	...	7½ — 8	7½ 8	7⅞	7¾
33,129	Do. do. do. Def. Ord. ..	7½	1 %	...	...	4 — 4½	4½ - 4¾	4⅝	4 3/16
389,521	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	106 — 109	106 — 109	108	107½
88,321	West India and Panama Teleg., Ltd.	10	½%	1 %	...	½ — ¾	½ — ¾	⅝	..
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	8 — 8½	7½ - 8	8	7 9/16
4,669	Do. do. do. 6 % Cum. 2nd Pref	10	6 %	6 %	...	5 — 7	5 — 7	6⅝	...
80,000*l*	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	...	105 — 108	105 108	...	...
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ..	$1000	7 %	7%	...	105 — 110	105 - 110	...	...
160,100*l*	Do. do. 6 % Ster. Bonds.	100	6 %	6%	...	100 — 105	100 - 105	...	...

ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME	Stock or Share. ‡	1895.	1896.	1897.	Closing Quotation, March 16th.	Closing Quotation, March 23rd.	Highest.	Lowest.
30,000	Charing Cross and Strand Electy. Supply	5	5 %	6 %	7 %	13½ - 14½	13½ 14½	...	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6¼ — 6¾	6¼ - 6¾	6 9/16	...
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	...	11½ — 11¾	10¾ — 11¼	11	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	4½%	4½%	...	115 — 117	115 — 117	...	...
50,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—90,000	10	5 %	7 %	10 %	26 27 xd	26 - 27	26¾	26½
10,000	Do. do. Prov. Certs. Nos. 90,001 to 100,000 £2 pd.	10	...	...	...	13 — 14	12½ — 13½	13¼	12¾
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17½ — 18½xd	17½ - 18½	17⅞	17¾
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	129 134	129 — 134	...	...
30,000	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—30,000	10	nil	nil	nil	14¾ - 15¼	14¾ — 15¼	15¼	14¾
20,000	Do. do. do. 6% Pref., 40,001—60,000 ...	10	6 %	6 %	6 %	15¾ - 16¼	15¾ — 16¼	15 15/16	...
17,400	Edmundsons Elec. Corp., Ltd., ord. shares 1—17,400 ...	3	...	...	...	3¼ — 3¾	3¼ — 3¾	3 5/16	...
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5		.	...	11 — 12	11 — 12	11⅞	11¼
10,000	Do. do. 7 % Cum. Pref. ...	5	...	.	...	11¾ — 12¼	11¾ — 12¼	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	4 %	5 %	6 %	20½ — 21½	21 — 22	21¾	21
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem. ...	10	...	...	3 %	20½ — 21½	20½ - 21½	21	20½
220,000*l*	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½ %	117 — 121	117 — 121	119	112½
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	2 %	4 %	6 %	19½ — 20½xd	19½ — 20½	20⅛	20 1/16
31,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord.	5	7½%	10½%	14½ %	18½ - 19½	18 — 19	19	18½
20,000	Do. do. 7 % Pref., 20,001 to 40,000	5	7 %	7 %	7 %	10 — 11	10 — 11	10¼	...
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	4 %	107 — 110	107 — 110	...	...
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2¼ — 2½	2⅜ — 2⅝	2½	2⅜
79,900	Westminster Electric Supply Corp., Ord., 101 to 80,000 ...	5	7 %	9 %	12 %	17½ — 18½	17 18	18	17½

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation March 16th.	Closing Quotation. March 23rd.	Business done during week ended Mar. 23rd, 1898. Highest	Lowest
30,000	British Electric Traction	10	..	...	...	16¾ — 17¼	16½ — 17	16⅞	16 9/16
90,000	Brush Elect. Engng. Co., Ord., 1 to 90,000...	5		...	...	1⅞ — 2⅛	1⅞ — 2	1 15/16	1⅞
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	5	..	...	...	2¼ — 2½xd	2¼ — 2½	2⅜	2¼
125,000*l*	Do. do. 4½ % Perp. Deb. Stock.... ..	Stock	..	...	...	110 —114	110 —114	...	...
50,000	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	102 —105	102 —105	...	...
19,894	Central London Railway, Ord. Shares	10	...	...	...	10¼ — 10¾	10½ — 11	10⅞	10⅝
129,179	Do. do. do. £6 paid	10	...	...	...	6¼ — 6¾	6½ — 6¾	6½	...
59,254	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1½ — 2	1½ — 2	...	...
67,680	Do. do. Def. do. £5 pd. ...		...	...	...	4⅝ — 4⅞	4⅝ — 4⅞	4¾	...
630,000*l*	City and South London Railway	Stock	1 1/16 %	1 9/16 %	1⅞ %	66 — 68	66 — 68	68	67½
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	.	*nil*	...	...	2¼ — 2¾	2 — 2½	2	—
99,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd 1 to 99,261	5	5 %	5½%	...	2½ — 3	2½ - 3	2¾	2½
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5½%	...	4 — 5	4 — 5	...	...
194,023	Do. do. do. 4% Deb. stock Red. ...	100		...	...	103 —105	103 —105	106½	...
119,000	Electric Construction, Ltd., 1 to 119,000	2	5 %	6 %	...	2⅝ — 2⅞	2⅝ - 2⅞	2¾	...
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 .	2	7 %	7 %	...	3½ — 3⅝	3½ - 3⅝	...	...
111,100	Do. do. 4% Perpetual 1st Mort. Deb. Stock	Stock	...	...	...	106 —108	106 —108	...	...
91,196	Elmore's Patent Cop. Depostg., Ltd., 1 to 70,000	2		.	...	½ — ¾	½ — ¾	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ..	2		...	...	⅜ - ⅝	⅜ - ⅝	...	...
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ..	10	10½%	.	...	9 — 11	9 — 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	8 %	10 %	12 %	22½ - 23½xd	22½ — 23½	23⅛	23½
8,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½ — 19½xd	18½ — 19½	19	...
50,700	Do. do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½ %	110 - 115	110 —115	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd.	10	10 %	10 %	10 %	21½ - 22½	21½ - 22½	22¼	21¾
300,000	Do. do. do. 4 % 1st Mort. Deb.	100		...	...	104 —108	104 —108	..	...
87,500	Liverpool Overhead Railway, Ord.	10	2⅞%	3⅞%	3¼ %	10 11/16 - 10 13/16	10⅝ — 10¾	...	...
18,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15¾ — 16½	15¾ — 16½	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	15 %	15 %	36 — 39 xd	36 — 39	...	...
150,000	Do. do. do. 5 % Bonds, red 1899	100	5 %	5 %	5 %	102 —105	102 —105	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	.	.	...	136 —139	135 — 138	137½	135½

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7%; 1890—8%.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

* Birmingham Electric Supply Company, Ordinary £5 (fully paid) 10½.

House-to-House Company, 4½% Debentures of £100, 107—109.

Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 17—18; 1st Preference Cumulative 6 %, £5 (fully paid), 8½—9. Dividend, 1896, on Ordinary Shares 7 %.

London Electric Supply Corporation, £5 Ordinary, 4—4½.

* T. Parker, Ltd., £10 (fully paid), 14—15.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8—8½. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount 3 per cent. (October 14th, 1897).

THE NORTHAMPTON INSTITUTE.

This Institute was formally opened last Friday evening by the Lord Mayor and Lady Mayoress, and the Sheriffs. As we have already mentioned, the land upon which the magnificent buildings have been erected, was presented by the late Marquis of Northampton and by his son, the present Marquis. The value of this gift is £25,000, and the erection and equipment of the buildings has cost £80,000. There is to be a further outlay of £10,000, to £15,000 for completing the equipment. The money was provided by the City Parochial Authorities, the Technical Education Board, the City Companies, &c.

The Northampton Institute forms an important branch of the City Polytechnic, and is to supply the neighbourhood in which it stands with the same educational advantages as are afforded by similar institutes to other parts of the metropolis, *i.e.*, the Birkbeck Institute, and the City of London College.

The scheme was originated in 1891, and the full work, both educational and social, started at the end of September, 1897. An idea of the success which has so far attended the Institute, may be gained from the fact that there are already 1,500 members. Mr. Charles Dorman, chairman of the governing body, in explaining matters to the Lord Mayor on Friday, said that they had equipped 17 large workshops, and seven laboratories in addition to numerous social rooms, studios, offices, &c. He remarked that perhaps no other district in the metropolis has such a large number of manufacturing trades as Clerkenwell, and the Institute could not fail to benefit the numerous mechanical, electrical, and artistic trades. The cost of carrying on the work of the Institute is estimated at from £9,000 to £10,000 per annum. Lord Mayor Davies delivered a speech well worthy of the occasion, and among other speakers were Sir Henry Longley, K.C.B., Mr. R. M. Beachcroft, L.C.C., (who, referring to the gifts of the City companies, said that if it were not for those companies we should be 20 years behind in technical education) and Lord Alwyne Compton, M.P., acknowledged the thanks accorded to the Marquis of Northampton.

An inspection of the various departments was afterwards made, while a concert proceeded in the large hall.

Mr. John Ashford, A.M.I.M.E., is the head of the mechanical engineering and metal trades department.

The engineering workshop is equipped on the two long sides with hand benches fitted with various kinds of vices. Down the centre of the room there are the machine tools—comprising, at one end, a Universal milling machine, next to that a large drill and a group of lathes, forming excellent examples of English and foreign designs. Across the other end of the shop are the grinders, consisting of an emery wheel for general work, a Universal tool grinder, and a twist drill grinder. The emery wheel shaft is directly coupled to the driving electric motor, and the shaft driving the other grinders also drives the blower for the smithy in the next room. The whole of the power for the machine tools is derived from three different electric motors, so that only the small amount of shafting connected with the tool in use need be run at any one time.

There is a smithy and carpenters' shop, the machine tools in the woodwork room being driven by an electric motor. They comprise at present a band saw, pattern makers' lathes, and a grindstone, but there is room for further tools.

The boiler house contains two 100-H.P. boilers, one of the Lancashire type, the other a Babcock & Wilcox tubular type. The object in having two such different boilers side by side is that the students may have opportunities of making comparative tests of the different performances of the boilers under different conditions of working, and with different kinds of fuel. The steam piping on the top of the boilers is constructed of welded steel, and has been specially arranged for experimental purposes. It is such that either boiler may be used separately from the other or in conjunction with it. Injectors, as well as a feed pump, are fixed, and the stop valves are of different patterns, so that the students may have opportunities of inspecting and becoming familiar with the various designs in use. The steam raised is used for both heating and power purposes.

The power room for the joint use of the mechanical and electrical departments contains a 100 H.P. Willans and Robinson high-speed engine, coupled directly to a 63-kilowatt dynamo, which is used for lighting the building and for supplying the power to the various workshops and laboratories. From a large switchboard erected at one end of the room 24 circuits can be controlled. Another dynamo has yet to be erected, and this will be driven by a slow speed engine. The power from both dynamos is brought to the switchboard to a couple of omnibus bars, from which it can be delivered to any one of the 24 distributing circuits. In addition, alternating current supply from the central station of the Public Supply Company is brought to another pair of bars on the board, and from these bars any of the 24 circuits can have power given to them. The board contains the usual measuring instruments, switches, &c.

One-half of the instrument workshop is equipped for bench work, and has benches both for metal and wood work with the ordinary hand tools. The other half contains the power-driven machinery, consisting chiefly of lathes of various patterns, a sensitive drilling machine, polishing spindles, and a grindstone, the whole of the power for these being derived from an electric motor placed in the room.

The largest class that meets in this room is that for electric light wiremen, who are practised in the manipulation of all kinds of electric fittings of the most recent type, and the most modern methods of jointing and insulating the joints by vulcanising and otherwise. In addition there are important classes in electrical instrument making and in the brass finishing, special attention being given in the latter to repetition work.

A special feature of the drawing offices is the system of lighting, which is that of inverted electric arcs. The same system is adopted for the art studio.

Dr. Mullineux Walmsley is the principal of the Institute, and he is head of the applied physics and electrical engineering department, with Mr. C. V. Drysdale as chief assistant and senior lecturer, Mr. E. T. Martin as demonstrator and instructor in instrument making, Mr. K. Edgcumbe as senior demonstrator, Mr. W. R. Elliott as junior demonstrator and assistant mechanic, Mr. A. C. Jolly as lecture assistant, and Messrs Robins and Grew as junior assistants.

In the electrotyping room all the mechanical operations connected with electrotyping are dealt with. The whole process of preparing the moulds for the bath and of mounting and finishing the electrotype after deposition is carried through here, but the actual electrodeposition takes place in a separate room set apart for electrochemistry.

A room is being fitted as a laboratory for metallurgical chemistry, but the equipment is at present incomplete. It is intended, with a metallurgical laboratory, to be ready next session.

The junior physical laboratory is fitted for technical work in applied physics, and during the present session its accommodation has been strained by large classes in electrical engineering, and telegraphy and telephony. It has also been used for physical work in connection with the engineering and building trades sections. The equipment consists of the most recent types of testing instruments and experimental apparatus, and the various experiments performed by the students are of a thoroughly practical character.

In the senior physical laboratory, a good start has been made in the provision of delicate and standard instruments for important technical testing and experiments, but the equipment is not yet nearly completed. The chief work at present carried on in the room is testing in its most advanced branches, in connection with the advanced courses of electrical engineering and telegraphy and telephony.

The heavy electrical engineering laboratory is placed in the basement, and next to the "power room," already described. It is being equipped for the most advanced work in electrical engineering. The power for driving various continuous current dynamos and alternators is supplied by a 6 H.P. electric motor, whose speed can be altered through wide limits. This motor is directly coupled to a Ferranti alternator, and drives other machines by belts. A special feature of the room is, that rails have been sunk in the floor, so that the placing of a new dynamo or motor in position for testing purposes can be accomplished in a very short time. On the window ledges are acid-proof chambers for two small batteries of secondary cells, which will furnish large currents when required for testing instruments. A special table is being fitted up with very complete arrangements for the calibration of commercial electrical measuring instruments.

Next to the senior physical laboratory, a laboratory for electrochemistry is being fitted up. The equipment of the room is not yet complete, but there will be found specially designed tables capable of accommodating 16 students in the subject at one time. There are the usual depositing and cleansing, &c., vats, those giving rise to deleterious fumes and vapours being placed under a large hood, communicating with a shaft in which there is an electrically driven fan for carrying off the noxious gases. A special feature of the room is, that the depositing dynamo is directly coupled to an alternate current motor supplied with power, not from the dynamo room, but from the public mains, thus practically demonstrating to the electroplaters of Clerkenwell a method for utilising the electric mains now laid throughout the district for the purposes of their trade, although the currents directly obtainable from those mains are not suitable for plating work. In addition to the dynamo, there are secondary cells on the window ledges capable of giving large currents for plating purposes when the dynamo is not running, and from these cells conductors will be run alongside the vats, and also to the experimental tables, giving in all parts of the room a ready means of procuring currents suitable for electro-depositing.

THE GAS ENGINE AND ITS MISSION.

In view of the increasing popularity of the gas engine, the *Railroad Gazette* publishes a series of articles under the above head, in which are discussed the points of the gas engine. There are stated to be 100 makers in the United States, one quarter of whom own genuine works exclusively devoted to gas engine business. We need not follow the writer through the history and elementary descriptions.

While the ordinary initial pressures are 250 to 300 lbs. per square inch, the writer has met with compression to 96 lbs. and an initial pressure of 405 lbs., pressures which make a large demand on workmanship. In America, the latest engine is the Westinghouse, with two vertical cylinders in the smaller sizes and three in the larger engines. The latter have, therefore, an impulse every 240° of crank revolution, and are claimed to give a brake horse-power for 13 feet of natural gas. They govern partly by reduced admission and partly by missed explosions.

Governing is a serious difficulty with gas engines. The omission of explosions requires high speeds and very heavy fly-wheels, and demands a margin of speed between upper and lower limits of some breadth. By reducing gas admission the efficiency is so much reduced that while the Belfast engines used 24 feet of Belfast gas under best conditions, the consumption rose to 40 feet for one-quarter load. The compromise system hits somewhere between the two.

American practice in ignition tends to the use of the electric spark as perhaps more convenient if less economical than the ignition tube. For valves, American practice resembles European in its use of the mushroom or similar valve, but tends towards their automatic movement, so abolishing much outside gear and producing a simple looking engine. With automatic valves engines may be run equally well in either direction. There appears also a tendency in America to employ gas engines, not simply in small industries, but in large works for sub-division of power of the kind one looks for with electricity. Small steam engines are very wasteful. Small gas engines are not anything like so wasteful as compared with their larger brethren as are small steam engines. But there is still a radical fault in gas engines. They have no reserve of power beyond their economical rate of working. A gas engine underloaded is wasteful. Its economy improves up to the point where every possible explosive stroke is explosive. When an engine is fully loaded, with steam valve open to the full, it begins to run slow if any further load is put on it and by running slow it increases its mean pressure and decreases its resistance. But, with a gas engine, as with an elephant, every response is made up to the maximum, and beyond this the engine lies down, so to speak, and stops. The gas engine lacks staying power because it lives a mere hand to mouth existence. Between the gas engine which will not run overloaded, and the oil engine which stops if too lightly loaded, the internal combustion engine cannot be held to have reached the forefront of prime movers despite its economy. We do not think so much of the starting difficulty as the author before us. The starting arrangements of large gas engines are various. There is the reservoir of compressed air, the hand pump on similar lines, the explosive cartridge, and various other self starters. We have very little doubt ourselves that the large engines of the future will follow on the lines of the large steam engines and be started by small engines, which themselves can of course be started by a man, as usual with a small gas engine. Messrs. Hartley & Petit do use this system, and applied the little starting engine to the large gas engine for Mr. Arthur Porrit, of Birstall, which they put down to work with the Thwaite gas producer we have already described.

The various difficulties with gas engines have no doubt kept them in the background, even where the conditions have been favourable to the employment of producer gas. Gas producers, however, until lately, have not been successful for powers much under 100 H.P., but they are now on the market as small as 35 H.P., at which size they are about as large and not nearly so dangerous as a 35 H.P. vertical boiler. Statistics for Germany point to one gas engine for each 1,015 inhabitants, and the average power is 3·36 H.P. Engines are increasing at about 9½ per cent. per annum in number, and about 12 per cent. in their average power. The author gives the cost of power for the four prime movers, steam, oil, city-gas engines and producer-gas engines as ⅞ cent. per H.P. hour, 1½ cents, 2½ cents, and ½ cent. Oil in America comes out cheaper than city-gas by a larger amount than it does in England where gas is cheaper and oil is dearer, but producer gas ought to be as cheap in America as anywhere, and we should look to a considerable extension of producer gas plants.

The author holds that the objections he has advanced are not perhaps insurmountable. At the same time they have not yet been surmounted, and they must be grasped and appreciated before the position of gas power can be properly understood. We always have had a good deal of respect ourselves for the Clerk gas engine with its separate pump, and should like to have seen it a success. We think in large installations of gas power that the engines will have an explosion every revolution, that one engine will be set apart pumping up a reservoir of gas and a reservoir of air to flow into the cylinder and push out the exhaust, and that in this or some similar manner engines will do double duty for their size as compared with existing engines. The gas engine is yet far from perfect, but it is slowly improving and it has the very powerful argument of economy to push forward its interests. In the steam engine power is manufactured and stored in the boiler. There is always fire enough to suffice for a very considerable number of revolutions of the engine at full power, apart from other reserves. Besides this store of heat there is a mass of heated water in the boiler ready to give off energy should the demand for steam exceed for a time its production, and there is yet a store of ready made steam in the steam space to fulfil the same end, and when power has been manufactured there is still the fly-wheel to store a portion ready for immediate calls. The steam engine has four items of stored energy. The gas engine has but one, the fly-wheel. It has no mass of partly burned fuel ready to give off heat and to go into a state of more energetic heat production by the opening of a damper. It has no heat stored in water, and no store of elastic vapour. The movement of its governor orders the "stoking" of a fresh charge of fuel, its lighting up, combustion, and steam raising, and in the fraction of a second the fuel is lighted, consumed, the steam it raises is used and discharged, and unless the governor again asks for it, the fire remains out.

A consideration of these facts shows us that in the gas engine there is cut out a considerable duration of time between the shovelling on of fuel and the use of the steam generated by that fuel. This explains at once both the economy and the delicacy of the gas engine. In the economy of nature the food of to-day may appear as muscular energy to-morrow, or it may be later. The animal machine will run for hours on no fuel at all. It will run for days on less fuel than is represented by the energy produced. The gas engine is like what a horse would be that could not walk 10 yards without a nibble from its nosebag. This is not to argue that the engine is on wrong principles, but that the mechanical difficulties which hem it in are yet only incompletely solved.

THE TELEPHONE SYSTEM IN LONDON.

Conference of Local Authorities.

On Thursday afternoon of last week a well-attended conference of local authorities, convened by the City Corporation, was held at the Guildhall, to discuss the question of the telephone system of London.

The Lord Mayor, in opening the proceedings, said he did not intend to take any part in the proceedings, for it was a subject he did not really understand, but he welcomed the local bodies outside the City to the Guildhall.

After some preliminaries, Mr. A. C. Morton was elected to the chair, and said that was a conference of delegates representing the vestries and local boards of the metropolis, convened by the Corporation with the object of ascertaining the views of the local governing bodies in London as to the cost and efficiency of the London telephone service. Thirty-one boards and vestries, out of 41, as well as the City Corporation, had signified their intention of sending delegates, and 25 of these bodies had intimated that they had applied to the Treasury for an inquiry into the cost and efficiency of the telephone service in London, and all matters relating thereto. They were aware of the action taken by the late Commission of Sewers with a view to obtaining a cheaper and more efficient service. The late Commission, in 1895, after having ascertained the views of the telephone subscribers in the City, gave evidence before the Select Committee of the House of Commons, which inquired into the matter last year, but in consequence of the dissolution of Parliament the Committee had not sufficient time to report, and they recommended that another committee should be appointed in the next session to consider and report on the evidence already taken, and, if necessary, to take further evidence. No action had, however, been taken. Having referred to the recent action before the Railway Commissioners between the Corporation and the Post Office, the chairman said that the opinion of the Corporation was that the roads and streets in the metropolis belong to the people, and that they ought not to be given up to any trading company, unless under conditions which would protect the public. The Lord Mayor had handed him a letter which he had received, and that he would ask the Town Clerk to read.

Sir John Monckton then read a letter which the Lord Mayor had received from the National Telephone Company. This communication, which was signed by Mr. J. S. Forbes, as president of the company, began with an expression of doubt that the announcement of the conference could be correct. If it should prove that it had been made on good authority, it seemed to the company that what was to be done was like inverting the natural order of things. But probably the real meaning was that the resolutions were only to be put when the conference had before it some reliable evidence. In any case it was clear that the company was to be treated as defendants in a suit, and it would only be fair that they should be heard in the preliminary inquiries, and before being, so to speak, committed for trial. As president of the company, and in the interest of all concerned in the conference and its results, he desired to tender some points which he thought might be usefully borne in mind in any discussion on the subject. His colleagues and himself would be the first to admit that the telephone service as at present conducted left much to be desired, not for want of will on the part of the company, but for want of those reasonable facilities at the hands of the local authorities, without which it was absolutely impossible to conduct the business with the highest efficiency. It was singular that in this matter London, generally so advanced, should lag behind Manchester, Leeds, and many of the other large cities and towns, in which the companies had succeeded by agreement with the authorities in securing upon moderate and reasonable terms the necessary use of the streets for underground cables and wires, to the immense advantage of the users of the telephone, owing to the improvement in promptness and efficiency which had immediately followed. It was true that in a few cases such powers had been granted in disconnected portions of London. But apart from this, the company's network of wires, accommodating close upon 17,500 subscribers, existed upon sufferance, and was subject to constant interference and interruption by persons who, from caprice or other motives, inflicted heavy loss upon the company, and serious interference with the subscribers. Under such a condition of things, a perfect telephonic system was impossible. The letter went on to say that the recent inquiry held in Glasgow, raised points identical with those sought to be raised in London. That inquiry lasted 11 days, the cost to the company was over £4,000, to the Corporation it was over £3,000, and to a combination of would-be promoters of a competing system, nobody knew how much. They did not yet know what the report of the commissioner was, but it might be worth while to wait until his report was before entering upon another precisely similar inquiry. Having frankly admitted the present shortcomings of the service, Mr. Forbes desired to say something on the subject of charge, and in doing so, he would deal with the year 1897. The London area covered 609 square miles, and the number of subscribers at the end of the year, was 17,371. The average subscription was £14 10s., equal to about 5s. 7d. per week, day and night, including Sundays. It had been computed by the general manager that during the year there were 30,000,000 calls, involving as many answers, or 60,000,000 conversations, each averaging 200 words. Each conversation cost the subscriber about 1d. When it was taken into account that the company had to pay about 10 per cent. on its gross receipts for exchange business to Government, and was subject to heavy charges for wayleaves, he thought the charge of 1d. a message was very small. Comparing this with the cost of Post Office telegrams, he found that the 73,000,000 messages sent—the total for the United Kingdom—averaged 7½d., representing only 15 words. In conclusion, Mr. Forbes said if the conference thought it expedient to appoint a committee as a preliminary to further action, the company would be ready to place at their service all evidence and information that their experience enabled them to offer.

The Chairman: I am bound to say that the answer to that letter is in the second resolution.

The letter was then laid on the table.

Mr. Robinson (Kensington) moved: "That in the opinion of this conference of delegates representing the Corporation of London and the vestries and local boards in the metropolis, the present telephone service of London is both inadequate, inefficient, and costly." The position before them was that the Treasury had laid down that if the service was inadequate or inefficient it would grant an inquiry, and as they were agreed that it was inadequate and inefficient, they had a perfect right to ask for an inquiry.

Mr. Matthew (Stoke Newington) seconded the motion.

Mr. Trenner (Holborn) said that Mr. Forbes frankly admitted that the service was unsatisfactory, and so he had practically pleaded guilty, and should have no objection to being sent to trial. There were many complaints as to the lines; they were told the lines were engaged, and he asked whether they thought the line was always engaged, or whether it was merely a flippant answer on the part of the girls managing the telephone.

The motion was carried.

Mr. Pankhurst (Marylebone) then moved that: "In the opinion of this conference an inquiry should be held by the Treasury as to the cost and efficiency of the London telephone service, and all matters relating thereto, agreeably to the request of the local authorities of London." He had had a painful experience of the telephone. His business brought him into relationship with Glasgow and Manchester, and other places, and he was told the charge was only £8 in some places. It was all very well for Mr. Forbes to try and hoodwink them that the average cost was only £14 10s., but the average business man paid £20 a year, and that was quite as much as he should be expected to pay. He certainly thought they should have a service for £10 in London.

Mr. Savory (Stoke Newington) seconded the motion, and referred to the time the company took to connect a new subscriber.

Mr. Trenner called attention to the fact that two years ago on the occasion of the great storm, the service completely broke down, but although many subscribers could not use their wires for two, and even three months, no reduction was made in the subscription.

Mr. C. W. Tagg (Camberwell) said that having passed the first resolution, he did not see why they should not adopt No. 2. If they were all to give their experience of the National Telephone Company, and the language they had used, he thought it would be preferable to put the question at once. The only people who could hold a proper inquiry into the matter was the Treasury, and any person who wanted to give evidence could do so before them.

Mr. Alderman Smallman observed that while the Corporation threw blame on the National Telephone Company, Mr. Forbes threw all the blame on the local authorities, and it was therefore better to have an inquiry by the Treasury.

Mr. Knight (Limehouse) thought it would be well for the company to arrange at once not only with the City of London but with the whole of the metropolitan boards and vestries for the right of way under the streets, and the difficulty would then be ended at once.

Mr. Kimber (Wandsworth) asked whether it would not be well to suggest some remedy for the existing state of things.

The Chairman: I think the words "all matters relating thereto" covers everything.

Mr. Kimber: Very well. I am satisfied.

Mr. Kershaw (Shoreditch) said he would have liked to have heard something about the average charge of £14 10s. How that was done was by bringing in the private house charge of £10.

Mr. Paton (Limehouse) said he had been a customer of the company from the commencement, and having paid at first £20, he now paid £17. He thought the Telephone Company were fools in their own interest for not paying the vestries to allow them to lay underground wires. If they lowered the charge to about half they would get double the number of customers, and the cost of working would be little extra.

Mr. Haskell (Hammersmith) said that the company allowed local lines of £10, but they could not speak to the City.

Mr. Valentine (Poplar) gave the result of some correspondence with the company which his board had had. The company only wanted to pay a few pounds for laying the wires underground, and consequently the board would not allow them to do so.

Mr. Waycott (Paddington) said there was a much wider question as to whether the telephone should be municipalised. He thought the resolution should be amended, somewhat in that spirit, whether it should not be municipalised either by the London County Council or by the vestries.

Mr. Richardson (Hampstead) rose to a point of order. He took it that the question raised by the speaker was not within the scope of the conference.

The Chairman: The question, in my opinion, is entirely outside the scope of the conference.

Mr. Waycott rose to speak again, but met with considerable interruption, and refused to speak further.

The Chairman said they wanted a much larger inquiry in London than in Glasgow. It might cost a little more money, but it was the only way out of the difficulty. The Corporation had never played the dog in the manger policy. They had said: "You can have our streets on terms and conditions which favour the public."

The resolution was then carried.

Mr. Dewey (Islington) said what had impressed him was that that conference had not been so much a conference of delegates of local authorities as of customers of the National Company. Every gentleman seemed to attempt to use his powers as a trustee for the public, to enable him to get some private advantage by means of the telephone. He said, unhesitatingly, that if the National Telephone Company had no statutory powers, the local authority had no power to grant easement. He said that was knowledge of 30 years of the Metropolitan Management Act. The local authorities had the powers of surveyors of highways over the streets, and nothing more. He thought the company should get statutory powers, and then the local bodies could have the power of purchase after a fixed number of years. He moved—"That, inasmuch as the National Telephone Company is not possessed of statutory powers for placing mains, pipes, or wires underneath the streets of the metropolis, the road authorities have no legal right to permit the user of the streets for such a purpose, and that it is undesirable they should profess to give such permission until the interests of the public are duly secured by statute, as in the case of tramways and electric lighting undertakings."

Mr. Giles (Greenwich) seconded the motion.

Alderman Smallman moved as an amendment:—"That, inasmuch as the National Telephone Company is not possessed of statutory powers for placing mains, pipes, or wires underneath the streets of the metropolis, it is undesirable that the local authorities should give such permission until the interests of the public are duly secured by statute, as in the case of tramways and electric lighting undertakings, and subject always to the previous consent of the road authorities."

Col. Probyn (Strand) seconded the amendment.

Mr. Tapp (Fulham) observed that suburban parishes were worse off for telephonic communication than small villages in New Zealand.

Mr. Tagg said it was simply a waste of time to discuss the question whether the local authorities had power to allow the Telephone Company to take up the streets, for if the company had no power, the Post Office had.

The amendment was carried.

It was agreed that copies of the resolutions be forwarded to the Treasury, the Corporation of London, the London County Council, and the vestries and local boards of the metropolis.

Mr. Paton moved a vote of thanks to the Corporation of London for calling the conference, and the proceedings closed.

THE NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

The Practical Operation of Multiphase Currents. By T. Hawkins, Member. March 14th, 1898.

An electrical transmission of power plant may be divided into three main sections, viz., generators, motors, and line. In describing or inspecting such a plant, one naturally starts at the power house.

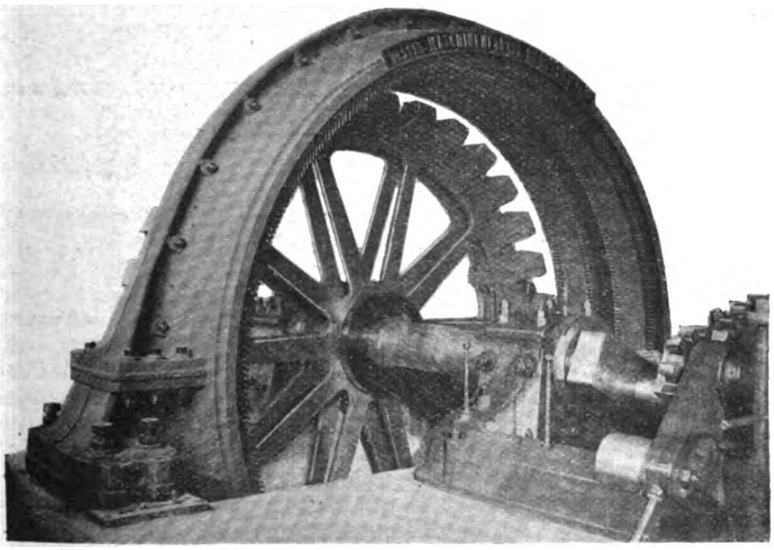


Fig. 1.—1,000-H.P. 3-Phase Generator Constructed by Oerlikon Company.

A multiphase generator is an alternating current dynamo, having its armature conductors grouped in such a manner as to give over a two-phase system two distinct currents differing 90° in phase. A three-phase generator would have its armature conductors arranged to give three currents differing 60° in phase.

For power plants where the distance between the generator and the various motors is not too great, and permits of a low pressure system being used (say 200 volts), a generator with a revolving armature makes a cheap and efficient type of machine. Where, however, the electromotive force exceeds 500 volts, it is better to have the armature stationary, which allows of increased facilities for securing and maintaining the insulation necessary for high voltages. In this case the field magnet is made to revolve, and the exciting coil or coils need not have a difference of potential exceeding 100 volts, even for very large machines.

The generators in use for the different plants described in this paper are of the "Inductor" type. This is undoubtedly a more mechanical piece of machinery than either of the foregoing. Its distinguishing features are that all windings are stationary, being fixed securely to the main frame, and that there are no brushes or sliding contacts whatever, the only revolving part of the machine being the iron or steel inductor. The armature consists of two laminated iron rings, enclosed by a cast-steel frame. This frame serves both as a support and as a magnetic path between the two laminated rings.

As will be seen from fig. 1, sufficient space is left between the two laminated rings for the insertion of the single exciting coil. The armature conductors are embedded in holes close to the inner circumference of the laminated rings. To prevent eddy currents, the pole pieces of the inductor are made up of laminated iron strips.

A multiphase induction motor has two distinct electrical circuits, viz., the primary and the secondary. The primary circuit, when supplied with multiphase currents, produces a rotary magnetic field. The action of this rotating field is to induce in the secondary circuit currents of low potential. It is the reaction between the rotating magnetic field and the induced currents in the secondary, which sets up a torque giving the required rotation. Either the primary or secondary can be designed to revolve.

If the primary circuit were made to revolve it would be necessary to fit it with sliding contacts, so as to connect it electrically with the feeding circuit.

One advantage attained by this method is, that it allows of easy insertion of a starting resistance into the circuit of the secondary; but as there is no difficulty experienced in inserting a resistance in a rotating secondary, if required, it is better to fix the primary and dispense with the sliding contacts. The stationary element is generally spoken of as the stator, and the revolving element as the rotor.

It is now the usual practice to have the primary or inducing circuit stationary, and to allow the secondary to revolve, so as to take advantage of the very low potential at which the currents are induced in the secondary circuit; also, because the circuit in this part is enclosed on itself, and is independent of the feeding circuit.

Small motors up to 8 or 10 H.P. are switched into circuit directly from the mains by means of an ordinary three-pole switch without the use of any resistances; but for larger machines, it is advisable to use starting resistances, either in the stator or rotor circuit, otherwise excessive current will be taken from the mains.

For large motors, not requiring to start against a heavy load, starting resistances can be used in the stator circuit. These resistances may be of two kinds: either inductive, known as automatic transformers, or non-inductive, which may be either liquid or metallic.

The maximum torque of a motor having a permanently short-circuited rotor, *i.e.*, a rotor which is not connected to an outside resistance is obtained when its full electromotive force is across the stator. If, however, the motor is not called upon to develop its maximum torque, a lower torque can be obtained by reducing the electromotive force across the stator terminals to such a point as will give the necessary strength of field for the required torque, the object of this being to reduce the starting current to a minimum and still enable the motor to get away.

The auto. transformer is of simple construction, and is similar to the "economy coil" used in alternating current arc lamps for obtaining a reduced voltage across the arc.

As an example, we will suppose the motor is designed to work on a 200-volt circuit; the transformer is divided into four parts, giving 200, 175, 150, and 100 volts. The motor may be connected to any one of these four voltages. We will assume it gives the required torque at 150 volts; a throw-over switch is required, one side of which is permanently connected across the 150 volts, and the other side across the maximum voltage of the circuit. To start up, the switch is put on the 150-volt side, and when the machine has attained its normal speed, it is thrown over to the 200-volts side, the automatic transformer being at the same time thrown out of circuit.

If a liquid resistance is used, it is made sufficiently large to prevent a sudden rush of current when the circuit is closed. The plates are then lowered into the liquid until there is sufficient electromotive force across the stator to start the machine. When the machine has attained its proper speed, this resistance is entirely cut out.

If it is necessary that the motor shall develop its maximum torque at starting, it is obtained by inserting a resistance in the rotor circuit. See fig. 2.

A starting resistance of this description is necessary, for the following reason:—When primary current is switched on, the rotary is, of course, at rest, and the lines of the rotating field are cutting the rotor conductors at a maximum rate, thereby inducing very large currents in the rotor, which has a very low resistance. These reduced currents in turn re-act on the stator field, and weaken it.

To obtain the greatest torque, we must keep up the strength of the stator field, and this is got by introducing resistances into the rotor circuit. Of course, the result of introducing the external resistance

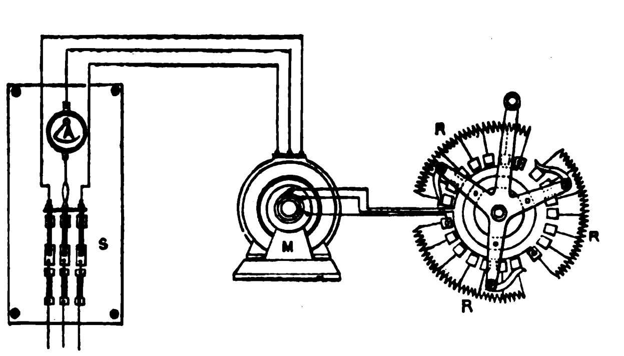


Fig. 2.

is to check the currents in the rotor, and so prevent them from unduly overpowering the stator field.

There is a certain resistance which allows the exact amount of current in the rotor to obtain maximum starting torque. The starting resistance should, however, be designed with resistance in excess of this, so as to prevent too great a current in the line when closing the circuit.

This variable resistance is connected in the rotor circuit in a three-phase motor, through three slide rings; the winding of the rotor and of the resistance box being in three circuits. This resistance is gradually switched out while the machine is running up to its normal speed. When this speed is attained, the resistance is short circuited and the three brushes lifted. The motor is now running quite free, without any sliding contacts or resistances; and for all constant-speed machinery these slide rings are only used for starting up.

I think I am right in stating that there is a much larger demand for constant-speed motors than for motors with a variable speed. It certainly is more economical to run the machines at the speed at which they are designed to give their maximum efficiency, and obtain, if possible, the variations by mechanical methods. Of course, this cannot always be done.

I have described to you the three ways which are commonly used for starting up multiphase motors. Motors up to 10 H.P. to be merely switched into circuit without resistance; motors of larger sizes requiring to give, say, twice their normal running torque at starting, to be switched in with the resistance in stator; and motors above 10 H.P., requiring to develop their maximum torque, to be fitted with sliding contacts, these sliding contacts to be used for starting purposes only.

Now, in a power plant calling for an aggregate of, say, 300 H P. in motors, it is likely that only a small number would be required to develop their maximum torque, and these could be supplied with a starting arrangement and slide rings.

We can suppose there are 20 motors below 10 H.P. absorbing a total of 130 H.P., four motors of 15 H P. with automatic transformers, two motors of 30 H.P., and one motor of 50 H.P., with slide rings, making in all 27 motors, three of which would be fitted with slide rings.

Here is a fairly large installation, requiring only three starting boxes amongst 27 motors, 24 having no sliding contacts whatever, and three having sliding contacts in use for starting purposes only.

If this were a continuous current installation, there would be, to begin with, 27 boxes; and to compare the motors, there would be 27 commutators, and about 150 carbon brushes and brush-holders.

The stator we may consider as corresponding to the field magnet of a continuous current motor. Both can be made reliable, and, as a rule, give little or no trouble. But it is to the merits of the rotor I particularly wish to call your attention. It is minus the commutator, brushes, and intricate brush work, and instead of taking the full potential of the circuit it has a difference of potential of only a few volts.

It is simply a laminated cylinder, with holes round its periphery, in which are placed solid rectangular bars connected at either end by a copper or brass casting, as per fig. 3.

The only part which has any insulation at all is the conductor, which has a light covering of tape, and this is only put on to confine the induced currents to the copper. This insulation gives a slightly increased efficiency, but should it fail the motor will still work, as the bars are already purposely short-circuited at certain points to the iron supports of the rotor.

Fig. 3 shows a rotor in which these bars are bolted directly to the end rings; no solder is used. The bolts have split spring washers under the nuts to allow of expansion and contraction of the metal, and still keep good contact. I may say that this particular rotor is one constructed by the Westinghouse Company.

You will notice, too, that there is no need for any binding wires or string. Not only is this part of the machine simplicity itself, but we have dispensed with comparatively high voltages, and as the machine is commutatorless and brushless, we can, once and for all, dismiss from our minds any anxiety as to sparking, even with sudden overloads, as sparking cannot occur unless the circuit of the primary or secondary is forcibly broken. The only limit to output is the heating of the stator on continuous overload. Wear and tear is reduced to the friction of the bearings, and as long as these get their proper supply of oil, the machine requires no other attention.

As an example, the multiphase motors at the General Electric Company's works, at Manchester, are only inspected once a month, and then only for the purpose of supplying fresh oil, if necessary.

The constant speed multiphase motor is a good regulator. Between no load and full load for an average size machine, the variation of speed is about 4 per cent.

The speed at which the motor runs depends upon the speed of the rotating field, and the speed of the rotating field is controlled by the number of the stator poles and the frequency which is being used in the installation.

At this point it would be as well to state that one cannot lay down a general law as to what frequency is best. As a rule, for motor work, it is not more than 60 cycles. The frequency is one of the two

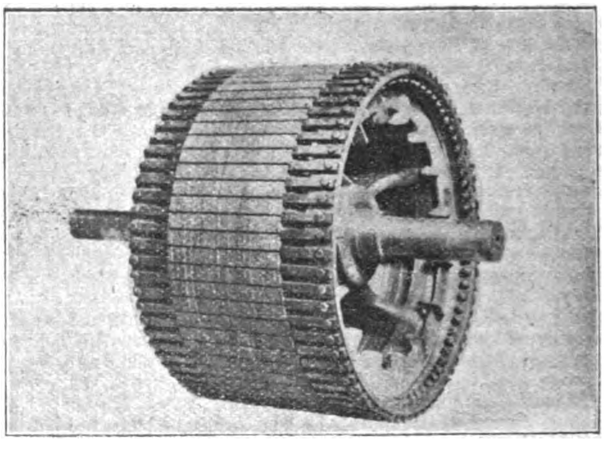


Fig. 3.

factors which control the speed, and it depends in a great measure on the class of machinery which is to be driven as to what is the best frequency to adopt. One would be inclined to keep it as high as possible, so as to keep down the weight, and therefore the price of the machine, as the speed varies directly as the frequency.

For instance, a motor giving 10 H.P. at 60 cycles and 1,150 revolutions per minute, would, at 60 cycles, run at 575 revolutions per minute, and give only 5 H.P.

The other way of decreasing the speed of the motor is to increase the number of stator poles; but this is not usually done, as to have too large a number of poles means great leakage, and, as a rule, the motors are, in the first place, designed with the maximum number of poles compatible with high efficiency.

I have stated that the multiphase generator need have no rotating windings at all; the only rotating part being a steel or iron casting. This reduces the attention and upkeep to a minimum, and I may here state that some installations which have been running in this country for two years, have, as yet, required no repairs whatever, and are practically as good to-day as the day they were put in.

(*To be continued.*)

THE RELATIVE IMPORTANCE OF CENTRAL STATION LOSSES.

A few sentences on the above subject are to be found among the editorials of the *Electrical World* of New York, dated January 29th. They point out in a brief and lucid manner what often escapes attention, namely, the relative importance of loss at the lamp terminals, for instance, as compared to the loss in the boiler room.

Bad firing or loss of heat by the chimney simply represents a waste of fireman's wages and coal. Then are traced the losses due to condensation in steam pipes and cylinders, which involve in addition to these increased boiler capacity to supply them; in turn, the losses in dynamos, mains, fittings, &c., are followed, each involving a corresponding increase of plant, until the lamps are arrived at.

It is not only astonishing but positively alarming, when one fully realises that the loss in efficiency in the lamps requires a proportional increase in boilers, engines, generators, mains, transformers, feeders, as well as wages for attendance, and also augment the losses in every part of the system where increased load means increased loss. Our contemporary's remarks end here, but we think they could have been carried much farther. In addition to all the above, we have to provide increased capital expenditure in plant, buildings, and mains, increased rates, rents and taxes, increased depreciation, repairs, reserve and maintenance.

The gentlemen who spend their time in securing every customer in every town where electricity works are established, and who often flourish certain letters on their cards which should guarantee their technical abilities, would do well to remember these facts. They should be most useful to the seller of a really good high efficiency lamp, and it would be worth his trouble to demonstrate to the engineer in charge of the electricity works in the towns he visits the truth of his assertions. We have generally understood from the gentlemen referred to, that their lamps were of the highest efficiency in the market, and a halfpenny cheaper than any other, and the halfpenny cheaper often sells the lamp.

It would afford an instructive evening's entertainment to many central station engineers to quietly think over what it means to them; the better and more efficient the lamps connected to his system the greater number he can supply with a given plant.

When he recollects how many tight squeezes he has had to "get over the peak," he will, perhaps, appreciate what it would have done for him had all his lamps been of the highest efficiency.

The generation and distribution of electricity has been reduced to a science, and it is unfortunate, in one sense, that the suppliers of electricity have no control of that part of their system most remote from the generating mediums where losses tell most heavily in proportion, namely, in the consumers' lamps. It follows that two towns similarly situated as to coal, water, and class of consumer with plants identical, may, from the fact that bad and inefficient lamps are used in one case and high efficiency lamps are used in the other show totally different results, and the true reason never be suspected. Little continuous wastes mount up to large sums when added up at the end of a year. We have known cases where the stopping of several small leakages at joints in the steam pipes has resulted in an appreciable lowering of the coal consumption; while the covering of the front of a boiler with non-conducting material and the stoppage of leaky glands have had the same effect.

True, these gains were small, but they were continuous and in time told up. Although the loss due to inefficiency in an incandescent lamp is small, yet it is taking place all the time the lamp is burning, and the number of lamps connected to the system being necessarily large, these infinitesimal losses soon mount up to a respectable amount, and begin to make themselves felt.

The losses in every step of the transformation process, from the latent chemical energy of the fuel to the light emitted from the lamps have been well thought out, and means taken to reduce them as much as possible; there are losses, however, which come under other heads, and the rectifying of which does not come under the control of the engineering staff, or we think they would be soon non-existent.

We refer to an item which might well come under the heading of wastes, for it no doubt influences, perhaps unconsciously, the efficiency of the whole system. We refer to the frequent changes taking place in the engineering staff. The man who puts coal on the fires, and the man who oils the bearings, are well paid for their labours; the policy being to get the best skilled labour in these departments, and to make the men contented with their posts, and thereby provide against their leaving.

Look a little higher up, and what do we find? Men who have spent years, and perhaps much money, to gain the experience necessary to enable them to fulfil the many and varied duties called for, and on whom the responsibility of the working and management of a most expensive plant, in many cases running into six figures, receiving wages, for we can scarcely call it salary, about equal to a foreman in a foundry, or a shopwalker in a draper's shop. We repudiate the idea that insufficient remuneration affects the performance of duty, yet we cannot help thinking the many changes we see week by week of engineers leaving one town to go to another when a slight increase of salary is attached cannot but have a detrimental effect on the economy of the system. In many cases we see men drifting right away into other channels where their experience commands more remuneration.

It surely holds good that if a skilled workman is to be made contented with his job and his services permanently secured, he must be suitably paid. The engineers should have a like consideration extended to them, and until this is done we feel sure that there will always be present a waste which has only one cure.

The man who has to give up social life, practically, if he does his duty, and devotes the whole of his time and attention to the duties of his office, cannot possibly do it complete justice if his mind is constantly occupied with the economical working of his household plant, if the term may be used.

ELECTRICAL DRIVING

MR. RAWORTH continues the correspondence in *Engineering* anent electrical driving, and assures Mr. Hirschmann, of whose letter we have already spoken, that 85 per cent. efficiency between indicated and electrical H.P. is not overstated, and claims that electrical engineers have ample proof that this can be attained and surpassed. He gives examples. A Holmes dynamo and Willans engine of 200 H.P. tested, by Prof. Kennedy, showed 85·7 per cent. in 1893. A Belliss-Crompton set of 200 H.P. at St. Pancras, tested by Prof. Robinson, gave 88·5 per cent. A Universal engine driving a Mordey alternator, was tested recently by Messrs. Kincaid, Waller & Manville to show 88 per cent., and included the power to drive air pump and exciter. Mr. Raworth points out that he allowed 65 electrical horse-power to produce 60 mechanical horse-power, so that he allowed 7½ per cent. loss on transmission and conversion at the motor—a narrow margin, it is true, but not too small if motor making is taken up with serious spirit. English made motors are, however, far too costly to permit of favourable comparisons with line shafts on the score of first cost, but American motors are now less than half the price of English motors of two or three years back, and great improvements may be looked for in this direction.

Mr. Raworth wants to make a national saving of 30 per cent. in fuel, and he does not doubt even the cotton spinner being able to see a profit and an advantage in ridding himself of belts, and of tall smoky chimneys. He suggests that electrical engineers may sit still if they choose, and watch the development abroad and in America, but he throws doubts upon the cordiality of the greeting of our grandfathers in the dim hereafter. This is very funny—"the dread of something after death," is to stir us now to "enterprises of great pith and moment." Three cheers for our grandfathers. But seriously, electrical engineers, and, indeed, all other engineers may wisely take Mr. Raworth in all seriousness. The cheapness of gas in this country has been a commercial set-back to the electric light industry, the excellence of our common roads has been against tramways of any kind, and not merely a bar to electrical progress. Moreover, the vested interests are so great in a settled old country, that it is difficult to get schemes taken up. We venture to say that, if new ventures in America demanded the same amount of preliminary energy to get them into shape that is required in old countries, the progress would be as slow as it is here, and Englishmen have not been idle even if they have not much to show. At the same time there is no harm done in reminding them that effort must be great and persistent. The mechanical work can be done if only it can be got to do. The difficulties are those incidental to any old-established country in which there are alternative methods. People who prate so very much of the American progress in electrical traction have failed to note that America has no common roads as we understand them. There may be cart tracks here and there, but the country is too new and too vast to have built a system of good roads.

For the American post office to carry on a parcel post by horse traction on the common roads, as is done here, would not be possible. Comparatively speaking, America has a very small mileage of railroads, and obviously the electric line has a larger and freer field for its growth than we have with our closer network of steam railroads as well as common roads.

But there are fields to be tilled abroad—in India and in China. In the latter country there must be a gradual leavening of returned Chinamen from California and Australia who are ready to ride on a car, and are in a position to expound matters to the stay-at-homes. China as a market ought to be preserved, or where are our engineering financiers to find play for their energies in the near future, before Africa is better developed?

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1898.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents*, 322, *High Holborn, London, W.C., to whom all inquiries should be addressed.*]

5,501. "Improved apparatus for regulating the pressure on electric mains chiefly in connection with storage batteries." J. S. Highfield. Dated March 7th.

5,533. "Improvements in electric high and low tension fuse-heads for blasting purposes." W. A. Malson and S. R. Malson. Dated March 7th.

5,544. "An electric fog-signalling apparatus." J. Woods. Dated March 7th.

5,550. "Improvements in and connected with dynamo-electric machinery." M. T. Pickstone, R. S. Portheim, and A. C. Peebles. Dated March 7th. (*Complete.*)

5,560. "An improved holder for carbon and other brushes for electric motors, dynamos, and the like." A. L. Armstrong. Dated March 7th.

5,571. "Improvements in or connected with the application of electricity to marine propulsion." W. T. Carter, John A. Dawson, and T. Gray. Dated March 7th.

5,584. "Improvements in switches for electric glow lamps." A. B. Kistritz. Dated March 7th.

5,590. "Improvements in microphones." A. H. Skold. Dated March 7th.

5,596. "Improvements in electric arc lamps." S. Bergmann. Dated March 7th.

5,644. "Improvements in electric lamps for photographic and similar purposes." W. C. Cubbin and G. E. Johnston. Dated March 8th.

5,663. "Improvements in metallic conductors for protecting electric wires and cables." P. C. Middleton and F. Huggins. Dated March 8th.

5,672. "An improved electrical safety lamp for miners." H. H. Lake. (O. Siedentopf, Germany.) Dated March 8th. (*Complete.*)

5,680. "Improvements in telephone speaking tube and like receivers." H. A. Cutmore. Dated March 8th.

5,686. "Improvements in and relating to dynamo-electric machines and electro-motors." S. G. Brown. Dated March 8th.

5,693. "Innovation in electric lighters (pyrophore)." W. von Zabern. Dated March 8th.

5,703. "Improvements in electrodes for secondary batteries or accumulators." H. Pieper Fils. Dated March 8th.

5,704. "Improvements in electrodes for secondary batteries or accumulators." H. Pieper Fils. Dated March 8th.

5,705. "Improvements in the manufacture and production of electrodes for secondary batteries." H. Pieper Fils. Dated March 8th.

5,729. "Improved apparatus for the electric ignition in internal combustion engines." R. A. Miles. Dated March 9th.

5,750. "An improved form of automatic transformer switch." J. E. M. Stewart. Dated March 9th.

5,783. "Improvements in electric tram and railway systems." W. C. C. Hawtayne. Dated March 9th.

5,806. "Improvements in the manufacture of metal bases for electric incandescence lamps." H. H. Lake. (La Compagnie General des Lampes a Incandescence, France.) Dated March 9th. (*Complete.*)

5,810. "Process for making an electrical conductor and an insulating body of tar asphalt and the like materials." W. P. Thompson. (A. Lessing, Germany.) Dated March 9th.

5,823. "Improvements in and in connection with underground conduit electric railways." E. Heyl-Dia. Dated March 9th.

5,820. "Improvements in and in connection with incandescent electric lamps." E. Heyl-Dia. Dated March 9th.

5,863. "Improvements in incandescent electric lights and in processes therefor." W. L. Voelker. Dated March 10th. (*Complete.*)

5,912. "Improvements in electrical galvanic batteries." G. Laura. Dated March 10th. (*Complete.*)

5,934. "Improvements in conduits for electric conductors." J. J. Bate. Dated March 10th. (*Complete.*)

5,950. "Improvements in or connected with the application of electromotors to propulsion." W. T. Carter, J. A. Dawson, and T. Gray. Dated March 10th.

5,959. "Improvements in guards for flames or fragile objects, such as incandescence lamps, glass globes, &c." H. N. Moody and A. L. Davis. Dated March 11th.

6,014. "The springless contacts bayonet holder for electric incandescent lamps." L. Bertgues. Dated March 11th.

6,022. "Improvements in primary, voltaic, or galvanic batteries." P. Lafargue and E. Droult. Dated March 11th.

6,024. "Improvements in and relating to conduits for electric cables." W. Sykes. Dated March 11th.

6,025. "Improvements in and relating to draw and junction boxes for electric mains." W. Sykes. Dated March 11th.

6,026. "An electric drill." R. J. Crowley and C. H. Preston. Dated March 11th.

6,028. "Improvements in the method of and apparatus for the electro-deposition of metals." J. Holloway. Dated March 11th.

6,032. "Improvements in electrical or electro-magnetic therapeutic apparatus." O. Waratka and E. Sachs. Dated March 11th.

6,039. "Improved apparatus for electro-plating and polishing various small articles." A. E. Honey. Dated March 11th.

6,044. "Improvements in secondary batteries." A. Werner. Dated March 11th.

6,049. "Improvements in electrical measuring and indicating apparatus." A. U. Alcock. Dated March 11th.

6,058. "Apparatus for transmitting motion to a distance by means of electrical energy." Siemens Bros. & Co., Ltd. (Siemens and Halske, Aktien Gesellschaft, Germany.) Dated March 11th.

6,108. "Movement mechanism for electric apparatuses." P. Richter and T. Weil. Dated March 12th.

6,109. "Improved electric arc lamps." P. Richter and T. Weil. Dated March 12th.

6,110. "Improvements in blades for electric current collectors." P. Richter and T. Weil. Dated March 12th.

6,135. "Improvements in electric incandescence lamps." W. Nernst. Dated March 12th.

6,145. "Process for hardening and rendering tenacious the active mass of electric accumulators." R. von Babby. Dated March 12th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free*, 9d. (*in stamps*).]

1897.

16,579. "Process of electro-glazing tile sections to form a plate for windows and the like." J. M. Ewen. Dated September 4th, 1897. This relates to electrolytic processes and devices applied particularly to securing tile sections of prismatic glass in the metallic frames intended therefor. In mounting prismatic glass sections, to form an entire sheet of glass for a window, such sections are arranged in a frame-like construction of thin metallic strips, which is immersed in an electrolytic bath. The current being applied, there will be an electro deposit along the metallic strips and between them and the glass sections, until finally a complete frame is formed and the glass or tile sections are secured together in one sheet. As frames and window openings are usually of great size, it is necessary to have a solution of very great depth in the tank; compressed air is forced through lead pipes at the bottom of the tank, which keeps the solution a uniform density, and thus stops all tendency towards irregular deposits on the foundation cathode skeleton frame between the lenses. 3 claims.

16,629. "Improvements relating to conduits for electric conductors." H. E. Newton. (The American Silesc Company, of 39-41, Cortlandt Street, New York.) Dated September 4th, 1897. This relates to improvements in conduits for electrical purposes with the object of providing a metallic race-way for the reception of either bare or insulated wires. The race-ways are constructed and the conductor may be drawn through them and consist of a suitable metal which is capable of being bent without breaking. They are made in lengths to correspond to the sections of a conduit in which they are located. They are packed at suitable distances apart from one another and from the interior wall of the conduit by means of powdered silesc; it being found that pure silesc has no tendency to absorb moisture, is a non-conductor of heat and is at the same time a perfect non-conductor of electricity. Wads of mica are provided at the ends of the adjacent sections of conduits and are snugly fitted around the race-ways and between the race-ways of the interior walls of the conduit, and provided with corresponding receding and projecting portions at the adjacent ends of the race-ways, for the purpose of breaking joint and to cause the adjacent faces of the wads to impinge against each other when the ends of the conduit sections are forced together. To connect these sections of conduit their ends are screwed on the outside and they are joined by a coupling nut. 5 claims.

THE

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TRANSPORTATION.

IN his address to the Society of Engineers, Mr. W. Beaumont made a statement pregnant with meaning. Here is part of it:—"We are using old machines, of which two are required to do the work of one new one, and we go on driving them, and the shafting for them, year after year, making very small instead of larger profits, and thus investing what profits we do make in things one-tenth as pregnant with dividends as investment in the proper plant for the works that made them would be." This statement is expanded in various ways—mill owners, for example, paying double for coal, because an engine and boiler must not be thrown away for no better reason than that they will run another 20 years, and men are constantly refusing to renew plant that will return a 10 per cent. saving, though they will invest money as savings at 3 per cent. Confining his remarks in a narrow channel, Mr. Beaumont referred more particularly to the millions thrown away annually for lack of roads and means of transport.

The importance of transport is evident, when it is remembered that our railways have cost over a thousand millions sterling. Transportation, indeed, is a factor in the value of so many material things, which, indeed, frequently have no value except when far removed from their place of origin, as, for example, coal. To-day it often costs more to send goods from place to place by rail than it did by horses on the common roads, and is it not a disgrace that the Post Office finds it cheaper to use horse vans on the road than to submit to railroad extortion for parcel carrying.

It costs 9s. 6d. per ton to send goods the 35 miles between Manchester and Liverpool by rail. It can be done by horse traction for 8s. 6d., and by road traction engines for 2s. 11d. to 3s. 6d. per ton. But the roads would be ruined by such carriage of 15,000 tons weekly, and this is only one instance of the need of better facilities. But there are wanted more transportation facilities in other places, and the time has now come for the engineer to improve his own works. Improved roads would admit of better vehicles, and would give rise to new industries in motor cars. Railroads sprang up from faulty roads. To-day roads are no better than some of those made by the Romans, and we admit this by laying metal rails and admit tramcars upon these to the detriment of every other form of street vehicle. Two horses can haul on a tramway 42 passengers against 26 in an omnibus, and so we allow our roads to be spoiled by grooved rails We refuse to make a good road all over, but convert our roads into poorly managed railroads.

All possible underground and overhead means of travel in London are overcrowded, and it is now a first necessity to improve the ordinary roads. To do this, the light vehicles must evidently accommodate themselves to the roads that will stand the wear of the heavier vehicles of, say, 2 tons per axle. This is easier done than to make a road to stand the wear and tear of horses. The need is for better and more durable surface and substratum, and better methods of maintenance and repair, and a general minimising of the gradients. Axle load can be dealt with by using more wheels, so that tyres of yielding but good wearing material may be employed in place of steel edge runners. We need not dilate on the folly of constantly tearing up roads to get at pipes and other things. The subway, as in Northumberland or Shaftesbury Avenues, is too obvious an economy to require any emphasis. Macadam roads are not made as they should be, nor attended after making as they ought to be, to keep them up to the mark while the new surface is consolidating.

Road metal ought to be much more finely broken. Referring to the great economy of man's time effected by railroads, as compared with the old coach system, it is said there are still 106,000 horses at work in London alone. They are pounding the streets to pieces, and doing double the destruction of iron-shod wheels, and they are also the cause of much traffic of food, &c., some 20,000 tons a week in fodder and food alone, while an army of scavengers with carts and other horses are required to clean up after them.

At least one-third the total vehicular space is represented by the horse. Abolish the horse, and the streets at once become 50 per cent. larger, and many street blocks would be avoided. This is quite apart from the loss due to stoppage of streets for repairs due to the pounding of hoofs. From one to two hundred millions sterling spent on our roads would be an economy. The resistance of a railway per ton is 6 to 12 lbs.; for a tramway, 15 to 40 lbs.; on a good road surface of best quality, 25 to 30 lbs.; on good macadam, 38 to 60 lbs., and so on to 140 lbs. for gravel. Thus, a horse's efficiency on asphalte is double what it is on macadam, and so on. Similarly the resistance due to gradients is enormous, and jumps from, say, 45 lbs. on the level for good macadam, to 157 lbs. for a slope of 1 in 20. Yet many gradients are 1 in 8, or 1 in 10, which latter would demand 269 lbs. per ton. It is these gradients which make a motor vehicle demand a 16 H.P. motor, where one of 3 to 4 H.P. would suffice.

There are 1,200,000 draught horses in the country. Assume only 500,000, however, at £30 a year each for food and lodging, at least a third might be dispensed with, and save the country £5,100,000 a year, or, capitalised, £170,000,000 at 3 per cent., which is, therefore, what might be spent on the roads at a low estimate to save one-third of the horses employed.

As regards tramway traction, Mr. Beaumont seemed to favour steam motors or gas, because at present the Serpollet cars of Paris, and the Blackpool gas cars only cost about 4½d. per car mile and electricity costs 6d. But he thinks no small tramway can succeed properly. Tramways ought to be worked by powerful companies, as is now being done for electrical traction, when, perhaps, steam and gas systems may succeed.

We fancy Mr. Beaumont in this has not taken into effect the rapid acceleration which electricity makes possible and the economy of time thus secured. The general trend of his remarks may be summed up as a call for better road surfaces, so that road motor vehicles could be used, and easier gradients. He might have added a special word of commendation of our early railroad engineers, who aimed at directness and as close an approximation to levelness and no gradients as possible. Few know what is being saved by George Stephenson's determination to make the locomotive a success. He never over-rated its powers, but built huge embankments and made heavy cuttings so that it might have a level road.

We do not know if it is wise for an engineer to neglect finance altogether. It may save the labour of many horses to spend millions on the roads; but the man who has no horse would object to pay a sovereign for road tax, in order that his neighbour, who has horses, may save, say, £30 a year. There is clearly something to be urged against the abolition of the old toll gates, which, at least, taxed users directly. Mr. Beaumont's paper is suggestive. It is a little unpractical, but presidential addresses are perhaps better when not too closely argued. The subject of good roads is a very wide one. From the socialist standpoint their improvement could be undertaken, for no doubt large expenditure would return good interest to the community at large. But socialism is not at present within the range of practical politics, simply for lack of the only single essential to success, to wit, absolute fair dealing. With no horses, and with all tyres of suitable width for their loading, and of soft material, there is an evident perfection of road surface to-day possible, which would have great durability, for there would be no grinding wear. Such roads would imply an immense motor car industry. Doubtless this was the thought underlying the address.

The Gale and the Wires.

In a recent issue of the *Globe* attention is once more drawn to the interruptions which have occurred to telegraphic communication caused by the late gale. The cause, says that highly scientific daily, "is perfectly well known, and has repeatedly been pointed out in this journal. It is neither more nor less than our foolish system of employing overhead telegraph wires. For this there is nothing whatever to be said, except that it is rather cheaper in first cost than laying them underground." . . . "Other countries have underground wires, why not Great Britain? Years ago, even Switzerland managed to organise such a system, and was charging half-a-franc for messages upon which we in England are still paying a shilling. There should be no difficulty in the way of laying the trunk wires underground in this country." Such effusions as the foregoing are so common in the daily press and indicate such accurate knowledge of governing factors, that no doubt the Postal authorities will be at last ashamed of themselves and will proceed to abolish the overhead system and substitute underground work, as it can be done at a trifling expense, and will solve the question of uninterrupted fast-speed telegraph working and long distance telephony. It is, perhaps, needless to say that the so-called Swiss system is a pure imagination of the writer in the *Globe*, and that the idea that an underground system capable of carrying the enormous traffic which passes over the immense network of wires of the United Kingdom could be laid without difficulty, that is at a small expense, is simply ridiculous, let alone the fact that long distance telephony through underground work is impossible with our present knowledge. No doubt, however, the writer in the *Globe* knows all about the mysteries of "K. R."

Board of Trade Electrical Standardising Laboratory.—We have received a copy of the Board of Trade table of fees for examination or testing of electrical instruments for the measurement of resistance current or electrical pressure.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

A strong muster of central station men graced the last meeting of the Institution of Electrical Engineers on Thursday, March 24th, to hear what Mr. Hammond had to say as to "The Cost of Generation and Distribution of Electrical Energy." The proceedings were exceptionally interesting, inasmuch as the paper before the meeting was in the hands of the members, and the writer of the paper explained what was in it in an able discourse, lasting three-quarters of an hour. We all know Mr. Hammond to be one of the hardest workers in the profession, and were prepared for the clear and decisive character of his speeches. On Thursday evening he was at his best, and, from a few notes, gave all the leading points in his most voluminous printed paper in a telling fashion, which went down with the meeting as no reading could have done.

To briefly summarise Mr. Hammond's remarks is to index his paper, and it is worth while to do so under the circumstances. Firstly, he pointed out the difference between local authorities and companies, as regards the location of salaries and wages in the Board of Trade form of accounts; then he stated that these accounts have been systematically kept since 1890, and expressed the hope that the time will come when the Board of Trade will publish the figures sent in according to statute. The usual method of dealing with the quantity of electrical energy turned out is to take the costs of the unit delivered to the consumer, although some would prefer, as fairer, that the units should be taken as they leave the works.

The editor of a well-known contemporary has said that the reduction of cost of electrical energy is always to come. It may be replied that the cost to the consumer is even now one-third of what it was in the earliest days of public supply, while any such statement bearing on the actual cost of production can be easily refuted by perusal of the figures contained in the paper.

Mr. Crompton's paper of 1894 showed what had been and might be done, and further evidence of reduction in cost was given by such figures as have been obtained year after year by the Westminster, Manchester, and Leeds stations, proving conclusively that the tendency of costs is always to decrease. Ideal costs could be obtained by taking the lowest of the respective items as they now stand; while at Edinburgh, Leeds and Manchester, figures closely approaching Mr. Crompton's ideal figures have been obtained with much lower outputs than Mr. Crompton allowed.

Mr. Hammond then considered the factors that affect cost, such as:—

1. Output, the leading factor.
2. Load factor, the next important after output.
3. Reliability of plant, the general smooth running of things.
4. Engineer factor, the ability, assiduity and earnestness of the responsible engineer or engineers.
5. Efficiency of plant, as affecting consumption of fuel, &c.
6. Efficiency of distribution, as affecting outside losses, &c.
7. Cost of fuel, &c.

We have now an approach to the figure given by Mr. Crompton as a prophecy, that the cost in London would fall to 1·32d. per unit, and Mr. Hammond ventured to add that, when the output *does* reach 5,000,000 units, we shall see the cost as low as 0·75d. per unit.

Major-General Webber then opened the discussion by expressing his desire to say that all felt that there are individuals on this earth to whom we should like to be introduced, and that he was then introduced for the first time to one whom he had been very anxious to meet, "Chesterfield Junior." While he did not doubt that the statistics of this gentleman were quite as accurate as other statistics, still he thought that from the way they must be compiled they could not be of much use to the engineer as an engineer. For example, from the respective positions of various companies in the coal statistics in the paper it may be well argued that the order of merit shows completely how unreliable such figures are in forming an opinion. In short, that these figures to the engineer, however valuable they may be generally, are nothing more than suggestions; outside the gentlemen interested he thought no one could tell the reason for the particular order in which the various concerns fall. Further, it might be of use, however, if tables were prepared bringing down the figures to a uniformity by giving the calorific value, &c. Losses unaccounted for might also be classified, as by a heavy expenditure on copper, losses by resistance are minimised; some systems embody storage, and so many points have to be considered, that if everything were taken into account the results might come out in some other way to that at first obvious.

Mr. Crompton felt obliged to Mr. Hammond for his paper, as he had at recurring periods of three years written papers on this subject, and in this case Mr. Hammond had done the work for him. Anyone who knew the trouble and labour involved in the preparation of such a paper must be wild to hear it spoken of—as had been the case—as a compilation. As regarded the paper itself, he did not wish to say anything on points on which others might speak, but from his special experience he would emphasise the importance of investigating details of costs and losses, and Mr. H. W. Miller, nearly 10 years ago, adopted such analysis, being thus almost the father of weekly returns. The very great advantage of the Board of Trade returns was the arousing of the sporting instinct of the race, where central station supply was concerned. Prof. Kennedy, and many others, frequently suggested improvements in the method of displaying and arriving at the figures given in *Lightning's* tables and similar summaries of the technical press, that the race for honours might be a fairer one, bringing out as far as possible the merit of the engineer, but where conditions differ widely, it is very difficult to do so. He knew the difficulty, as in his last paper he attempted, by a knowledge of the calorific values of different coals, to arrive at a fair comparison, but was told that the resulting figures were his figures, and he admitted this. It was extremely difficult to bring things to a level. Engineers do not often have control of the management, and they cannot control the local authorities. Local taxation sometimes is very heavy, and may even now reach a value of two-thirds of the cost of coal; as times goes on, the two curves will cross one another.

After some remarks on the coal bill and its effect on the cost per unit, Mr. Crompton went on to say that a low coal bill is not of much credit to a station if extinctions frequently occur; that it is a suicidal policy to restrict the generation to a single station, and it is better to have two or more stations for a large supply. This is a little more expensive, and large London companies with multiple stations cannot be fairly compared with other systems, such as Brighton, worked from a single station. Quite recently there have been a good many smashes, and a point he attached importance to was the unreliability of directly generating at very high volts, as, if steam pipes break, bang go your coils. Such machines will not stand large quantities of escaping steam with impunity.

He had proposed the word "load factor," but the present use of this term was not quite satisfactory, and although his present proposal was rather complicated, he thought it more useful; that is, to take the number of hours per year that the plant would have to run to give the actual output—not a difficult thing to calculate.

Then low costs are due to the men controlling works. It is most important to get the very best men, and he would wish some means could be found to give the real representative order of merit, so as to show who really are the best men. Continuous publication of results is developing a race of highly skilled organisers—men who must be well paid, and will not be obtained for the remuneration of a mere clerk.

Mr. Wordingham thought the labour of preparing the paper must have been enormous, and as an evidence of the care taken in working out the figures, Mr. Hammond, he noted, had not overlooked the fact that last year was leap year. He thought it rather a mistake to leave out of sight capital cost, and the charges due to this often amount to half the real costs of production. Load factor is, after this, the real thing affecting cost. Ideal costs may be rather misleading, as electricity supply may be combined with other work. Also, there is a danger of competition being carried too far, and everything being sacrificed to low figures. He then referred to the low charges made at Manchester and Brighton, and urged the putting aside of a certain sum periodically to depreciation. He stated that he should personally be obliged to any contractor who would tell him actually the upper or largest size of unit actually to be obtained.

Prof. Forbes considered the curves of very great interest to all. After some general remarks on the desirability of limiting the use of curves and figures to the obtaining of facts and arguments which could, without error, be obtained from them, he pointed out that not only did the cost per unit fall with lapse of time from the start of a work, but also with output—which rose as time went on. Part of the reduction may be due to improvement in plant and methods, and part only to increased output.

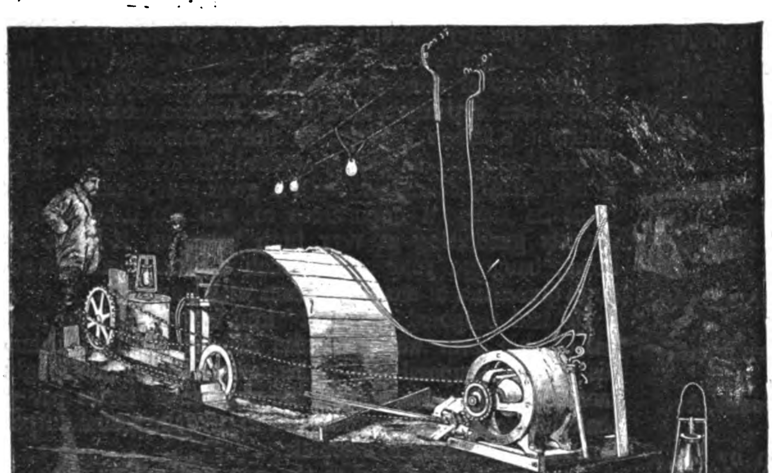
Mr. Grimshaw explained a diagram he had prepared, showing that at the Eccleston Place works of the Westminster Company, he had got down to 4·75 lbs. of coal per unit with exceptionally good loads, and had reached 4 lbs. on a 3—11 p.m. shift in winter, and considered it improbable that very much lower figures would be reached for some time to come.

Prof. R. H. Smith thought that Mr. Hammond's estimate of reduction of cost with output was exaggerated, as workmen and managers would expect some increase in greater proportion than seemed to have been allowed. It is also always a question of incidence of interest and depreciation, against decrease of working cost on the other side, as by spending capital the working cost can be reduced.

At this stage the discussion was adjourned until next meeting.

ELECTRIC TOWBOAT IN A SEWER.*

The city of Worcester has a large sewer 18 feet wide and 13 feet high. The sewage of the city is treated chemically to render it fit to flow back into the Blackstone River, so that it is desirable to separate the storm water from the sewage to lessen the expense of the chemical treatment.



In order to accomplish this end a smaller sewer, 6 feet wide and 4,000 feet long, is being built inside the larger one, utilising the bottom and one of the sides of the sewer. A cofferdam is constructed to enable the other wall of the sewer to be built, and in order to deliver materials to the workmen an electric scow was rigged up, which has been found very satisfactory. Electricity is also used to light the sewer, to operate ventilating fans and to work electric pumps. All of the lighting and power are generated on the premises in a small building outside the sewer. About midway between the ends of the sewer a small dock has been constructed and the materials are delivered to it by an incline through a hole made in the top of one wall.

The towboat is a catamaran 22 feet long and 5 feet wide. Each of the small boats is 18 inches wide. In the middle of the catamaran is a small paddle wheel box which is to prevent splashing. This is driven by means of sprocket wheels and chains which are connected with an electric motor of 2½ horse-power. At the stern end is a rudder and controller, so that one man can operate both. Only one electric boat is used. It tows six scows, which have already handled 12,000 bricks, 50 barrels of cement and 100 barrels of sand daily. The double trolley system is used, the wires being hung from insulated brackets secured to the top of the arch in such a way that a trolley can be run on it. A scow is also fitted with a centrifugal pump which is used for pumping out the cofferdam, and it is driven by another motor of 14 horse-power. The application of the electric towage to sewer construction is novel, and the results obtained are most satisfactory.

The electric scow was designed by Mr. Harrison P. Eddy, Superintendent of Sewers, Worcester, Mass. Mr. Robert N. Kendall is the assistant in charge of the electrical work.

* *Scientific American.*

CONDITIONS OF CONTRACTS.

We have several times lately referred to the onerous and often unfair clauses of specifications which are enforced against contractors. As we write, we have before us several specifications, from which we propose to select a few samples of clauses which, in our opinion, cannot be fairly upheld.

For example, in a clause for testing materials, the contractor is required to supply, free of charge, all labour and testing apparatus, and the tests are to be made when and how the engineer may direct. Without doubt the engineer ought to have the power to specify tests, but why should the contractor be exposed to the cost of finding apparatus and labour to his own possible undoing. This clause does not appear satisfactory, because it is not sufficiently rigid, and presents a difficulty in estimating the price to be put in. A personal knowledge of the engineer and his testing idiosyncrasies might be sufficient to give a great advantage to one contractor over another, while the lack of such knowledge might put a contractor to an unexpectedly large expense. Tests should, therefore, be standardised where possible, and an aggrieved contractor should have an appeal to an unbiased outside authority.

Under the head of power to vary works we consider it eminently unfair that a contractor should be paid under schedule of prices only. What of materials rendered useless by the variation? Is the contractor to have no recompense for his time and trouble, but simply be paid perhaps a few pounds on a schedule rate which was priced for amounts 50 times larger than those involved in the alteration.

In public work the item of watching may prove serious, so also may the contractors' responsibility for accidents even when caused by following the engineer's instructions. An engineer demands something to be done, perhaps, to expedite work; the contractor is obliging and does not wish to object, or, if he do object, he may become liable to penalties at the sole option of the engineer, and then when an accident happens the contractor bears it all.

There is a clause as to daywork in one specification before us, to the effect that daywork must be sent in not later than the next day after the time was made. There is nothing unfair in this, and contractors ought to be very stringent on this point. We have known where a contractor was easy and was anxious to help on work, and neglected to divide off the daywork from contract work and lost the whole of it amounting to over 10 per cent. of the whole work. Contractors find a difficulty with workmen. It is almost impossible to get the average working engineer to keep time separate on day and contract jobs. Workmen are hopelessly unintelligent in this respect, and if pressed to keep the time feel aggrieved as though they were being doubted. We have seen a good tradesman fairly dance with excitement when pressed to keep a time record on jobs, and end up by asking for his—money, and departing. Engineers who are intelligent and see no difficulty in keeping time separate, fail to appreciate the position of a contractor who has workmen to deal with. Take that honest man, the bricklayer, who shatters his health in disposing of a couple of hundred bricks daily. When these men are requested to hurry a job along down go their trowels and off they troop to the pay office, and between slow work and no work the contractor does not know how to meet the demands of the engineer for more rapid progress. *Apropos* of the recent *fiasco* at Bradford, there is a good clause before us, to the effect that no alternative scheme shall receive consideration. At Bradford, we presume, this was not a clause, and an alternative scheme was considered, and it ought not to have been in the absence of a special proviso to that effect. Alternative schemes either should be invited or should be specially barred out.

In another specification we find a particular type of boiler is demanded, and its evaporation per hour is laid down when using steam coal hand fired, both in the gross and per pound of coal. Now this is open to many objections. The engineer ought to fix the size of the boiler if he can fix its maker. One contractor may supply a boiler that is too small; he may make an error. True, he could be made to put in another boiler to do the specified duty, but this is not the object of employing an engineer. It is the engineer's duty to avoid disputes, not to lay traps for mere contractors.

The same engineer who specified as above, also specified for a gas engine to run at an absolutely steady speed of so many revolutions per minute. He specified a make of engine which governs by cut-out explosions. How then could he expect to get a steady speed of 160 or 190 revolutions when the cut-out is effected by speed variation. "Absolutely steady" are the words used, not sensibly steady; but further on it is provided that the speed variation shall not exceed a given allowance. Why first have asked for an impossibility, and then have toned down. These tonings down are apt to be extended by contractors perhaps too liberally to other clauses.

In yet another specification the contractor is under penalty to complete at a date given, and the engineer has the right to delay delivery or erection without extra payment, and the contractor's only benefit is to be an extension of time at the option of the engineer.

There are all sorts of claims which may be enforced against the contractor even to delaying work, and yet enforcing the penalty for non-completion by given date. We should doubt whether, under such circumstances, a court of law would allow a penalty to be enforced, but here again is that loophole for dispute and legal action which an engineer should avoid, which he is paid to avoid in truth.

This is a point on which we would like to insist. It is all very well to treat contractors as so many mere money grubbers. Contractors have their retort upon engineers, many of whom are not free from the reproach of making little jobs into big ones for the extra commission thereon. But whether contractors are all that many specifications would seem to imply, or whether they are not, a specification is intended to be a document that shall obtain justice all round. At present the aim of some specifications seems to be to place the contractor in a position to bear the brunt of any possible mistake or oversight on the part of the engineer, so that the engineer's paymaster may not be called on to pay for such oversight or error. This is unfair to the contractor. Of course, in the long run, the cost of these things comes upon the customer, for the contractor adds for contingencies, or in other ways increases the amount of all his tenders to cover such items. At the same time if such clauses could be eliminated, and contractors could rely upon fair treatment, all work could be taken at narrower margins and really just specifications would carry weight and could be easier enforced.

In one specification only do we find a bonus for earlier completion as well as a penalty for late completion. This is fair, but it is not fair to delay work and allow nothing for delay. A contractor is not necessarily wealthy. He has provided for delivery of goods and often wants payment to meet his liabilities. If compelled to obtain an overdraft he has got to pay several per cent. for the accomodation, and his banker only then grants it if he is sure of the final money. The very delay in work may be weakness and may stop a contractor's overdraft. Power to delay work irresponsibly, especially where the contractor has hurried goods forward to avoid penalty, is grossly unfair. As an American writer pointed out lately, it demoralises the workshop to see push goods lying waiting delivery after proper date.

The very presence of unfair clauses emboldens the unfair contractor to encroach, for too harsh a document enlists sympathy with him, and as juries were wont to convict sheepstealers of manslaughter to save their lives, so will contractors escape just penalties if held liable to unjust punishments.

It is not only in commercial clauses that we find items that are difficult to consider. What, for example, are we to think of an engineer's demand for gas engines to secure the highest economy and the minimum speed variations, conditions inimical to each other, the one demanding a system of governing differing from that demanded by the other?

Why, too, should a contractor be made responsible for the efficiency of producer gas supplied to work his gas engines, and be compelled to bear the expense of proving the gas quality to be wrong? If there be a doubt as to producer gas, a holderful could be made and its quality ascertained, and the engine run upon this. Producer gas must be fairly bad if a gas engine cannot work with it. There might be a standard gas, one that should not contain less than, say, 30 per cent. of combustible.

In reading through many specifications for all manner of work, it occurs to us that it is to the credit of our engineers and contractors generally that matters go as smoothly as they do. But specifications are usually so outrageous, that when a contractor goes to see plans and read specifications, he pays little attention to the most objectionable clauses. We have seen an inexperienced man with no knowledge of these matters, when confronted with objectionable clauses, put on outrageously big sums to cover them, to his own undoing and the loss of profitable work. Of course, such a man ought not to see such specifications, but the question arises, Should such things to be? Is it not possible to secure good work with more rational and standard clauses? The trial is being made. Let us hope success may attend it.

THE EFFECTS OF TENSION AND QUALITY OF THE METAL UPON THE CHANGES IN LENGTH PRODUCED IN IRON WIRES BY MAGNETISATION.

Mr. Byron B. Brackett has recently published in the *Physical Review* (America), Vol. V., No. 5, an account of the results of a long series of experiments on the subject of the title, with special reference to the effects of tension upon the phenomena. The experiments have been carried out with great care, and values of the different quantities involved very completely recorded. Tests are reported on piano wire in its natural condition under two different stresses, 658 and 1,949; on annealed piano wire under three different stresses, 62, 699, and 1,949; and on soft iron wire under four different stresses, 48·3, 430, 752, and 1,720; stresses being in all cases measured in kg. per sq. cm. The diameter of the piano wire was 1·25 mm., and of the iron wire 1·31 mm. Round the vertical stretched wire as an axis were arranged three pieces of apparatus. The first attached to the wire at two points was an arrangement of levers carrying a tilting mirror for observing on a scale the changes in length of the wire. The movement observed on the scale was 25,000 times the change in length of the wire. Round this was a cylindrical jacket of circulating water, designed to prevent, as far as possible, any change in the temperature of the wire by radiation from the magnetising coil; and outside this was the magnetising coil itself. Both these last pieces of apparatus were supported quite independently of the wire. The maintenance of a steady temperature was very important, as the largest magnetic effect observed in the series of experiments is about the same as would be caused by a change of ·3° C., and even with the water jacket the temperature changes are said to have been very inconvenient. For the details of the apparatus, which had been used by two previous observers, we may refer our readers to the original paper, and confine ourselves to the results obtained. The quantities observed or calculated at each stage of the magnetisation were the following:

1. The extension or contraction $\pm \frac{d\,L}{L} \times 10^7$, called E_T, when the magnetic force was applied, with B the magnetic induction, I_T the magnetisation, and H the magnetic force.

2. The same quantities with the magnetising current interrupted, viz, the residual extension, or contraction, $\pm \frac{d\,L}{L} \times 10^7$, called E_R, and I_R the residual magnetisation.

The course of taking the observations was as follows:—Starting with the wire demagnetised, a small magnetic force was applied and E_T and H noted. The magnetising current was stopped and E_R noted. A stronger current was applied in the same direction as before, and E_T and H again noted. The current was again stopped and E_R taken. This course was followed up to the highest magnetisations employed. Another series of observations was afterwards taken with increasing reversals, and a secondary coil in circuit with a ballistic galvanometer, to obtain the values of B corresponding to the values of H previously employed. I_T and I_R were calculated from the B H figures.

The numerical results are given in tables, and plotted in diagrams. The five sets of results obtained from the steel piano wire, hardened or annealed, and under different stresses, give curves of very similar character, and we reproduce one as an example. In every case the magnetisation under the magnetising current was raised to about 1,400, with a value

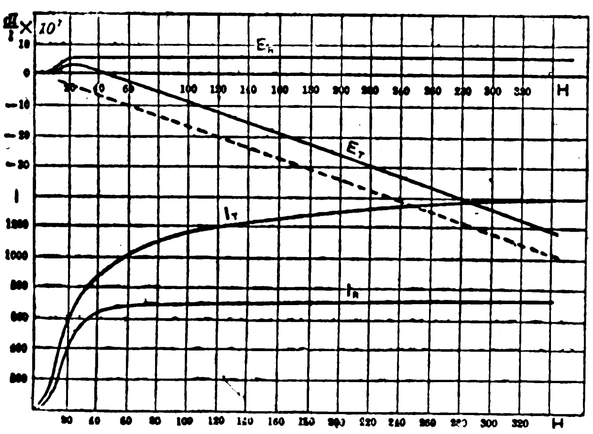


FIG. 1.—ANNEALED PIANO WIRE; TENSION 699.

of H about 340. The two curves giving the values of I_T and I_R, *i.e.*, of the intensity of magnetisation with the magnetising current, and after the current has been interrupted, are of the usual character, and call for no special comment; but those giving the values of the extension and contraction of the wire, drawn on a large scale, are of considerable interest. Comparing the curves (fig. 1) of I_T and E_T plotted to H, it is seen that no extension was observed till a considerable magnetisation was attained—E_T does not leave the zero line till $I_T = 9$. The extension soon attains a maximum when $E_T = 2·84$, and $I_T = 81$, and then diminishes, quickly changing to a contraction. The curve of E_T then follows a descending straight line which shows no sign within the range of experiment of a minor limiting value.

Comparing the curves of I_R and E_R, also plotted to H, it is seen that E_R remains zero till a certain magnetisation is attained, but begins to have an appreciable value at a lower magnetisation than E_T, the curve leaving the zero line when $I_R = 26$. The value of E_R then increases to 5·4, when $I_R = 580$, and retains the same value through the rest of the experiment, although I_R continues to increase throughout very slowly after a value of 700. The author points out that the curve of E_T appears to represent the sum of two quantities, first, the curve of E_R, and second, the dotted straight line drawn in the diagram (added by us to the author's figure), and it is suggested that the change in length is the sum of two effects: an extension due to the magnetisation, represented by the curve E_R, and a contraction directly proportional to the magnetising force, or perhaps to its excess over a certain small amount. In considering this very interesting suggestion, it should be borne in mind that the maximum contraction observed in any of these experiments on piano wire only amounted to $\frac{1}{2000000}$th part of the length. The experiments on these wires under different stresses

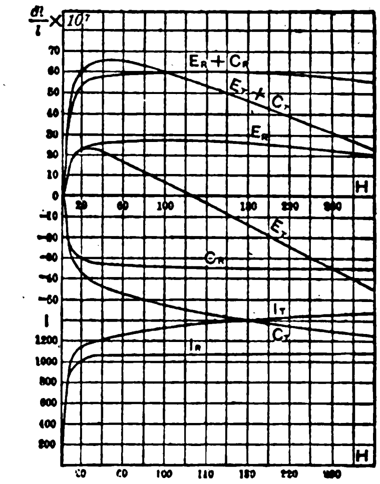


FIG. 2.—SOFT IRON; TENSION 430.

showed that an increase in the stress has no effect on the position of the dotted line, but tends to bring the curve of E_R nearer to the zero line, and the point where it first reaches its maximum nearer to the origin.

The reduction of the experiments on iron wire is more elaborate, but the results are very similar. Acting on a

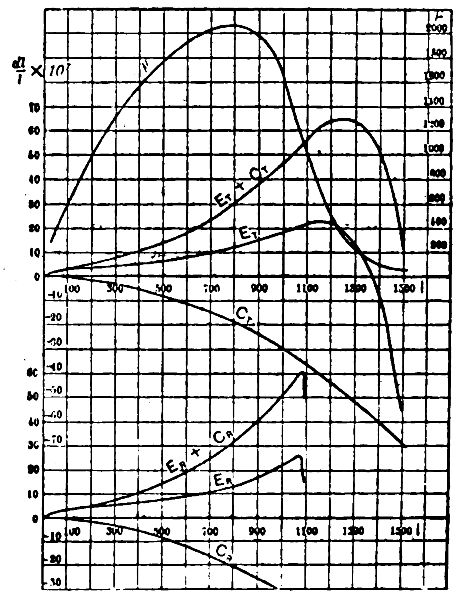


FIG. 3.—SOFT IRON; TENSION 430.

suggestion of Prof. Rowland that the induction, B, must produce a mutual attraction between the elementary magnets, and consequently a compression proportional to $\frac{B^2}{8\pi}$ (or in the case of residual magnetisation to $2\pi I^2$), divided in each case by Young's modulus. The values of these compressions, called C_T and C_R respectively, are also plotted. The curves lettered $E_T + C_T$, and $E_R + C_R$, are drawn giving what may be supposed to be the total extension due to the magnetisation, independent of the compression C_T or C_R.

Figs. 2 and 3 give the results of the investigations on iron wires under a tension of 430 kg. per cm. plotted for H and I respectively.

In fig. 3, the near equivalence of the curve E_T, to a combination of the curve E_R with a straight descending line, is well seen. The effect of increased tension in lowering the curve E_R without affecting the position of the descending line, was found to hold in iron as in piano steel.

Explanation of the Tables and the Notation used in the Tables and Plates.

H = the magnetising field.

$E_T = \frac{\text{change of length}}{\text{length}} \times 10^7$ while H is on.

$E_R = \frac{\text{change of length}}{\text{length}} \times 10^7$ after H is removed.

B = total induction or $4 \pi I + H$.

I_T = magnetisation of specimen with H on.

I_R = magnetisation of specimen with H off.

μ = magnetic permeability or $\frac{B}{H}$.

$C_T = \frac{\text{change of length}}{\text{length}} \times 10^7$ that would be caused by a mechanical pressure $= \frac{B^2}{8 \pi}$.

$C_R = \frac{\text{change of length}}{\text{length}} \times 10^7$ that would result from a mechanical pressure $\frac{(4 \pi I_R)^2}{8 \pi}$.

If these compressive forces actually exist, then the values of E_T and E_R computed from the observed changes are too small by C_T and C_R respectively, and

$$E_T + C_T = \text{the real } \frac{\text{change of length}}{\text{length}} \times 10^7 \text{ with H on.}$$

$$E_R + C_R = \text{the real } \frac{\text{change of length}}{\text{length}} 10^7 \text{ with H off.}$$

THE COST OF GENERATION AND DISTRIBUTION OF ELECTRICAL ENERGY.

The paper on the above subject, prepared by Mr. Hammond for the Institution of Electrical Engineers, and of which an abstract was read by him at the meeting on March 24th, is certainly one of the most valuable contributions of recent times, and should be specially appreciated by all those who desire to make themselves acquainted with the present position and future prospects of the supply industry on account of the great mass of statistics which has been collected and tabulated by the author.

In introducing his subject, Mr. Hammond explains how it is that the supply industry is obliged to furnish such detailed cost sheets, to prepare the annual statement of accounts in a prescribed form, and to publish and sell these statements to any applicant for not more than a shilling a copy. It certainly does seem remarkable that this obligation should have been accepted without a murmur when we know that no other trading concerns are under the same necessity, and that the majority of them would strongly object to publishing details of their costs of production; but it must not be forgotten that the conditions are somewhat special in that, with very few exceptions, there is no direct competition, and that a knowledge of the working costs of one concern can seldom be used to its detriment by a rival company anxious to engage in a war of cutting down prices. Whatever the reason may have been for the acceptance of this obligation, there is little doubt that the publication of these accounts has had a beneficial effect, and has fostered a healthy rivalry between managers and engineers of supply undertakings, each of whom has generally been anxious to go one better than his neighbour. There is a danger that this may be carried too far at the expense of the financial soundness of the undertaking, and that managers may have a tendency to charge certain items to capital account which more properly should be included in revenue account; but we believe that the Board of Trade is not by any means inclined to leave such matters entirely in the hands of the managers, and that this danger, if it exists, is therefore not an important one.

Attention is drawn to certain differences in the form of accounts prescribed for local authorities and for companies, and we quite agree with Mr. Hammond that it is desirable to procure uniformity as an aid to a useful comparison of the accounts of various undertakings. These differences are that the companies have to charge a proportion of the salaries of engineers to cost of generation and distribution, whereas the local authority charges the whole to management, and that provision is made in the companies' form for remuneration of directors and auditors and for depreciation. With regard to the salaries of engineers, it would certainly be more reasonable that the local authority should do as the company is obliged to do, and that in both cases a proportion of the salary of the managing engineer only should be charged to management; and as regards depreciation, a more uniform manner of dealing with this charge is desirable, although we do not see how this can be brought about by any change in the form of accounts.

Before dealing with what is the subject proper of the paper, viz., the cost of production, we would refer to one or or two points connected with the financial side of the matter, and to which reference is made by the author. Mr. Hammond almost apologises for going beyond the analysis of the works' costs, on the ground that it may be objected that anything else is outside the province of the engineer; but, although this is true to a certain degree, it is equally true that the extent to which electrical energy will be used does not depend only on the works' cost, but on the total cost, or rather on the price at which the unit can be sold. Although it is quite true that in any existing undertaking the engineer cannot exercise any control over the cost of management, and that he may have had nothing to do with the choice of the system and the design of the plant, so that he is in no way responsible for the amount of the annual charges on capital expended; yet, if anyone is desirous of arriving at a just comparison of two undertakings, it is impossible to leave out of consideration those sums which must be paid out or set aside annually in order that the undertaking may be worked on a sound financial basis. With the local authority there are annual charges which must be met for interest on and redemption of loans, and with companies there are dividends which, from the shareholders' point of view, it is absolutely necessary to pay; and these payments, the amount of which depends on the capital expenditure, must be paid out of revenue, and very materially affect the price at which the unit can be sold, and therefore the chance of success of the undertaking.

We all know that working costs can be kept down by the expenditure of large sums on economical engines and dynamos, on condensing plant, and on works for providing a supply of water for condensing so that water rates have not to be paid, on labour-saving appliances, and on the laying of very heavy copper mains to keep down the cost of distribution; but would it be fair to place such an undertaking in front of another whose working costs are somewhat higher, because it has been deemed advisable not to expend large sums on condensing plant, and on various appliances the use of which tend to reduce working costs, or because owing to local circumstances it has been decided to use smaller mains and transforming apparatus, without taking into account the difference in the capital expenditure of the two undertakings? Of course it may be that the expenditure in the first case is fully justified, and that the total cost of the unit, as we understand it, is lower than that in the second; but there are many cases in which this would not be so, and where the saving in capital charges would more than counterbalance the increased cost of working.

Another point which is discussed by Mr. Hammond is the amount which should be set aside for reserve or depreciation fund. Mr. Hammond agrees with the opinion held by many local authorities, that the obligation in their case to repay the loans to cover capital expenditure in about 25 years is sufficient for all purposes, and that it is not necessary to set aside anything for reserve under these conditions. We consider that those authorities are acting wisely who exercise the power given them by the Board of Trade to set aside annually a sum for depreciation until this reserve amounts to one-tenth of the aggregate capital expenditure; since, although their plant may be kept in good working order by the execution of repairs, yet it does not follow that all the plant will have a useful life of 25 years. For example, is it not probable that, before the 25 years have expired, some of the boilers may no longer be fit for use at the high pressures which are now generally employed? They may have been maintained in good condition, but it is a common thing to find that, after 10 to 12 years, the boiler insurance inspector insists on a reduction of working pressure, and in such a case, although the boiler may be perfectly serviceable for continued use at this reduced pressure, it is no longer suitable for the service required of it in the central station.

Again, it often happens that a station starts operations with generating units which are found to be too small after a few years working, and have to be taken out to make room for larger units; and it would be sounder finance to pay at any rate a proportion of the cost of this charge out of a depreciation fund, rather than to create fresh capital charges for the whole. We have, so far, spoken only of local authorities, but the same remarks apply to companies; and, indeed, these latter, in the great majority of cases, do not set aside as much as the 3 per cent., which is the average annual charge for the redemption fund of the local authority. Although it may not be advisable to handicap an undertaking in its earliest years by a heavy charge for depreciation, we think that as soon as it is possible to pay a dividend which will keep the value of the shares at par or a little over, it would be better finance to devote any surplus revenue in the first instance to building up a reserve fund, and that in considering the possible minimum gross cost of the unit when supplied by a well established company, a charge of something like 5 per cent. should be included for depreciation and reserve.

These general questions are of interest in considering an extract from our contemporary, the *Engineer*, which was quoted in the paper and commented on by Mr. Hammond. This extract, after stating that it is only under peculiar circumstances that the unit can be obtained at a less price than 5d., concludes by saying: "For about 20 years we have been told that its cost is to be reduced next year. The reduction has not come yet; and the worst of the matter is that all the large producing companies, who ought to know—and who are for the most part keenly competitive—tell us that they see no prospect of being able to reduce the price." Mr. Hammond justly takes exception to the first part of the paragraph we have quoted, and points out that both the cost of production and the selling price of the unit have been very largely reduced, since the first pioneer companies started operations less than 20 years ago. But on the question of the gross cost of production, or, rather, on the probable minimum selling price of the unit, Mr. Hammond says very little; and we think that our contemporary, as we ourselves should, would rather that Mr. Hammond should have dealt more fully with this part of the subject, and have given us his ideas of the probability of a general reduction of the price below 5d. per unit.

With a company much depends on what the directors consider a proper remuneration to their shareholders, but with a local authority, where there are no shareholders to consider, and where the charges for interest and redemption are fixed, it is possible to get some idea of the minimum selling price which would pay the works' costs and the charges for management, interest, redemption and depreciation. If we consider the balance-sheets for 1896 of five of the leading Coporations, Bradford, Brighton, Edinburgh, Glasgow and Manchester, we find that their aggregate capital expenditure at the end of the year was £965,000, and that they sold during that year 7,930,000 units, at an average price of 4·46d.; and further, that after paying the cost of production, including management, and the interest on their loans, they set aside £41,500 for depreciation and redemption fund, and still had a surplus of £29,500. The average cost per unit sold, including rent, rates, taxes, management, &c., was 1·62d., to which interest on loans added ·69d., and depreciation and redemption fund 1·26d., making a gross cost of 3·57d., which is therefore the average price at which the unit might have been sold if no surplus had been made. The amount set aside for depreciation and redemption fund varies considerably, Glasgow having set aside over 8 per cent., whilst Brighton's figure is little over 2½ per cent.; but if we allow a uniform charge of 2½ per cent. for interest, and 5 per cent. for depreciation and redemption fund taken on the capital expenditure at the end of the year, we find the gross cost per unit sold would have been 3·81d., so that we may confidently expect that, for important undertakings, local authorities will be able to supply at an average price of 4d., and that at that price the undertakings will be on a thoroughly sound financial footing, and will have a margin to spare after the payment of all charges.

(*To be continued.*)

SOME NOTES ON SINGLE-PHASE MOTORS.

By A. C. EBORALL.

(*Continued from page 356.*)

The curves given in figs. 14 and 15 are typical of the excellent single-phasers made by this firm. Fig. 14 gives the efficiency, power factor, and speed regulation of a 110-

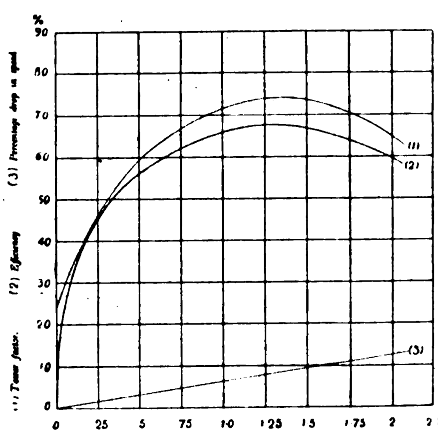


Fig. 14.

volt, 40 ~, 1½ H.P. motor fitted with simple short-circuited bar armature. It will be seen that the power factor and efficiency are both high over a considerable range, and the speed regulation is also very good, especially when the small size of the motor is taken into account.

Fig. 15 shows the same thing for a six-pole motor designed to give out 3 H.P. at 100 volts and 100 ~. It had a wound

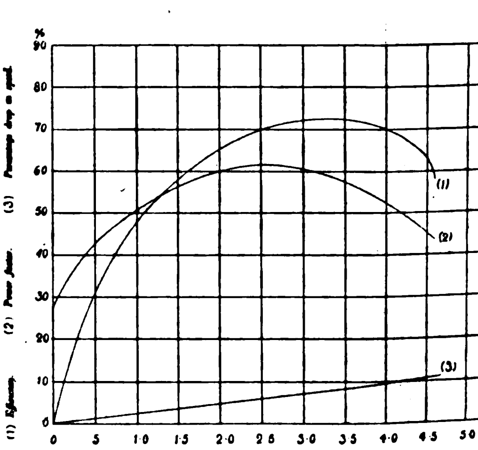


Fig. 15.

rotor arranged for a starting resistance. The efficiency is very high, but the power factor not quite so good as in the last case, owing to the greater number of poles. The starting torque was equal to the full load torque when the starting current was allowed to be about twice the full load current.

Fig. 16 concludes this account of the Brown single-phasers. It is a 70 H.P. motor, working on the Frankfort 45 ~ 2,800-volt lighting mains, and runs at 540 revolutions per minute. The starting arrangements have already been shown in fig. 12B.

(*B*) *The Oerlikon Company.*—This is another company who were early in the field with single-phasers. Their constructions do not call for special notice, as they are very similar to those of the last firm. Their starting device is, however, somewhat different, owing to the fact that a choking coil is used instead of a condenser. The motor being wound with two windings, a choking coil is put in series with the one of greater self-induction, which is generally the starting winding with many turns, and a non-inductive resistance in series with the working winding. The two are put in parallel across the mains, when the difference of phase produced is large enough to start the motor up on a loose pulley. Sometimes the non-inductive resistance is left out—and a rotor resistance is always used for the larger units. This starting device requires more current than the previous ones described, and, generally speaking, is not so effective.

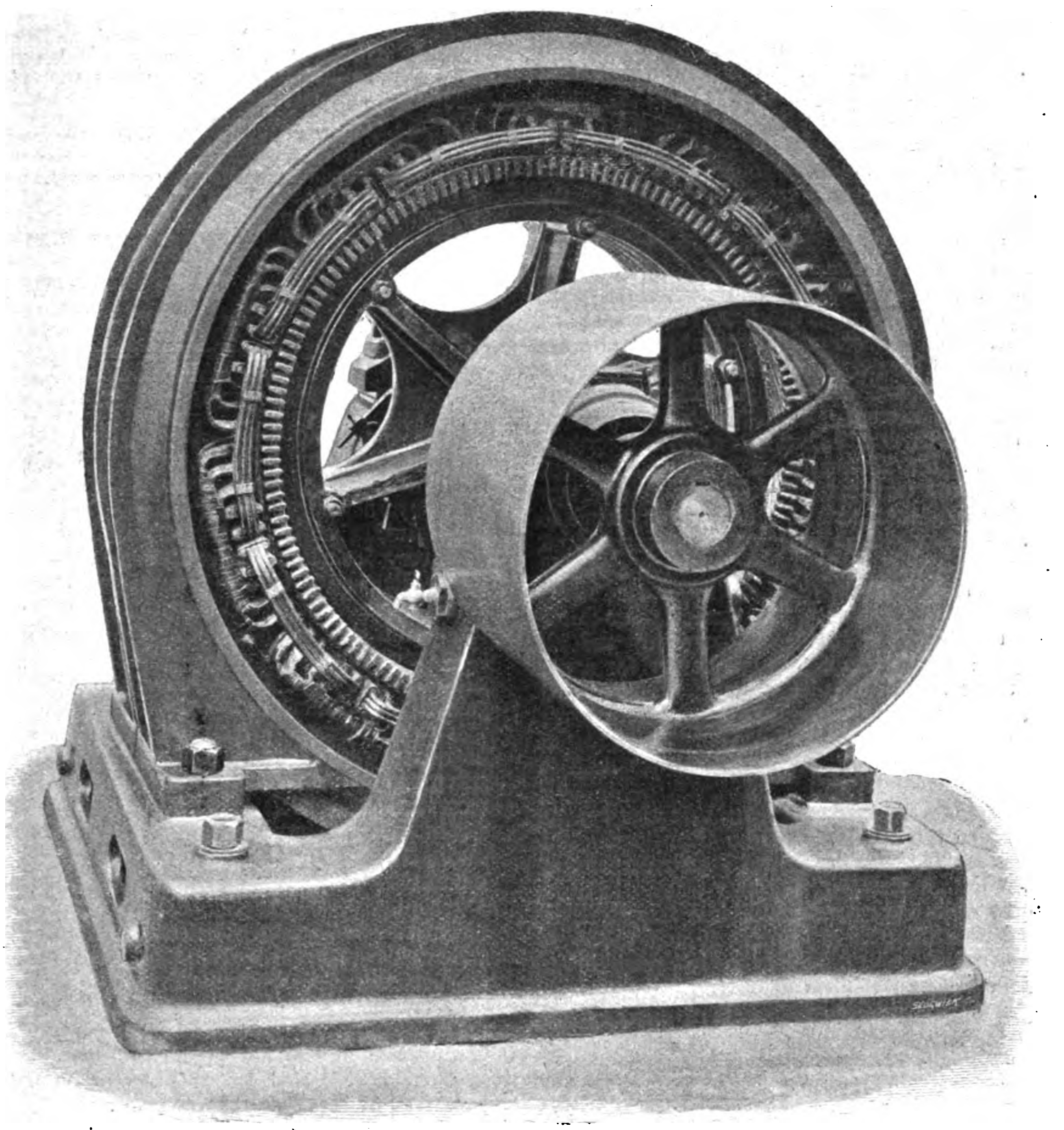


Fig 16.

(*C*) *Messrs. Kolben & Co.*—This firm is the latest making a speciality of alternate current plant, and especially of induction motors. Their single-phase motors show in their design that attention to detail which would be expected from Mr. Kolben's large experience with this class of work. The accompanying table gives some interesting information in regard to the low tension motors for 50 ~ circuits made by his firm.

Table II.

Horse-power ...	·2	·75	2	3·5	6	10	15	20
Full load efficiency (per cent.) ...	55	64	68	72	76	80	82	83
Half " " " ...	42	53	56	60	65	69	72	73
Full load watt consumption ...	270	860	2,160	3,600	5,800	9,200	13,500	17,800
Half " " " ...	170	520	1,300	2,150	3,400	5,700	7,700	10,900
Full load power factor (per cent.) ...	65	68	72	73	75	80	80	82
Half " " " ...	48	51	55	56	60	62	62	64
Amperes at starting } At 110 volts. ...	7·5	18	38	50	65	90	120	145
" " full load } At 110 volts. ...	3·8	11	27	45	70	105	154	200
Revolutions per minute running light ...	1,500	1,500	1,500	1,500	1,500	1,500	1,000	1,000
" " fully loaded ...	1,350	1,390	1,400	1,430	1,430	1,430	965	965

(*To be continued.*)

CORRESPONDENCE.

The Burning Question.

The interesting communication of your correspondent, A. J. Liversedge, again prompts me to trouble you with a few lines upon the above subject, and to join with him in expressing personally my thanks for the opportunity you have given for full and free discussion in your valuable paper, the ELECTRICAL REVIEW, and it is at the present moment that we are particularly grateful, for although much has been "utterly erroneous," the time is evidently rapidly approaching when "Eureka" will be your proud motto blazing forth above the portal of your office in all the beauty given by 10,000 incandescent lamps, the outcome of the now all-powerful compound "pressed sludge and house refuse." That I am right in this conclusion I feel quite sure. Mr. Liversedge virtually says that "Now we shan't be long," and I will not attempt for one moment to go behind the happy conclusions at which he has arrived; at the same time it would be more satisfactory when figures are quoted as to the cost of burning, that it should be clearly stated whether or no the capital charge, principal and interest has been taken into account. There are so many items to be fairly dealt with, that I need not make any apology for the suggestion. Mr. Liversedge's reference to a previous correspondent whose "imagination" went somewhat astray with respect to what takes place at Ealing is very much to the point. I did not reply to the said previous correspondent, time I felt was "too precious." I may, however, now add to previous information that one-third of the house refuse is used in the drainage of the sludge, the remaining two-thirds is tipped on the destructor in the ordinary way and all burned together; the drainage goes on usually for seven days. One thing is certain, that although I have tried again and again the burning of *pressed* sludge, I have never succeeded in obtaining as a result a good hard and useful clinker such as I obtain from the compound produced at Ealing.

Mr. Liversedge has referred to a communication I made some years ago to the old Metropolitan Board upon this question, and in looking over my papers I turned up one of my lectures 1890 which deals with this very point. In eight years necessarily there have been change and improvement, but the general remarks will apply almost as well to-day as when they were written, and as it may interest some of our readers, the following extract gives the principal points:—

I have spoken and written upon this subject of house refuse and sludge burning for some years past, and I called the attention of the Metropolitan Board to the matter, but without effect. Although they did carry out some experiments, they were carried out in such a way that it was impossible for them to succeed, so little did their officials know about it. At the discussion at the Institute of Civil Engineers upon Mr. Dibden's paper upon "Sewage Sludge," Mr. Dibden said: "Mr. Jones did not contend that he could burn the unpressed sludge, but only the pressed, and based upon that an enormous annual outlay for the purpose of pressing. But the real fact of it is, gentlemen, I have never pressed a ton of sludge since my destructor has been in work, but it is mixed with house refuse, goes into the furnace in almost a semi-liquid state, and is delivered as a hard and valuable clinker. Mr. Dibden stated that before the pressed sludge can be burned the water must come out by heat, but he concluded with these significant words, that if dust-bin refuse of a town is available, doubtless the object can be attained by the use of destructors." In these few words I maintain that you have the solution to the difficulty. Why should not the Metropolitan Board of Works have had the refuse of the dust-bin? The various authorities along the banks of the Thames would have been only too glad to have had a depôt, and barge it down to the northern or southern outfall. We all know the trouble that for years and years has gathered round this question, when a remedy so readily might have been found. I have been told that the quantities are so large, and the amount of sewage is so great; but it seems strange in these days of the Forth Bridge to hear words of this class. The whole treatment of the London sewage at two outfalls would be a mere bagatelle, if those with whom the matter rests would face the difficulty. I have stated that in England at the present time there are some 200 cells at work employing less than 100 men, and dealing with something like 500,000 tons of refuse. How much room do you think these 200 cells would take, supposing they had been built at Barking, where, I believe, there are some 70 acres of land available? You will be surprised to hear that they can be put upon an acre of land, with plenty of room to work between them, and that the cost of erecting them would not amount to more than £300 or £350 per cell. Supposing the 200 cells had been built, and the question tried, there would have been, according to the data which we have, and which there is no disputing as it is in daily work, 1,000 H.P. at hand, or in other words, the coal bill would have been saved. No nuisance would have been created by the adoption of the process, which after all that has been said with respect to other systems, has held its ground, and will do so still. I refer to the milk of lime process, which will ultimately come about. I know that it may be replied that the effluent that is turned out by this process is not pure. No one in the present day would say that it was, but the question is, is it not pure enough to be discharged into the Thames at Barking and Crossness? I have been sending, to the satisfaction of the Thames Conservators, from 750,000 to 1,000,000 gallons of effluent per day for many years into the Thames, and many visitors have made the remark, and not a few of them members of the Metropolitan Board of Works, why cannot we do the same, and I say unhesitatingly, that under the lime process and the destruction of refuse, as suggested by me, the river would assume a character in every way satisfactory, and at a mere bagatelle of cost when compared with the expensive schemes already referred to. Other points might be raised in connection with this effluent water, for instance, that of aeration. And here I may add that sufficient steam would be produced from the refuse, over and above the quantity required for ordinary pumping purposes, which might be brought to bear upon the effluent in aeration, and which, to my knowledge, can be productive of immensely beneficial results.

Charles Jones, M.Inst.C.E.

Ealing, *March*, 1898.

Electric Power Supply from Central Stations.

I am obliged by the length at which you have reviewed my little paper on "Electric Power Supply from Central Stations." The paper was read at short notice before a body of men who are not specialists in electricity; it was also desired that it should not take more than an hour in delivery including the exhibition of some 30 lantern slides. Further, it is to be remembered that the proposals of the Midland Electric Corporation are still *sub judice*, and that until it is settled over what areas they will have powers it is very difficult to speak exactly from an engineering point of view. For all these reasons then the paper was qualitative in character and tone, rather than quantitative.

As regards your suggestion that more actual figures as to the capital cost of water power installations should have been given, it would have been beside the purpose of the paper to have treated this part of the subject in greater detail. In the discussion, however, which followed, the president, Mr. J. W. Hall, gave some actual figures entirely confirmatory of my general conclusions, of which I enclose a copy.

Coming now to your criticism that in estimating the relative cost of coal and stoking for a plant running continuously, as compared with a plant working 54 hours per week, I had not made sufficient allowance for "Power Factor."

Allow me on this point to refer to a paper on the "Electric Transmission of Power," read on December 8th, 1894, before the North of England Institute of Mining and Mechanical Engineers, by Mr. Alexander Siemens.

On page 5 the paper reads as follows:—

"As far as they go these comparisons prove that the electric transmission has been economical, but in order to obtain satisfactory information as to the performance of the plant, a series of tests were conducted by the experimental department under the direction of Dr. Eugene Obach, as follows:—

"The boiler tests and the engine tests were carried out separately in two series. The first series was intended to determine the weight of steam generated per pound of fuel, and this test extended over a month of ordinary working, and included all necessary coal for lighting up. The second test series was intended to determine the weight of steam required by the engines, per Board of Trade unit delivered to the distributing bars of the central station switchboard. This was found by exhausting the engine under test into the main condenser, and measuring the overflow from the air pump, taking care that no other could mix with overflow.

"These engine tests were subdivided again into two kinds: —(1) Running on steady artificial loads of about one-quarter, one-half, three-quarters and full load, and (2) running on the ordinary day load.

"*The second set of tests was undertaken to see if a varying day load required the same weight of steam per Board of Trade unit as a perfectly steady artificial load giving the same output. This was found to be the case, the point obtained by the day load test fell exactly on the curve obtained on the steady load tests.*" (Fig. 6, Plate 15.)

In a central station with a number of engines, those working would always be near their economical load, and boilers give a high efficiency when worked at low rates of evaporation.

In the case of the Midland Electric Corporation there is every reason to anticipate that with good management a better load factor than 54 hours per week will be secured, even without the use of accumulators.

I now come to your remarks on the rates it is proposed to charge for power by the Midland Electric Corporation.

As a matter of fact there is nothing in my paper as to the rates at which the Midland Electric Corporation actually propose to supply power. What I did say is as follows:—"In their agreements with the local authorities, who have so far come to terms with the Midland Electric Corporation, the following are the rates for power supply, which are not to be exceeded: 3d. per unit for first hour's use per diem, taken on the maximum demand in any quarter, the number of first hours being taken as 78, *i.e.*, 6 days per week for 13 weeks, ·825 of a penny for each subsequent hour's use."

I did not say that these are the terms on which the Midland Electric Corporation have determined to supply, *but these are the terms which they have agreed not to exceed.*

In electric lighting orders it has been usual to specify that the maximum charge for supply shall not exceed 8d. per unit. It does not necessarily follow from this that the company or authority will charge the full maximum even to start with, nor that they will charge large and good customers the same rate as the small ones.

The actual rates for power supply I must leave to the future, all I will remark is, that there is no reason to doubt that as time goes on, power supply undertakers will be able to make as great a reduction in their initial maximum rates as electric light undertakers have been able to make on the maximum rates of electric supply for lighting during the last 10 years.

Further, coming to your comparison of the cost of power generated by an isolated plant with the rates per annum the Midland Electric Corporation would charge under similar conditions, I am pleased to see that you acknowledge that even on the assumptions you make, for any power up to 50 kws., it would be advantageous to take supply from the Midland Electric Corporation, the user securing all the advantages of electric working into the bargain.

A 50-kw. plant needs an engine of at least 80 I.H.P to drive it, and as there is usually some saving in power in employing electricity, you appear to agree that there would be advantages in replacing every engine in the district working under the conditions you mention as ordinary ones, up to 100 I.H.P., the advantages increasing very rapidly as the sizes got smaller.

Now 100 I.H.P. is a considerable size for the engine of ordinary engineering and manufacturing works, excluding rolling mills, textile factories, and some other industries; such an engine implies a factory employing approximately 150 to 200 men under present conditions.

But your comparison even on this basis does not include anything for spare boilers or plant, either mechanical or electrical, in the case of the isolated plant—a most important consideration to a manufacturer; while by taking power from the central station he would have nearly the security of duplicate plant. Lastly, you assume that the maximum load to be met with will be double the average load, which, as a general statement, is no doubt accurate. The deduction which you make from this, however, that it is proposed to take full advantage of this fact in supplying current from the central station on the demand meter system, is not correct.

It is one of the great advantages of centralisation that the wider the range of supply the less are sudden local increments of power felt, and it has always been the desire and policy of the directors of the Midland Electric Corporation to give manufacturers, as far as reasonably could be done, the benefit of this.

While, consequently, they have decided to supply electric power on the demand meter system, it is not their intention to do so with the aid of recording wattmeters or ammeters. What they do propose is to use something of the character of Mr. Wright's instrument, which takes some time to reach a maximum reading.

In this way the maximum demand will not bear an undue proportion to the average, so that the average cost of power to manufacturers will be less than you assume, even taking the full rates which the Midland Electric Corporation have undertaken not to exceed.

Although it is not alluded to in the paper, the Midland Electric Corporation proposals also include the provision of electric lighting over a large district at cheaper rates than the authorities could do it for themselves, even if they cared to embark in the necessary capital expenditure.

While, therefore, your conclusions are generally favourable to the Midland Electric Corporation's enterprise, I think you will agree, after this explanation, that their proposals, if the local authorities allow them to be carried out, will be considerably more advantageous than your leading article indicates.

Remember, also, that this is what prudent men, after carefully weighing the circumstances, feel that they can do to start with, and it is always the beginning that is the difficulty.

I am sorry to have written you at such length, but in justice to the directors who have spent much time on the undertaking, and especially the chairman, Mr. J. F. Albright, it is important that there should be as little misunderstanding of their proposals as is compatible with the inauguration of a new enterprise, and one which to a considerable extent breaks fresh ground.

G. L. Addenbrooke.

The Association of Electricity with Atmospheric Phenomena.

Your correspondent, "Delta," will perhaps be interested to hear that early on Tuesday, the 15th inst., a similar phenomena to that of the Aurora Borealis was seen from Blackpool and Thirsk and at other northern towns; and about the same time and day a *water-spout* was seen from the coast of the Isle of Man. This is a remarkable coincidence, and points to an electrical association. Perhaps some of your readers could say whether there were any striking barometrical changes on the date named in the places mentioned.

Magnet.

LEGAL.

Leicester Corporation *v.* Warren Hill.

Important Judgment.

At the Leicester County Court on Friday, his Honour Judge Wightman Wood delivered judgment in the case of the Leicester Corporation *v.* Warren Hill, electrician, King Street, Leicester.

His Honour said the case, which was heard last month, was one of unusual importance to come before a court of limited jurisdiction. The action was in respect to the price of lamps and other fittings used in connection with electric lighting, sold and delivered to the defendant, who, whilst admitting the purchase, said that it was *ultra vires* of the Corporation to trade in such articles, and that they could not maintain an action for the price. He (the Judge) further understood that the claim was resisted in order to test the right of the Corporation to deal in such things. Under the Electric Lighting Act of 1882, the Corporation were licensed by the Board of Trade to supply electricity for public and private purposes, and besides laying wires, erecting the necessary machinery, and supplying the electric energy to such householders as liked to have it, they had also opened an emporium—he supposed they did not term it a shop—for the sale of lamps and such other fittings as were required in houses by persons who made use of the electric light. No attempt was made to confine the sale to householders who took the electricity, nor was the defendant such a person. He was an engineer with a similar business of his own, and the articles which he purchased from the Corporation he added to his stock. All the facts were admitted, and the matter in dispute was entirely a question of law. A corporate body could only do such things as it was authorised to do by charter, Act of Parliament, or means of association which brought it into being, or supplementary Acts or charters, including all such things as were necessarily incidental to the expressly authorised objects. All other things it was prohibited from doing. The plaintiffs' charter was not produced, and it was conceded by their advocate that no right to trade could be deducted therefrom, and he relied entirely on recent electric lighting legislation. Having reviewed the various sections of the Acts of 1882, 1888, and 1890, his Honour said he could see nothing by reasonable implication to authorise the Corporation to supply any material fittings except meters. The Corporation advocate, however, had placed great reliance on a form of account sent down by the Board of Trade, and it certainly appeared from that form that the person who drew it up contemplated that the Corporation would buy and sell lamps and other apparatus, and it might be that the Corporation had taken their cue from it, and had taken to trading in lamps on the strength of its wording. He was, however, of opinion that a mere indication by a Government department that in its judgment a thing may be properly done, could not have the effect of authorising that which would otherwise be contrary to law. Section 9 gave the Board of Trade no authority to authorise anything at all, but merely to prescribe the form in which the Corporation were to present their accounts "of the undertaking" authorised by the Act—that was, the duty of supplying electric energy. *He was therefore of the opinion that the contention of the defendant that the Corporation had acted beyond their legal powers in selling the articles in question was correct.* Defendant, however, having taken and kept the goods under an implied promise to pay, the question arose, "Could he now set up as a defence to an action for the price that it was *ultra vires* of the Corporation to sell?" In his (the Judge's) opinion he could not, for the defendant having had the goods, could not be allowed to refuse to pay for them on the ground that the Corporation went beyond their legal right in selling them, and could not have been held to their contract to deliver them had they refused to do so. The defendant had got what he bargained for and he must pay the price, notwithstanding the flaw which he had rightly called attention to in the capacity of the Corporation to carry on their business. As he was against the plaintiffs on the point on which they relied, and which the parties came there to contest, he would give no costs, and judgment would therefore be entered for the plaintiffs for £4 19s. without costs, with leave to appeal.

VAUGHAN & BROWN *v.* TERRY.

AT the Clerkenwell County Court on Friday last, plaintiffs, electrical engineers, of Kirby Street, Hatton Garden, sued Mr. Edward Terry for £9 14s. 8d. for work done in connection with Terry's Theatre. For plaintiffs it was stated that the order had been given by Mr. Brickwell, Mr. Terry's business manager, and Mr. Brickwell gave evidence that he had acted in that capacity in giving the order to plaintiffs. Mr. Terry gave evidence that Mr. Brickwell was, at the time this contract was given, temporarily acting for Mr. Carr at 15 guineas a week. He never authorised Mr. Brickwell to carry out the work claimed for. The deputy-judge (Mr. Horton Smith) found for the defendant, with costs.

BUCK & HICKMAN *v.* BINKO & CO.

THE plaintiffs in this action, a firm of tool manufacturers, sued Mr. Henry Binko, electrical engineer, of 34, Leadenhall Street, at the Lord Mayor's Court, before the Recorder, to recover the sum of £16 2s. 4d. in respect of goods sold and delivered. The defendants pleaded that the whole amount was tendered before the action was brought, and the sole question was as to whether there had been a proper tender. Mr. Henry Binko stated that in January last he received an application from Messrs. McKenna & Co. for an amount of £16 2s 4d. due to plaintiffs. There was a dispute at the time between him and plaintiffs over a sum of 4s. 5d. Witness drew a cheque for £15 17s. 11d., and subsequently, after his attention had been called to two credit notes for the 4s. 5d, he added another 4s. 5d. That amount was taken on to plaintiffs, but was refused on the ground that the matter was out of their hands. The plaintiffs contended that the amount tendered to them was £15 odd, and as that was not the full amount, they refused to accept it. Eventually the jury found for the plaintiffs for the amount claimed.

WILSON *v.* ELLIS.

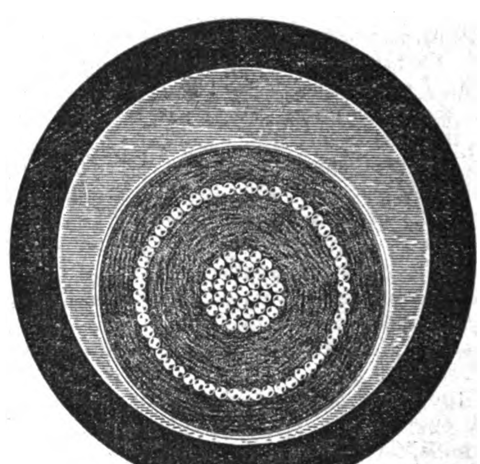
THIS was a claim by a traveller for £28 odd for commission for orders for electrical work obtained for the defendant, who has an office in the district of the Westminster County Court, and a branch at Croydon. Plaintiff, it seemed, obtained an order from the builders who were reconstructing the "Old George," Croydon, to do the wiring, and for that he was entitled, with other jobs, to £11 commission. Subsequently, through his introduction, defendant obtained the order for fittings. Defendant's case was that the order for the fittings came through another servant of their's and that plaintiff knew nothing of the order for fittings until after it had been obtained. They had paid the other amounts into Court, but this £18 they did not think he was entitled to. His Honour, in giving judgment for the plaintiff, said the introduction came through him, and but for that defendant would not have obtained any order at all.

BUSINESS NOTICES, &c

American Competition in Europe.—Mr. F. H. Mason, United States Consul-General at Frankfort, has, says the *Times*, given some interesting information on the subject of American competition in Europe in his annual report to his Government. He states that 1897 will be remembered as an epoch in the industrial and commercial relations between the leading European countries and the United States. The remarkable fact of the year has been the enforced recognition of the truth that in several important lines of manufacture—notably that of iron and steel—the sceptre of economical production, combined with the payment of the highest wages to labour, has passed from the old world to the new. It has been demonstrated that, under intelligent, progressive management, highly paid labour, especially when employed to use complicated machinery, is, after all, the cheapest, and that in the race for supremacy the people of the old world have been in many cases left behind by those who, more than any other, have reduced economy of labour to an exact science. It is now seen that it is something besides the tariff that has made the cost of producing Bessemer pig iron from 10s. to 15s. per ton less in the United States than Great Britain, has enabled the steel-makers of Pennsylvania to underbid those of England for the rails and other supplies of the London underground railway, and to place an order for 8,000 tons of steel rails with the Indian Government. Neither has fiscal legislation enabled the machinists of Philadelphia, Pittsburg, and Chicago to sell locomotives, mining and electrical machinery, tramway outfits, bridges, and architectural iron in competition with British, German, and Belgian agents in South America, Australia, and the Cape of Good Hope. The leading makers of electrical machinery in the United States have set a standard of cheapness, prompt delivery, efficiency, and economy of service, especially in electrical railway plant, with which their European rivals find it difficult to compete.

Birmingham Electrical Exhibition.—The installation for lighting the buildings of this exhibition at Bingley Hall was put down by the Walsall Electrical Company. Messrs. Henry Sassons and Co. have an effective display of fittings, and there are exhibits by a large number of electrical firms. There are to be wireless telegraphy, and X ray demonstrations.

Brook's Semi-solid System of Insulation.—Messrs. Johnson & Phillips have issued a pamphlet on the above system. We understand they have had experience of these cables for the past eight years, and are convinced that they are an advance in the right direction as regards the transmission of electrical energy. No faults have occurred on the lines laid; but, on the other hand, the insulation measured in megohms, and, what is of more importance, the insulation as regards dielectric stress, is in all cases higher to-day than when originally laid. We illustrate a full size section of the ·15 square inch high tension concentric cable supplied for the Corporation of Worcester, which has relied for some years on two Brook's mains for connecting the city with the generating station some three miles in the country. The pamphlet before us describes



the Brook's system in detail, together with the method of laying and jointing. In this system the copper conductors are closely and thickly covered with two helical bindings of strong fibrous material impregnated with a highly insulating compound. The cables are drawn into thick iron tubes, which are afterwards filled with a highly insulating semi-solid dielectric and hermetically sealed. The cables are thus completely protected from all deteriorating influences. It is claimed that with the use of this type of underground cable there is a great factor of safety against faults, an absence of material exposed to any action likely to deteriorate it, and by its use one has an insulation as reliable and permanent as is possible.

Catalogue.—Messrs. Binko, Ridsdale & Co., Limited, of Leadenhall Street, and Minories, have issued a 290-page catalogue, bound in red cloth covers, in which they describe, illustrate, and give prices of the great variety of electrical apparatus and accessories, in which they trade. Department I. covers electric signals, electric telegraphs, telephones, electric bells, fire alarms, lightning conductors, and medical appliances. Section II. is devoted mainly to electric lighting, and describes accumulators and fittings for ships and domestic use, dynamos, and motors, &c. The book will be of service to the firm's customers, and the electrical trade generally.

Crompton & Co., Limited.—The petition presented to the Courts for confirming a special resolution reducing the capital of this company from £280,000 to £162,000, will be heard by Mr. Justice Wright in the Chancery Division, on April 6th. Anyone desiring to oppose the proposal should then appear.

Dissolution of Partnership.—Messrs. A. Harrison and E. C. Pringle (trading as Harrison, Coles & Co., electrical engineers, Hermitage Works, Richmond, and Kensington) have dissolved partnership.

Electrical Wares Exported.

Week Ending March 29th, 1897	£	s.
Albany	800	0
Amsterdam	809	0
Antwerp	56	0
Auckland	35	0
Bilbao	10	0
Bombay...	125	0
Calcutta	176	0
„ Teleg. mat. ...	36	0
Colombo	85	0
Copenhagen. Teleg. cable	364	0
Delagoa Bay	107	0
Durban	340	0
East London	7	0
„ Teleg mat.	1,890	0
Flushing	110	0
Hamburg. Teleg. mat ..	505	0
Hong Kong	17	0
Madras	171	0
Melbourne. Teleg. mat.	683	0
Ostend	24	0
Otago	27	0
Passages	135	0
Perth	438	0
Port Elizabeth	225	0
Rouen	32	0
Santos	25	0
St. Petersburg. Teleg. mat.	268	0
Shanghai	157	0
„ Teleg. mat.	35	0
Singapore	43	0
„ Teleg. mat.	234	0
Stockholm	70	0
Sydney	648	0
Trinidad	10	0
Wellington	52	0
Yokohama	60	0
Total ...	£8,800	0

Week Ending March 29th, 1898.	£	s
Alexandria. Teleg. mat.	426	0
Amsterdam	200	0
Bangkok	467	0
Bilbao	88	0
„ Teleg. mat. ...	790	0
Boca	77	0
Buenos Ayres	285	0
„ Teleg. mat.	100	0
Calcutta...	196	0
Cape Town	1,487	0
Colombo	848	0
Durban	1,707	0
„ Teleg. mat. ...	1,097	0
East London	513	0
Flushing	8	0
Gibraltar. Elec. cable	700	0
Gothenburg	133	0
Hamburg	10	0
Hong Kong	14	0
Launceston	14	0
Madras	218	0
Malta	54	0
Natal	78	0
„ Teleg. mat. ...	1,945	0
Passages	107	0
Perth	200	0
Port Elizabeth... ...	31	0
Port Said	13	0
Rangoon	345	0
Rio Janeiro	20	0
Rosario. Teleg. mat. ...	60	0
Santos	26	0
Seville	100	0
Shanghai	271	0
„ Teleg. mat.	350	0
Singapore. Teleph. mat.	45	0
Spezzia	650	0
St. John's, N.B. ...	10	0
Stockholm. Teleg. mat.	122	0
Sydney	441	0
Tientsin...	35	0
Wellington	85	0
Yokohama	585	0
Total ...	£14,881	0

Foreign Goods Transhipped.

	£	s.
Monte Video. Teleph. mat.	9	0
Sydney. Teleph. mat.	74	0
Total ...	£83	0

Electrical Installation at the Thames Ironworks.—The Institution of Junior Engineers will to-morrow (Saturday) morning pay a visit to the Thames Ironworks and Shipbuilding Company's works at Blackwall. The following notes on the electrical engineering department are of interest. The central generating station has been established in the works near the shipyard gate. The installation consists of three locomotive and two "Gunboat" boilers —the latter of the company's manufacture—aggregating 600 I.H.P.; engines and dynamos aggregating 360 I.H.P., three of them built by the company. Distribution of current is effected by three-wire system, the main cables to distributing centres being of vulcanised India-rubber insulation, laid in cast-iron pipes underground. The electric current generated is chiefly used for lighting purposes, but several examples exist in the works of the use of electromotors, and the use of electricity for power purposes is in course of extension. Electric drilling machines are a speciality. Several types of these machines are found on H.M.S. *Albion*, in shops of the shipbuilding department, and in various parts of the yard. Others are under construction in the upper machine shop of the engineering department. Dynamo and motor construction is carried on as a branch of the engineering department (upper shop). Electro-galvanising of boiler tubes, plates, &c., is seen near ss. *Diogenes* and alongside boatbuilding sheds. Current for plating is obtained by transformation from the electric lighting mains.

Elmore Director's Fees.—At the Leeds Assizes on Saturday last, Mr. Justice Ridley gave judgment for the plaintiff in the case in which Mr. J. North, solicitor, of Leeds, sued the Elmore's Patent Copper Depositing Company, of London and Leeds, for £600, as director's fees. For the defence it was argued that directors' fees had been held to be a gratuity and could not be sued for. His Lordship, however, ruled against this point.

Fires.—On Saturday last a fire occurred on the premises of Messrs. Downie & Adams, electrical engineers, Newman Street, Oxford Street, W. The fire originated in the showroom of Messrs. Wenham & Waters, and Messrs. Downie & Adams ask us to state that their business has not been in any way interfered with by the occurrence.

On Saturday last a fire occurred on the premises of Messrs. C. and G. A. Parson, electricians, George Street, Bath, and did considerable damage.

On Thursday night last week, a fire occurred on the premises of Messrs. Hamer & Co., electricians, in Herton Street, Halifax. The building is a three-storeyed block.

Electric Light Fittings.—Messrs. H. M. Salmony & Co., of Charing Cross Road, have brought out a new catalogue. The copy before us is an *edition de luxe* of about 400 pages, including section P.A., describing electric light plant and accessories; section F.G. dealing with electric light fittings and glassware; and section H.C.

Fig. 1.

particularising electric heating and cooking apparatus. We can only afford space for brief mention of the great variety of machinery and apparatus which is well illustrated and clearly printed in this volume. Section P.A. deals with dynamos, motors, combined plants (gas, oil

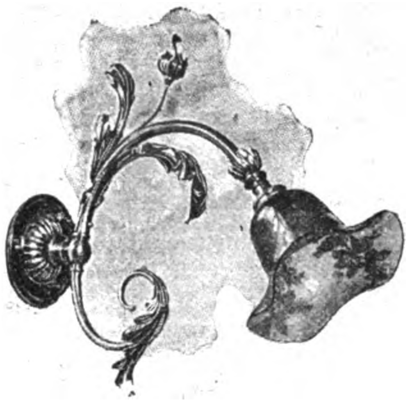


Fig. 2.

and steam), turbines, accumulators, arc lamps, switches, cut-outs, measuring instruments, &c. The electric light fittings section embodies a really excellent selection of artistic fittings, such as brackets, standards, electroliers, ceiling fittings, &c. For neatness of

Fig. 3.

design and general arrangement they compare very favourably with anything of the kind that we have seen. We select a few of the specimens for illustration. Fig. 1 shows a three-light pendant in brown or grey bronze, with spray for the lamps. In fig. 2 is shown a bracket made in either polished brass, dead gold or wrought iron. A high-class ceiling fitting with hand-wrought leaf work is shown in fig. 3, with three lights. This is made in polished brass or copper. Fig. 4 shows a six-light electrolier, made either in polished brass or dead gold, with cast brass leafwork and ornaments, and cutglass

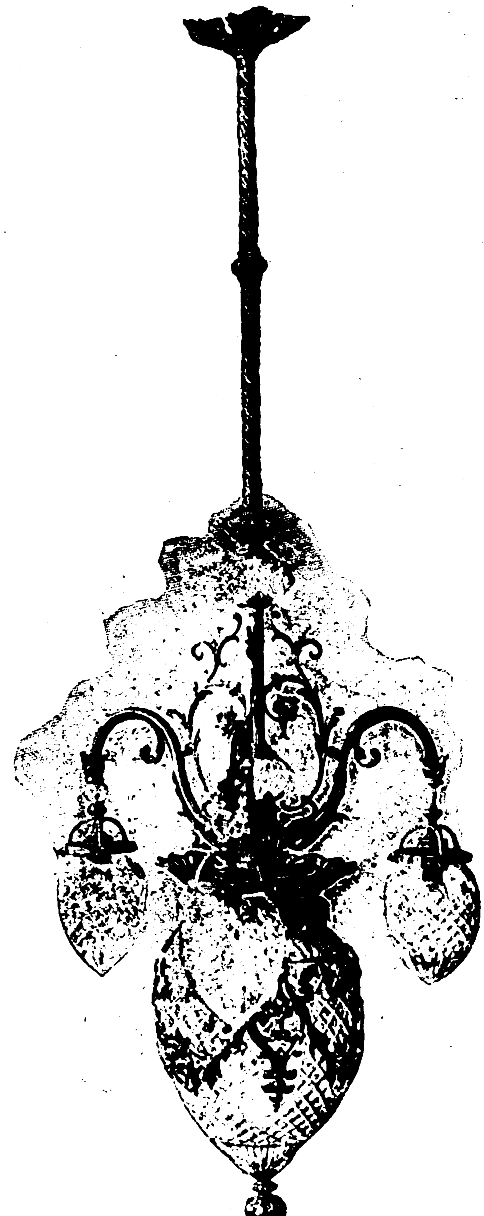


Fig. 4.

shades. These are only a few specimens selected off hand from the catalogue, but at the very complete showrooms in Charing Cross Road a great variety of excellent fittings can be seen to greater advantage than in illustrations. To facilitate the visits of contractor's customers to the showrooms a sheet of perforated introduction cards is given with each catalogue.

Holophane, Limited, v. the Stewart Electrical Syndicate.—In the Chancery Division on Friday last, before Mr. Justice North, Mr. Eady, Q.C., mentioned a motion in this case for an injunction to restrain the infringement of patents and passing off. Counsel stated that the motion was adjourned from last week, and since then an arrangement had been arrived at whereby the defendants had agreed not to dispute validity, and to submit to a perpetual injunction with inquiry as to damages and costs.

Lists.—Mr. J. D. Sutcliffe (of Sutcliffe, Statham and Co., Fennell Street, Manchester), sends us a copy of a paper read by him before the Manchester Society of Architects, on "Combined Warming and Ventilation of Public Buildings."

Mr. A. W. Roy, of Heaton, Newcastle-on-Tyne, has issued a March, 1898, list of his small dynamos and motors, and materials for same.

Receiving Order.—Messrs. James Fletcher and J. A. Hirst (trading as Fletcher, Hirst & Co., electrical and mechanical engineers, Bankfield Works, Curzon Street, Burnley, and lately at Chester and Derby) filed a petition for receiving order in bankruptcy on March 24th.

To Creditors.—Creditors of Bennett & Druce, lately trading as electrical engineers, at 30, Winckley Square, Preston, Lancashire, who have not already sent in their claims to Mr. J. Todd, receiver and manager, must do so by April 8th, after which date distribution of assets will be proceeded with.

Micrometers.—We have received from Mr. Robert Mühle, of Glashütte, i/S Germany, particulars of three forms of micrometer which he is manufacturing for the use of electrical engineers. For these is claimed the extreme accuracy rendered necessary by the delicate distinctions of diameter and thickness brought into use in modern electrical practice. Fig. 1 shows (half natural size) the

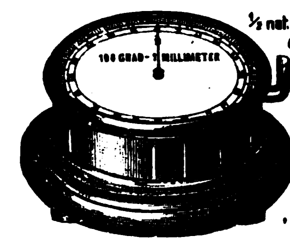


Fig. 1.

standard form of micrometer measuring by $\frac{1}{100}$th mm. This is made either in brass or nickel, the jaws project and are opened by means of a lever to admit the subject for measurement. An arrangement of spring, levers and gear actuates the pointer and shows the actual measurement on an easily read scale. The knife edges of the jaws are finely polished and are made with jewelled points if required, for measuring incandescent lamp filaments, screws, plates, wire, &c. These instruments are also made to read in $\frac{1}{200}$th, $\frac{1}{400}$th, and $\frac{1}{500}$th mm., and are guaranteed not to vary even with constant use. Fig. 2 is

Fig. 2.

another form with extended scale to show extremely fine divisions from $\frac{1}{100}$th mm. to $\frac{1}{3000}$th mm. The opening in this instrument is much larger. In the three sizes made the jaws open 12 mm., 40 mm. and 50 mm., and the largest size can be used up to even 75 mm. The illustration is half natural size. Fig. 3 is a convenient form for

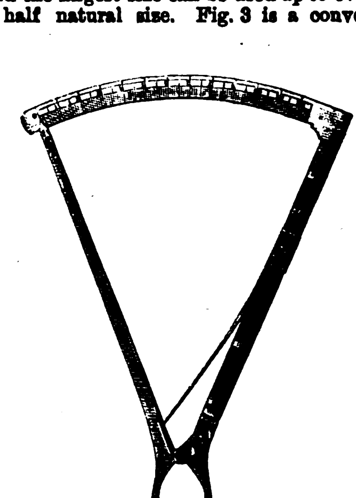


Fig. 3.

workshop use when extreme accuracy is not required, the readings being $\frac{1}{10}$th, $\frac{1}{20}$th and $\frac{1}{50}$th mm. The scale is isometric, thus avoiding circle errors. The adjustment is easy and the instrument is strongly constructed to stand ordinary workshop use. The firm of Robert Mühle was established in 1869, and has devoted a vast amount of attention to the perfecting of measuring instruments, of which the types we describe are good examples.

New Patent Friction Clutch.—The friction clutch illustrated below has been designed by the Unbreakable Pulley and Mill Gearing Company, Limited, of Manchester, to overcome some of the many difficulties attendant upon this apparently simple, but really very exacting class of mechanism. With regard to the clutch proper, it is not greatly different in the main design from some others in the market. The driving power is transmitted by heavy arms or horns, on which the friction blocks slide, so that all strain, except that of putting the blocks into gear, is taken from the screws. These are two in number, right and left handed, and the arm for their rotation is forged solid. The main and lock nuts are gun metal, to avoid any chance of rusting, should the clutch remain for long either in or out of gear. The patented novelty lies in the method of the application of the power from the usual sliding sleeve upon the shaft to the extremities of the screw levers. Instead of the connecting links

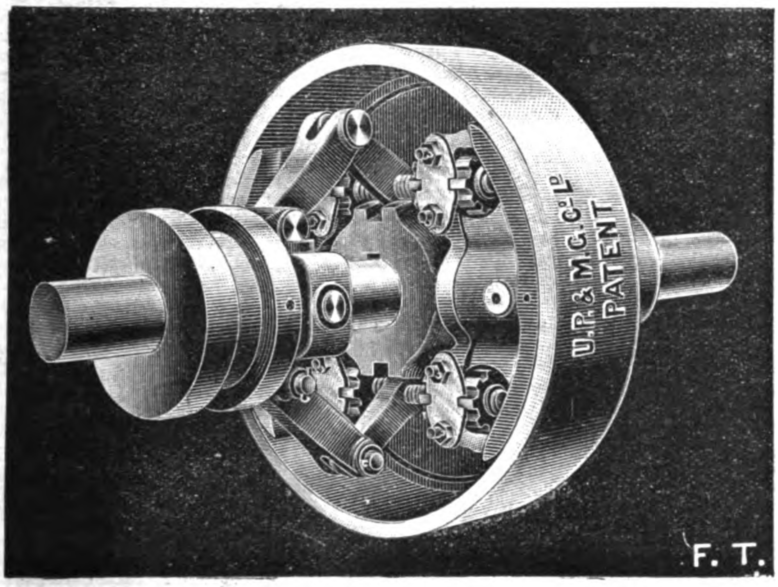
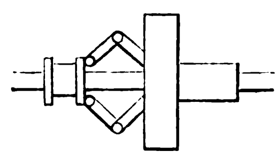


Fig. 1.



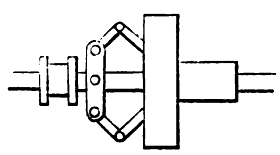


Fig. 2.

being carried in rigid centres on the sleeve, as is usually the case (fig. 1), they are pinned to a gimbal or ring, pivoted on the sleeve (fig. 2). It will be seen that, by this arrangement, any pressure put upon the sleeve must be transmitted with absolute equality to the two friction blocks, as either one of these gives the reaction for the other. Any chance of uneven wear on the blocks, or undue strain upon one part of the mechanism is thus avoided. We understand that a number of these new clutches have been sent out, and have been at work for considerable periods. Many repeat orders are stated to have been received. The clutch is made in various sizes, according to diameter of shaft and power to be transmitted, and may be used either to couple shafts or to carry a pulley. Adjustment is provided for in all ways, and all the parts, although guarded by the outer shell, are in full view, and at once accessible.

Paterson & Cooper.—Discharge Granted.—The case of Paterson & Cooper, electrical engineers and contractors, of the European Works, Pownall Road, Dalston, and Victoria Street, Westminster, with branches at Manchester, Glasgow and Dundee, reached the final stage this week at the London Bankruptcy Court, when Mr. Registrar Brougham granted an unconditional order of discharge to both debtors. The firm failed in August, 1896, with total liabilities £19,514, and assets valued at sufficient to pay the debts and leave a margin of £7,021. The debtors started business in 1882, with a capital of £18,000, and a further £6,600 was afterwards provided. In 1886 they purchased from the inventor, M. Eugene Hermite, a half share in the British and foreign patents of an electrical sanitation and bleaching process. Since then they have been almost continuously engaged in exploiting and working the patents, and have, in one way and another, expended from £12,000 to £13,000 in connection therewith. In 1886 the British patents were sold to a limited company, which proved unsuccessful and entailed a loss of about £5,000 to the debtors. Four years later the French patents were sold to a French company, and the debtors eventually realised £1,800 by the sale of their shares, received in payment of their interest in those patents. For some years before the failure the debtors were endeavouring to form a company to take over the patents, plant, and business of the French company. They attributed their failure entirely to delay in realising their patents. When the discharge was first applied for in January 1897, the Official Receiver reported as an offence that the assets were not equal in value to 10s. in the £ on the unsecured debts. That finding was challenged on behalf of the debtors, and the hearing has since been adjourned from time to time to enable the assets to be realised. Mr. E. Moore, the trustee, now stated that he was satisfied that the assets would realise in the gross sufficient to show 10s. in the £ on the liabilities. The Official Receiver offered, in that case, to withdraw the allegation, and said he would not oppose the granting of the discharge. His Honour remarked that as the only reported offence had now been displaced, he was enabled to grant to the debtors an unconditional order of discharge.

The Stratton Separator.—Mr. C. R. Heap, of 47, Victoria Street, S.W., who is the sole importer in the United Kingdom for the Goubert Manufacturing Company, of New York, sends us a pamphlet, emphasising the necessity of employing dry steam in order to obtain the maximum of economy, efficiency and safety, giving an exposition of the various methods of obtaining it, and describing good points of the Stratton system of mechanical separation. A page illustration is given of a 10-inch Stratton combined separator and steam receiver, connected to 1,200 H.P. compound Westinghouse engines at the power house of the United Electric Light and Power Company in New York City. Other illustrations show separators used by the Philadelphia Traction Company, and the Springfield Street Railway Company. There is a list covering many pages, giving particulars of firms and works in America employing the Stratton separator.

ELECTRIC LIGHTING NOTES.

Aberdeen.—Last week the Gas and Electric Lighting Committee resolved to reduce the cost of electricity for motive power from 6d. to 4d. for the first hour. The price for the current thereafter will be the same as formerly—1½d. The report of Prof. Kennedy regarding the lighting of the west end was deferred until the committee had had another interview with Prof. Kennedy.

Electric light is to be introduced into West Parish Church.

Barmouth.—A movement is on foot to acquire the old reservoir at Ceilwart whereon to erect the necessary plant for generating electricity.

Bath.—The electric light works insurance is to be increased from £12,000 to £20,000. The insurance company has reduced the premium from 7s. 6d. to 5s. per cent.

Barking.—The clerk reported at the last District Council meeting that the provisional contracts for erection of the electric light station, and for supply and erection of generating plant had been entered into, and that the remainder of the contracts would be completed shortly. As to the electric lighting loan, the present application was for sanction to a loan not exceeding £15,000, and the Local Government Board would require the Council to state a definite sum. The clerk and the engineer are to go into the matter, and report the exact amount required. A letter was received from the Board of Trade, stating that if the Council proposed to make an earth connection, the approval of the Board, with the concurrence of the Postmaster-General, would be necessary, and the clerk reported that he had replied that it was proposed to connect the intermediate conductor of the three-wire system with earth, and that the Board of Trade's conditions would be complied with. The Sunderland Forge Company, Limited, wrote, quoting £825 for the duplicate electric lighting plant required, and £75 for copper pipes, including erection. Consideration was deferred.

Bedford.—The stall-holders in the Bedford Market have requested the Corporation to instal the electric light, and have offered to pay 4d. per night per lamp of 16 C.P., which they suggest would produce £176 3s. 8d. per annum. They are agreeable to amalgamate the stallage and charges for light, pay in advance, and sign an agreement to that effect. They prefer, however, the engineer to undertake the complete installation, owing to their employés inexperience in the *technique* of electricity.

The Town Council has decided to reduce the charge for current to 4½d. per unit (5d. less ½d. for cash in a month) from July 1st. Six transformers of increased voltage are to be purchased for the new area at a cost of £300.

Birmingham.—Estimates have been invited for an electric lighting installation for St. Martin's Church, and the work will be done after Easter.

Bridgend.—The Urban Council recently met in committee to consider the application of a London firm of electrical engineers to take over the Council's provisional order for the electric lighting of the town. A committee was appointed to carry out the negotiations with the firm in question and present a report.

Brighouse.—The Town Council is to take over the electric lighting plant belonging to Mr. Brook.

Chester.—At midnight on Thursday last week the electric light works at Chester, with staff, station, and plant, passed into the hands of the Corporation. Since December 17th, 1896, the concern has been run by the contractors, Messrs. Thomas Parker, Limited. All the staff is taken over, with Mr. F. Thursfield, A.M.I.C.E., as resident engineer, and it is stated that for the future Prof. Kennedy ill not be called in for extensions, &c.

Clerkenwell.—The Vestry had a discussion on electric lighting recently. The members are impressed with the successes of municipal plants elsewhere, including Brighton, and it was resolved to apply for powers to supply the parish.

Dingwall.—The Electric Light Committee on 18th ult. considered the draft agreement to be made between the Town Council and the electric lighting company. The company will have the use of the present lamp-posts, and the installation will comprise eight 500-C.P. arc and nine 32-C.P. and 16 16-C.P. incandescent lamps.

Dorking.—A poll of the ratepayers has resulted in favour of the work of electric lighting being carried out by the District Council.

Durban.—£300,000 is being raised for borough improvements, and £50,000 of this is for electric lighting extensions.

Exeter.—At the last City Council meeeting, the Electric Lighting Committee reported that the lamps for street lighting had been delivered, and examined by an electrician sent from London, who had satisfied himself that they were incapable of being adjusted to meet the requirements of the Council. A correspondence has taken place, says the *Western Morning News*, with Drake & Gorham, the manufacturers of the arc lamps to be supplied, wherein they undertook to make a new set of lamps, properly adjusted to meet the requirements of the Council's system of electric lighting, in lieu of those already delivered, and guaranteed the delivery within five weeks from March 8th. The Council has decided to apply to the Local Government Board for permission to borrow £7,000 for additional plant and cables.

Folkestone.—The prospectus of the Folkestone Electric Supply Company, Limited, has been issued this week. It shows that contracts have already been entered into with the Corporation for lighting the most important streets, including the Lees Promenade. The directors include several local public men, viz., Alderman George Spurgen (chairman), Councillor D. Baker, Councillor S. Penfold (Mayor of Folkestone), and Councillor C. J. Pursey.

Gloucester.—Mr. Hammond attended before the Electricity Supply Committee, and submitted a plan showing how he proposed to arrange the Electricity and Dust Destructor Works upon part of the Bearland estate, and conferred with the Committee as to the various kinds of dust destructors. The Committee approved of the plan submitted by Mr. Hammond, subject to any modifications that may be found necessary in working out the details. Mr. Hammond was instructed to invite the following firms to submit plans and estimates for four dust destructor cells:—Messrs. Beaman and Deas; Goddard, Massey & Warner; Manlove, Alliott & Co.; the Horsfall Syndicate, Limited. The foregoing was approved at a meeting of the City Council on Tuesday.

Greenock.—Representatives of the Corporation are to meet the Board of Trade in London this month in conference on the question of the introduction of the electric light into the borough. The North British Electricity Company, Port Glasgow Town Council, and Gourock Commission, will also be represented.

Hackney.—At the last Vestry meeting, says *Daily Tenders*, a letter was read from an electrical engineer, offering his services in connection with the electric lighting schemes, &c., under consideration. It was decided to receive the letter, the opinion being expressed that it was time that these gentlemen should cease advertising themselves.

Hornsey.—The District Council, which is applying for a provisional order, has refused consent to an application received from Mr. F. J. Hider, inquiring whether he would be allowed to carry the cables for a small electric lighting installation in the Broadway, Crouch End, on the low tension system, over a few thoroughfares, with a view to lighting a few of the shops.

Italy.—The report of the Società Anglo-Romana per l'Illuminazione di Roma shows that its electrical branch is now supplying current to an equivalent of 56,698 16-C.P. lamps. An increase of 4,633 lamps during the past 12 months.

Johannesburg.—The price of current has been reduced to 1s. per unit for dwellings, churches, theatres, and public places. The Council has also reduced the price of gas from 21s. to 20s. per thousand, and increased discounts are given.

Leigh.—The District Council has decided to lay down an electric lighting installation at a cost of £10,000.

Leith.—The plans of the electric light station buildings have been approved at the Dean of Guild Court.

London County Council.—At the weekly meeting of the Council on Tuesday, the adjourned report of the Main Drainage Committee in regard to the proposed electric light installation at the Crossness outfall, to which we referred last week, was adopted. It was decided to approve the estimate of £7,000 for the carrying out of the work, and to invite tenders (1) for the supply and fixing of the engines, dynamos, switchboard, and principal mains, and (2) for the service mains, wiring and fittings.

It will be remembered that early in February the Council decided to ask the Board of Trade to give preference to the orders applied for by the Charing Cross and Strand Electricity Supply Corporation in respect of the Holborn and St. Giles districts over that applied for by the County of London and Brush Company for the same area (which the Metropolitan Electric Supply Company has now power under its Mid-London Order to supply), the reason being that the former company's supply in its present areas is by continuous current, instead of alternating current, which was understood to be the system of the latter company. Since then the Highways Committee has received a letter from the County of London Company, stating that it is prepared to charge at a lower rate than the Charing Cross and Strand Company, and at the same time to supply alternating current by low tension for lighting purposes, and continuous current at 500 volts pressure for motive power. The Board of Trade having intimated its intention to hold an inquiry at which the parties interested should be represented, the chairman of the committee was requested to attend, and to state that, upon the understanding that the County of London Company's supply, if the order be granted, would be given in accordance with the above letter, the opposition of the Council to the granting of the order to the company would be withdrawn so far as related to the rates of charges and the supply by means of alternating current. It would thus be left to the Board of Trade to decide which of the two companies concerned should be allowed to supply the areas referred to in the respective orders. Arising out of questions on this matter, the chairman of the committee mentioned that at the inquiry in question, the Board of Trade decided that it was advisable to leave that area south of Oxford Street to the Charing Cross and Strand Company, and that on the north of Oxford Street to the County of London Company.

As will be seen from the following paragraph from the report of the Highways Committee, the County of London Company has been successful in its appeal to the Board of Trade on the much vexed question of transformer boxes.

The Committee reported:—The Council on December 7th last formally disapproved of the construction of four transformer boxes by the County of London and Brush Company, under its Northern Extension Order of 1897; and against this decision the company appealed to the Board of Trade. The Board gave its award on March 19th, allowing the appeal, and approving the construction of the transformer boxes, subject to the following conditions—(*a*) that the said transformer boxes be constructed in a manner precisely similar to the transformer boxes constructed within the area of the County of London (North) Electric Lighting Order, 1892; (*b*) that there shall be no gas pipe within such distance from any box as is equal in feet to the diameter of the gas pipe in inches. The company has since served a fresh notice, dated March 21st, 1898, of intention to construct the boxes referred to in the previous notice and sanctioned by the award, and has also submitted drawings showing the construction of the boxes as to be in accordance with the conditions attached to the award; and in the circumstances the Council can take no further action in the matter.

Manchester.—The Electricity Committee has adopted a report of its engineer recommending the extension of the Corporation electric lighting plant.

Mexico.—On 8th ult., according to the *Two Republics*, there was a failure in the electric light plant put down by Messrs. Siemens & Halske. It was said to be due to the derangement of the boiler, and of one of the dynamo brushes, and other causes.

Monmouth.—Complaints were made by members of the Council at the last meeting regarding the great delay that had arisen in the completion of the electric lighting installation. Alderman Tippins remarked that a year ago they were told the machinery was all ready, and, further, £1,000 was then paid on account. He also asked why was not the work of laying down the mains proceeding? The chairman's reply, as given in a Hereford paper, was: "I believe the answer is that the making of the turbines was let as a sub-contract, and some delay has been caused thereby."

Salisbury.—It is stated that the electric lighting works will probably be in a position to supply current about the middle of this month.

Southampton.—The electric lighting mains are to be extended down a number of roads. The electrical engineer reports the number of units registered during February, 1898, at 20,288, being an increase of 43 per cent. on that for February, 1897. Mains are to be laid in a number of additional thoroughfares.

West Ham.—Messrs. Ferranti have sent a long letter to the Council, in which they said that they could not undertake to have the engines and other machinery ready before June. The letter, which added that the engineering dispute had hampered them a great deal, was referred to the Highways Committee.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Anglesey.—It is suggested by the County Council that the electric line from Garth to Beaumaris should be on the sea or south side of the main road. The promoters proposed to lay it along the opposite side.

Bangor.—It is stated that a number of private gentlemen are setting an electric tramway scheme on foot, the line to run from the far end of the Bangor Pier to the railway station.

Bristol.—A few weeks ago in referring to the position of affairs between the Bristol City Council and the Tramway Company, who desire to go in extensively for electric traction, the word "deadlock" was used to describe the state of affairs. The accuracy of the term is shown by the voluminous report of the Sanitary Committee issued this week for the consideration of a meeting of the Council on April 1st. The document includes the correspondence between the committee and company. The committee, in their first letter of March 3rd, declared the committee would not assent to any arrangement which would involve any extension of the period at which the power to purchase any part of the undertaking would arise and insisted on the condition, No. 10 of their list, which said:—"The date at which the Corporation's power to purchase the power station and proposed extension would arise to be the same as for the present horse tramways." The committee further intimated they would not be able to recommend the adoption of the overhead wire system on some of the existing tramways. The company expressed, in their reply, astonishment at hearing the committee now objected to the overhead system on some lines. The company had no intention of adopting any other than the overhead system which was the only one accepted as practicable by all companies and municipalities in this country dealing with the subject. Insistance on No. 10 would preclude the possibility of further negotiations. In their next letter, of March 9th, the committee modified their position a little. They said: "The committee would be prepared, if all other questions with the company were arranged, to recommend the Council to assent to the use of the overhead system upon all the existing tramways and upon the extensions, on condition that if any other system of electric traction which might appear to the Council to be an improvement on the overhead system were adopted and worked at a profit of 5 per cent. or upwards on the capital employed in five or more towns in the United Kingdom with a population exceeding 50,000, the company would adopt that system on notice from the Council." They also asked if the company were willing the extensions should be constructed by the Corporation and leased to the company for a term of years expiring at the date when the civic power to purchase the horse tramways would arise, at a rent sufficient to cover the interest and annual instalment of the loan for defraying the cost of the work. The company declined both proposals, declared they were anxious to give to the public the benefits of the overhead system of electric traction, and suggested that failing agreement with the Corporation the settlement of a uniform period of purchase by the city be left to the Parliamentary Select Committee. They further suggested the Sanitary Committee might name a period at which all tramways existent in the city or which might be constructed, including so much of the Hanham Light Railway as might be in the city, should be purchasable. The committee in answering varied their condition with regard to calling on the company to alter the overhead system for one deemed preferable, chiefly, by making the towns referred to, have a population of over 100,000 instead of 50,000, and inserting the proviso that the civic demand should be subject to the Board of Trade, regarding it as equitable that the company should make the change. The committee declined to leave it to a Parliamentary Committee to fix a term at which the lines might be purchasable. The company accepted in principle the amended suggestion as to conditions on which they should be asked to change their system, but adhered to their previous determination in regard to condition No. 10 in the list. The horse lines, it should be explained, have about 14 years to run, and the Tramway Company want for the extensions the full 21 years allowed by the Tramway Act. The Sanitary Committee now recommend the Council not to agree to an extension of the period of purchase, and not to agree to a use of the overhead system throughout the tramways; further, that they be authorised to require the company to withdraw the Extension Bill when the Council think fit, and that the Committee be authorised to proceed with the opposition to the Electrical Powers Bill.

Charing Cross, Euston and Hampstead Railway.—The Unopposed Bill Committee of the House of Commons last week passed the Bill promoted by the Charing Cross, Euston and Hampstead Railway Company, which was incorporated in 1893 for the purpose of constructing an underground electric railway between the points named. By this Bill the company is authorised to extend its Charing Cross terminus from the Charing Cross Road to a point under Craven Street, Strand. The Bill also extends the time for constructing the authorised lines until August, 1902, which is two years beyond the time originally granted.

Chesterton.—The British Electric Traction submitted a plan of the proposed route of the Chesterton Tramway to the Parish Council last week for suggestions, and several alterations were proposed.

Christchurch and Poole.—The British Electric Traction Company has proposed a new scheme for electric tramway communication between Christchurch and Poole. The Christchurch Council will grant the Company an interview this month.

Clontarf.—On Saturday last a large number of gentlemen representing the local authorities, accepted the invitation of the Dublin United Tramways Company for the inaugural run to Clontarf and back on the electric system, which has just been completed between Nelson's Pillar and Dollymount. Four special cars were placed at the disposal of the guests.

Dublin.—On 22nd ult. Major Cardew inspected, on behalf of the Board of Trade, the electric tramway from Nelson's Pillar to Dollymount.

Dudley and District.—On Monday at the monthly meeting of the Stourbridge Urban District Council, a draft order of the Light Railways Commissioners with reference to the Dudley and District Light Railway was received, and the Council was asked to send any observations on the same to the Commissioners. The matter was referred to a committee.

Electric Traction for London.—Mr. Douglas Young, in a paper on "London Traffic Problems and their Solutions," read before the Auctioneers' Institute in London on Tuesday, referred to the subject of electric traction. He said that the "enterprising municipalities of Glasgow, Belfast, Leeds, Manchester, Liverpool, Sheffield, Huddersfield, and Birkenhead, to say nothing of many great Continental, American, and Colonial cities, had, after careful experiment or inquiries, arrived at the conclusion that the best discovered system of tramway was that known as the overhead electric system. The electricity was generated at a centre, and conducted along overhead wires, which were either carried from house to house or suspended on ornamental columns with arms. He had seen this system at work in Bristol, Rome, and Milan, and could say that, from an æsthetic point of view, little or nothing was to be urged against it, in fact the pillars or wires suspended from place to place were made to hold the electric lamps, and might be made an ornamental feature. The system was safe, rapid and elastic as to speed, clean, comfortable, and flexible enough to apply to all routes, and met all contingencies of street traffic under ordinary circumstances. It was supplanting all other systems, and in the farther suburbs the prospect of tramcars running in connection with a well-conceived circle system of underground electric railways, opened up a bright future for largely solving the problems of street traffic, and for the comfort and convenience of our people and city.

Fatality.—At Douglas on Thursday, an engineer named Cæsar Brew, employed by the Isle of Man Electric Tramways Company, was attempting to jump on an electric motor car when he slipped and fell on to the line. The car went over his head, almost severing it from the body, death being instantaneous.

Flamborough and Bridlington.—The Flamborough and Bridlington Light Railways Bill has received the formal assent of the Board of Trade in spite of the opposition of the local authority concerned. The work may be expected to be commenced shortly. Messrs. Siemens, Bros. & Co. and Messrs. Whittaker Bros. are the contractors for the electrical plant and the earth work, the civil engineer being Mr. Myers-Beswick, and the electrical engineer Mr. Bernard Drake. Apart from the passenger traffic, which is considerable during the season, the introduction of this line is expected to have an important bearing on the fishing industry of the North, for it is stated that frequently boats which cannot enter Grimsby, will deliver their fish under the shelter of Flamborough Head as soon as facilities for transport exist.

Glasgow.—At an early meeting of the Tramway Committee the proposal to work the new tramway line to be laid in High Street and Castle Street with electricity, in conjunction with the Springburn route, will come up for consideration. There will be sufficient car accommodation and electric power at the Keppochhill depôt to enable the extension to be worked with the Springburn section.

L.C.C. and Electric Traction.—When reporting in February upon the applications for electric lighting provisional orders this session, the Highways Committee expressed the opinion that a clause should be inserted in each order for the protection of the Council's interest in the tramways already purchased, and those to be acquired in the future. At the request of the Committee the following clause was prepared by the Parliamentary Committee:—"If and when the London County Council adopt or permit the use of electrical traction on any of the tramways of the Council, including tramways in any street in which electric lines have been laid down under this order, it shall be lawful for the Council to serve on the undertakers notice in writing requiring them to make such alterations in the position of their lines and works as may be required for adapting such tramway for the use of electric traction thereon, and the undertakers shall thereupon proceed with all reasonable despatch to effect such alteration or removal, at their own cost, and without having any claim against the Council for compensation. Provided that if any difference arises between the Council and the undertakers as to whether the required alterations are necessary for the purposes aforesaid, such questions shall be referred for determination to the Board of Trade, whose decision shall be final." The Highways Committee recommended that the Board of Trade should be requested to insert the above clause in those provisional orders which might be granted in the present or any future session. This recommendation was adopted, the Chairman promising, at the suggestion of Earl Russell, that the clause should be made clear to the Board of Trade to refer only to alterations from a mechanical point of view.

Liverpool.—Thirteen members of the Tramways Committee, accompanied by the Lord Mayor, left Liverpool on Friday afternoon last for Hamburg, to inquire into the working of the electric tramways of that city.

Middlesborough, Stockton and Thornaby.—In regard to this electric line a Middlesborough paper says that the work at the power houses and depôt at Stockton is now in a forward state. The machinery and plant is being rapidly laid down and all the arrangements completed and closed up against the time when the preliminary trials will have to be made.

Ostend.—The Société Anonyme des Railways Economiques de Liege Seraing et Extensions, and the Compagnie Générale des Railways à Voie Etroite of Belgium have just ordered, says *Daily Tenders and Contracts*, a complete electrical equipment from the Westinghouse Electric and Manufacturing Company for a storage battery system traction road in Ostend, Belgium, which promises to prove remarkably successful. The generating plant will consist of a 60 H.P. compound high pressure engine, connected with a Westinghouse multipolar dynamo of 38 kw. capacity, running at 600 revolutions a minute, and producing a current at 280 volts. The cars are to be equipped with a group of batteries and will be able to run 40 miles before recharging. A complete Westinghouse system, with switchboards will be placed in the generating station.

Power Distribution.—On 22nd ult., before the Institution of Engineers and Shipbuilders in Scotland, Glasgow, Mr. Henry Mavor contributed a paper on "Some of the Economic and Practical Aspects of Electrical Power Distribution in Factories." During the past few years, he said, there had been a decided awakening of interest in the possibilities of electrical distribution of power in factories. Long distance transmission of power was of less interest to us in this country because of our local conditions. In reference to the power scheme for the Midlands, he said that it seemed probable that the operation of such a scheme would only be commercially practicable in districts where the local authority does not control the electric supply, because, when the local authority has to be dealt with, the price obtainable from it would not exceed the rate at which it could itself produce the power without any allowance for profit. On the other hand, there was undoubtedly an enormous field for the electric motor among small users of power who could obtain the electric current at a moderate rate from supply companies or local authorities. The lecturer divided power consumers into various groups —(1) The case of factories, chiefly textile, where the power is delivered from one large engine from gearing or belting of machinery closely grouped round the source of power, such as spinning and weaving factories; (2) in the case where the nature of the work is such that the power must or ought to be delivered direct at the point where it is applied to the work. This included factories and works where the machines to be driven were widely divergent in character, were widely spaced, and run at different and varying loads and speeds, as in paper mills, print works, chemical works, steel works, foundries, shipyards and many engineering establishments where work of a varying character is to be accomplished. In the latter group the lecturer considered there is a very wide field for the application of electric power distribution in the Glasgow district.

South Staffordshire.—At a meeting of the Tipton Council on Tuesday, a letter was submitted from the Board of Trade enclosing a communication received from the South Staffordshire Tramways Company respecting the renewal of steam licenses, but it was stated by the chairman that the Council would not take any further action in the matter until an application was made for Parliamentary powers for the use of electric traction.

Stourbridge.—The Urban Council has received the draft order of the Light Railway Commissioners relative to the Dudley and District Light Railways. The Council was asked to consider the draft, and if it had any representation to make, to do so by April 7th. The order proposed to give the promoters three years to finish the work in, but a representative of the British Electric Traction Company stated that the existing tram line would be converted and the electric trams running in the present year. The draft order was referred to a committee.

The "Underground" and Electric Traction.—The Metropolitan Railway Bill, under which powers are sought to work the lines by electricity, was before a committee of the House of Commons on Monday. Mr. Littler, Q.C., opened the case for the promoters, and Mr. John Bell, the chairman of the Company, gave evidence in support of the Bill. The Great Western Railway Company appeared in opposition, and with respect to this, Mr. Freeman, Q.C., speaking on behalf of the promoters said:—"I may say that under the Bill as drawn, if the Metropolitan Company satisfy themselves that electric traction is the proper power to use on the railway we shall require the Great Western to alter their engines to suit the new conditions. Their engines would be under our control, but if they objected they would then have power under previous agreements to take us to arbitration." Mr. John Bell stated that if the Metropolitan had to make an enormous change for the benefit of the public he did not see that the Great Western would have any ground of complaint if they were compelled to do the same with regard to the few trains that run over the system in the course of the day. If the electric traction is the success they expected it would be they would not extend the electric traffic to Aylesbury. They did not propose to go further with it than Swiss Cottage. Sir John Wolff Barry, engineer to the company, and Sir Benjamin Baker, gave evidence for the promoters on the engineering aspect of the scheme.

The committee sat again on Tuesday to consider the Bill. Mr. Pember, Q.C., for the Great Western Company, briefly addressed the committee, contending that, if his clients were forced to adopt electric traction, they should be compensated for the extra expense involved in the provision of electric engines and rolling stock. He submitted for insertion in the Bill a clause drawn up by the petitioners to the effect that nothing in the measure should prejudice the working of agreements already in existence, and that questions as to the method of carrying out the proposed change should be referred to arbitration as well as any alterations that might be necessary in Great Western engines and rolling stock, and any alterations in working, and also the question of cost. Mr. Freeman, Q.C., replying for the promoters, said the company were proposing to incur this great expense simply and solely to improve the conditions of working the traffic. The Great Western Company, who were virtually partners in the railway, would be equally benefited so far as their traffic over the line was concerned. His company were prepared to safeguard all the rights of the Great Western Railway Company, and to do this his company would consent to the inclusion in the Bill of a clause providing that, should the Metropolitan Company at any time require the Great Western to substitute electric traction for steam locomotion on any of the trains of the Great Western Company working over the Metropolitan Railway, either of the companies should be entitled to refer such requirement to arbitration as if the same had been included under the terms of the existing agreement. He submitted that it was unreasonable to expect that the Metropolitan Company should pay the expense of converting the rolling stock of the Great Western if, under the pressure of public opinion, it became necessary for that company to follow the example of the Metropolitan Company and use electricity. The chairman asked if the petitioners doubted whether electricity would ever be used on the railway. Mr. Worsley Taylor said they acknowledged that electricity might be useful, but were of opinion that to adopt it might involve great changes in the rolling stock, and that before they were called upon to pay for the change the subject should be threshed out before an arbitrator. After some further conversation, the chairman said there was no opposition to the suggestion that sooner or later electricity would have to be used on the Metropolitan Railway, and, as the Great Western Company were to a great extent parties to the working of the railway, the committee felt that in making the great change which was not contemplated in 1869, there should be some special clause introduced into the agreement. Time was allowed to the parties to prepare a clause. In the course of the proceedings the chairman said that the committee were satisfied that there was every prospect of electric traction being used on the railway. The committee sat again on Wednesday and adjourned.

Waterloo and City Railway.—It is stated by a morning contemporary that there is talk of running the first train over this line on Monday, May 2nd.

Whitley.—A public meeting, on 24th ult., approved of the proposal of the British Electric Traction Company to establish an electric tramway from Cullercoats through Whitley, and suggested that it be carried on to the sea front at Monkseaton Lane. Mr. Frank B. Lea explained the scheme. The opposition was weak as water, but it was certainly novel, for a Mr. Saint "expressed the fear that the introduction of tramways into the district would give facilities to persons to travel more easily beyond the three miles limit on a Sunday to obtain drink. He also regarded the trams as a danger to children."

TELEGRAPH AND TELEPHONE NOTES.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1893 ...	...
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Cayenne-Pinheiro ...	March 24th, 1896 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Cable Obidos-Manaos ...	March 9th, 1898 ...	March 26th, 1898
Cyprus-Latakia	Feb. 10th, 1898 ...	...
Gibraltar-Tangier	March 19th, 1898 ...	March 28th, 1898
Lourenco Marques-Durban...	March 19th, 1898 .	March 25th, 1898
Havre-Waterville ...	March 28th, 1898 ...	...
Odessa-Constantinople ...	March 28th, 1898 ...	...
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1898 ...	...
Cartagena-Barranquilla ...	July 4th, 1896 ...	...

The Telephone Service.—According to Wednesday's *Standard*, Mr. Faithfull Begg proposes to bring forward an amendment to Mr. Caldwell's resolution with regard to the telephone system which will be moved on going into Committee of Supply on the Civil Service estimates to-night (Friday). The amendment is to the effect that the acquisition by the State of the whole telephone system of the country is the only solution of the difficulties which exist, and are increasing under the present system of licences. The amendment can only come on in case Mr. Caldwell's resolution is carried.

(*Continued on page 447.*)

TORQUAY MUNICIPAL ELECTRICITY WORKS.

As we briefly announced last week, the municipal electricity works were formally opened on March 17th.

The municipal authority of Torquay obtained powers to undertake a public supply of electricity as far back as 1891; but it was not until 1896, when there was some danger of the provisional order being revoked, that the Corporation really determined to erect electricity works. Mr. Trentham, who had previously prepared reports on the subject, was entrusted to prepare a plan and specifications, which were adopted by the Council, and have since been carried out.

The system that has been adopted in Torquay is a high pressure alternating current supply; the pressure at the consumers terminals being 200 volts, the street lighting being done by means of arc lamps using rectified currents. An unusual feature about the works is, that, subject to modifications, a building was ready to hand in the shape of large and lofty coal cellars owned by the Corporation. The cellars can scarcely be said to be underground, being, as a matter of fact, formed from excavations made under a high level road, entrance to them being from a low level road adjoining the harbour. Although provided with four walls for housing the generating plant, it was necessary to carry out important alterations to adapt the cellars for electric lighting purposes. For instance, it has been necessary to excavate for the purpose of making foundations for the machinery. This operation entailed the removal of 300 tons of limestone rock, which had, for the most part, to be blasted. The machinery now rests upon a solid block of concrete, which is isolated from the adjoining walls by means of hair felt. It was discovered, at the conclusion of the excavations, that at times of very high tide sea water percolated through the walls, and to avoid this the lower part of the excavations has been concreted. An ordinary wide road divides the works from the harbour, and this contiguity to the sea provides facilities for obtaining seaborne coal; moreover, it gives an abundant supply of water for condensing purposes.

"Where's the chimney?" was propounded as a sort of conundrum on the opening day, and certainly, to one who is accustomed to look upon a tall chimney as a guide to electricity works the matter was slightly perplexing. As a matter of fact, the chimney shaft passes up through an adjoining building, owned by the Corporation and utilised for concerts and entertainments, the top of the chimney being no higher than the roof of the building. In consequence of the chimney being restricted to a height of 60 feet, forced draught has been resorted to.

The internal appearance of the dynamo room by no means suggests anything of the cellar; the room is lofty, of a considerable size, and is well lighted. An excellent idea of the arrangement of plant will be obtained from the general view of this room. The boilers are placed in an adjoining room, which has been permitted to retain much of its underground attributes.

Laying the Mains.

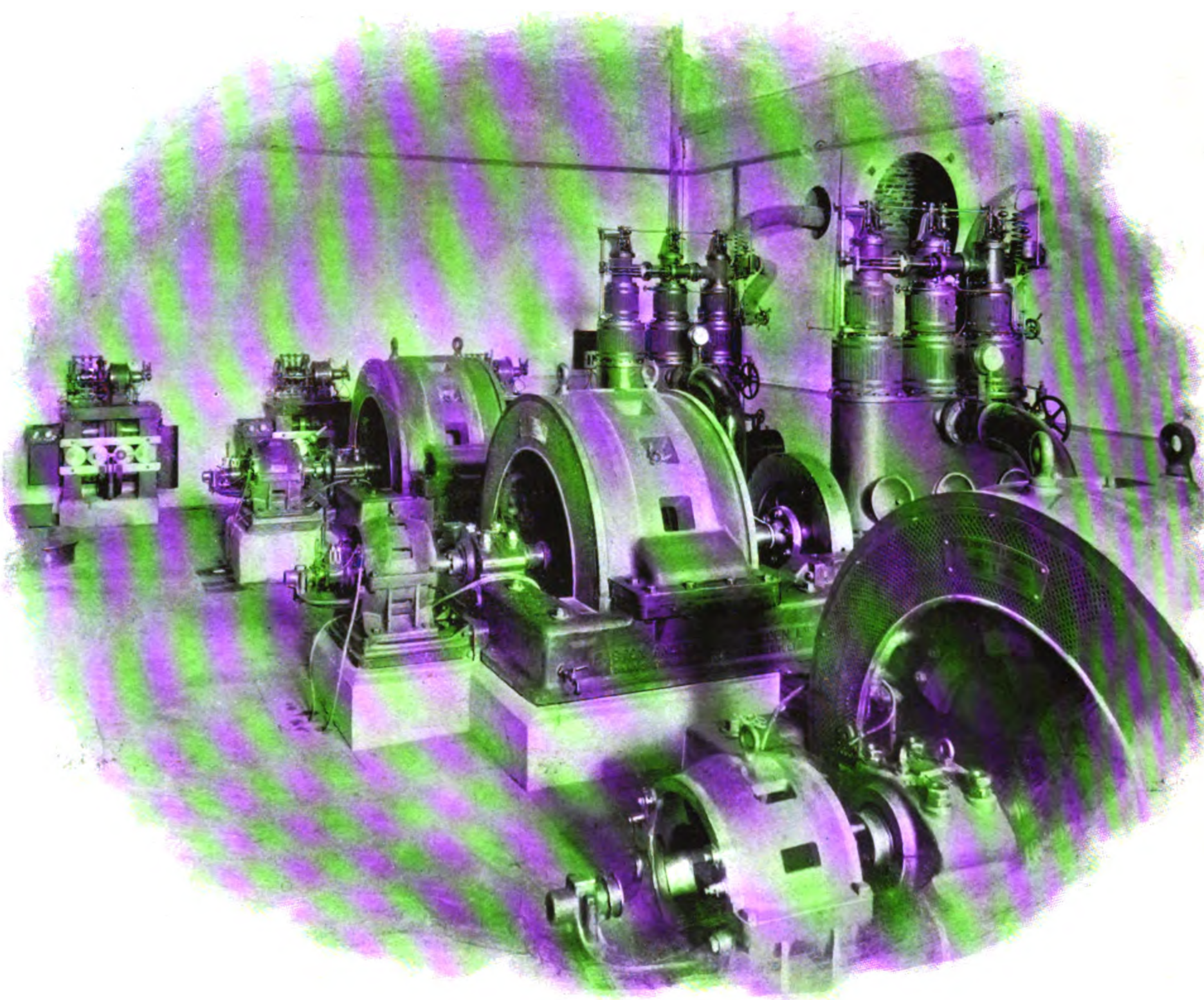
Coming to the more prosaic details of plant, we will begin with the boilers, of which there are three, each having 1,619 square feet of heating surface, and 30 square feet of grate area. Each boiler is composed of eight sections of tubes, each tube being 18 feet long.

The horizontal steam and water drum is 3 feet 6 inches in diameter and 22 feet 7 inches long. Each boiler is complete with the usual fittings, including Hopkinson's safety valve, stop valve, blow-off valve, &c. The fact has been mentioned that forced draught is necessary, and each boiler is, therefore, fitted with steam blowers for forced draught. In addition there is a Babcock & Wilcox patent superheater, having 226 square feet of heating surface, and consisting of 32 drawn steel tubes $1\frac{1}{2}$ inch in diameter, connected at the ends to a wrought steel cross box, the tubes being fastened therein by expansion. The upper cross box is connected to the steam and water drum by two 4-inch steel tubes expanded into a nozzle provided for the purpose, and at the upper end of these tubes there is a cast-iron dry pipe. Prevention against overheating during the time of raising steam is insured by the arrangement for flooding the superheater, and using the superheater then as part of the heating surface of the boiler, although if the flooding is omitted, when raising steam, damage is not likely to result if the fire is not forced too rapidly.

In conjunction with the steam raising plant there is the inevitable Green's economiser, which is made up of 192 pipes, and fitted with the usual safety valves, thermometer, scrapers, &c.

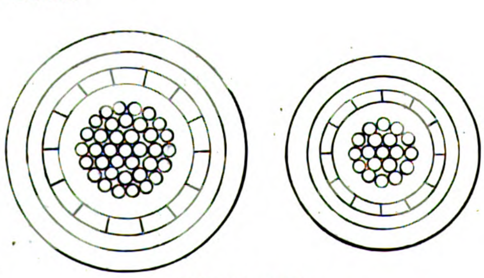
In a triangular apartment between the engine room and the boiler cellar are the pumps for feeding the boilers and for the condensing water.

The boilers are fed by two Worthington duplex feed



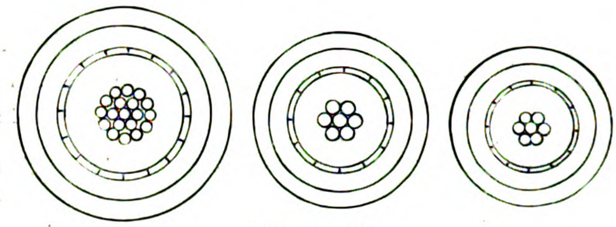
Engines and Dynamos.

pumps, each having a steam cylinder 5¼ inches diameter and a water cylinder 3½ inches diameter, the length of stroke being 5 inches.



L.T. concentric.
37/14 S.W.G. section ·1906. 19/14 S.W.G. section ·0976

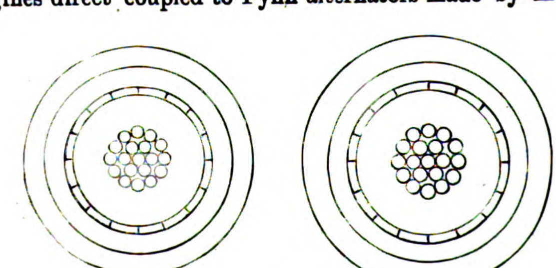
Before passing on to consider the other plant, it may be mentioned that, though no detailed tests have yet been made to show the effect of the superheater, the steam is apparently very dry, there being, as a rule, no water deposited in the separators. The fuel at present used is a mixture of



H.T. concentric.
19/16 S.W.G. section ·0625 7/14 S.W.G. section ·0359. 7/16 S.W.G. section ·0230.

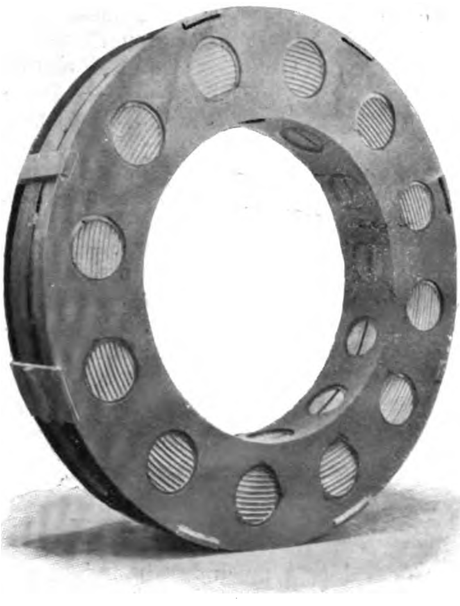
three parts of coke to one of Welsh coal, the price of the former being 12s. and of the latter 20s.

We have already referred to the interior of the dynamo room. The plant at present erected consists of three Willans engines direct coupled to Fynn alternators made by Messrs.

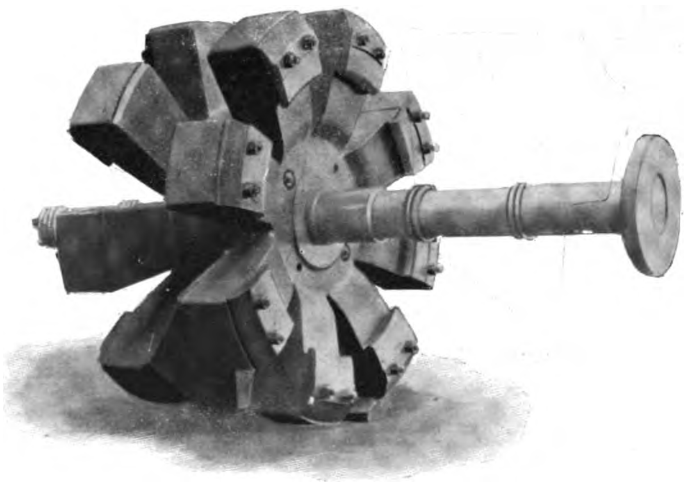


H.T. concentric.
19/15 S.W.G. section ·079. 19/14 S.W.G. section ·0976

Easton, Anderson & Goolden. The engines are of Willans three-crank compound condensing type working at a steam pressure of 130 lbs., and developing 200 B.H.P. The alternators, to which we have not had previously an opportunity of referring, are of the inductor type, running at 380 revolutions and having a ~ of 50. The armature forming the outer frame of the machine, the field magnets (the



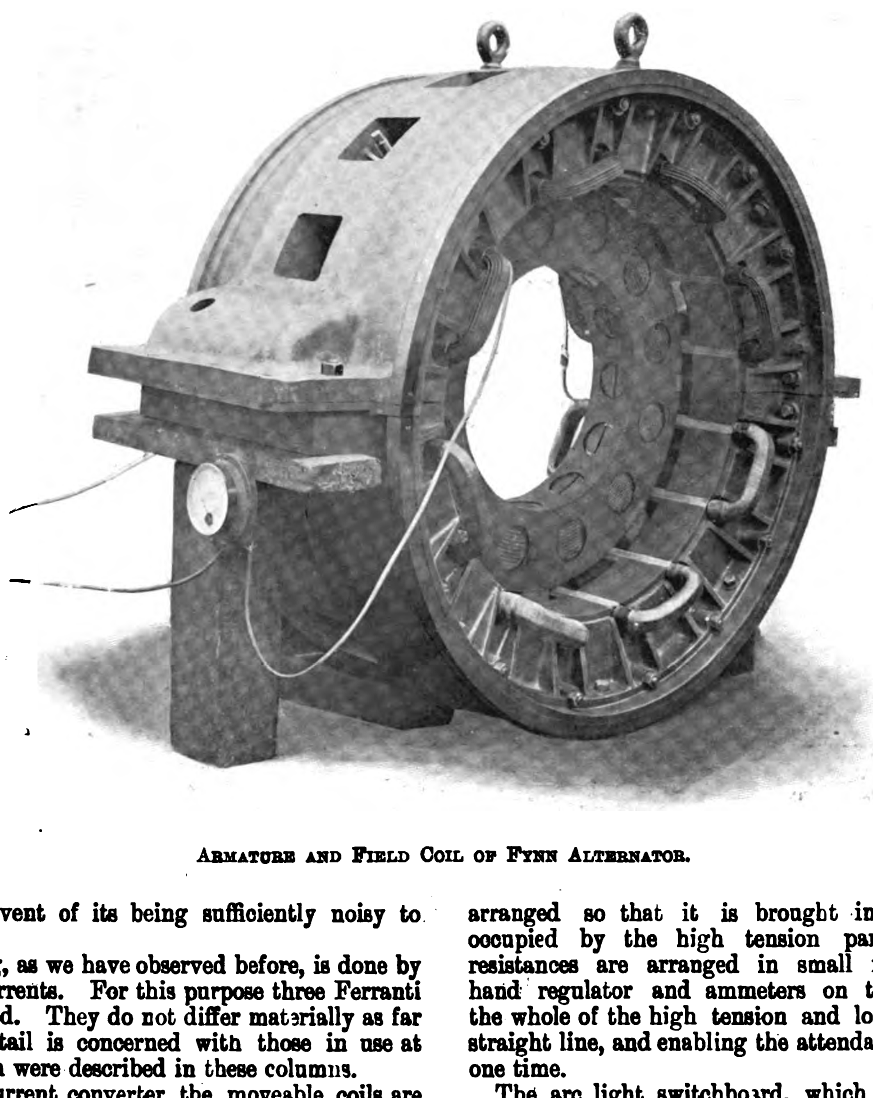
Field Coil of Fynn Alternator.



Field Magnets of Fynn Alternator.

revolving part) being mounted on the main shaft of the alternator.

There are eight armature coils in each machine, which are wound with stranded double cotton-covered cable. The coils are laid in paper tubes, and laid in slots in the laminations. Inside the armature frame is placed the field magnet coil, which is supported on brackets, this being shown in one of the illustrations. The field magnet coil occupies a position in the completed machine, between the poles of the revolving field magnets. It will be observed from the illustrations that the two circles of pole pieces are so arranged, that the poles in one circle are opposite the gaps in the other circle. The inside diameter of the armature is 4 feet 6 inches, and the width is 40 inches.



Armature and Field Coil of Fynn Alternator.

The alternators have been specially designed for noiseless running, there being a stringent condition in the specification compelling the contractor to remove the machinery to another site in the event of its being sufficiently noisy to create a nuisance.

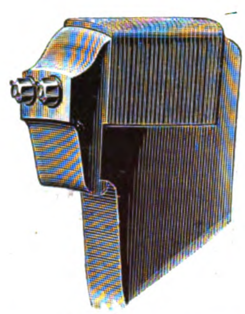
The street lighting, as we have observed before, is done by means of rectified currents. For this purpose three Ferranti rectifiers are employed. They do not differ materially as far as constructional detail is concerned with those in use at Hammersmith, which were described in these columns.

In the constant current converter, the moveable coils are supported on toothed wheels which gear into a rack. On the top of the constant current converters is mounted a base plate carrying the alternating current motor, and on the end of the shafting of the alternating current motor is arranged the high tension commutator with its rocker and brushes complete. At one side of the constant current converter is attached the two-unit converter required for running the alternating current motor, and on the other side is attached the water break switch which is connected in series with the arc lamps.

The switchboard is similar in construction to the now well known type of Ferranti switchboard, the board being composed of slatework partitions, so as to be thoroughly fireproof throughout. Each partition forms a separate dynamo, or circuit panel, each one being provided with a special spring break switch.

Each panel is provided with a duplicate set of fuse contacts and oil break fuses, the arrangements enabling any fuse to be withdrawn and examined whenever desired without interfering with the working of the circuit. On each panel is arranged a vertical scale ammeter. The bus bar is arranged on the ring main system, enabling any circuit to be isolated and the remainder of the circuits to be run without interference. The usual synchronising arrangements are provided. Low tension gear is also attached to this board and is arranged so that it is brought into the 6-inch centres occupied by the high tension panels above it. The resistances are arranged in small resistance boxes, with hand regulator and ammeters on the top, thus placing the whole of the high tension and low tension gear in one straight line, and enabling the attendant to attend to both at one time.

The arc light switchboard, which is placed near to the rectifiers, is arranged for controlling three rectifiers and the respective circuits; it is, however, arranged to enable any new rectifier to be connected at once on to any circuit or any rectifiers running any number of circuits together. It is provided with a plug box on the bottom of the board, which plug box receives the current from main board and distributes it to each rectifier through an independent fuse. The plugging arrangement of this board is noteworthy, the plugs being attached to flexible cords and weighted with a



Showing Methods of Fixing Pole Pieces in Fynn Alternator.

pulley, so that when not in use they are kept in a fixed position. Each circuit is provided with an ammeter and pole indicator. A voltmeter is arranged with a plug and a pair of flexible cords, plug sockets being fixed for each circuit panel, so as to enable one to ascertain the voltage of any circuit.

The outside work reveals nothing that can be considered very novel. The low pressure distribution is accomplished from scattered transformers placed in the roadway. The street lamps are not placed on alternate mains, but one main feeds the whole of the lamps in one part of the town and other mains supply current to other sections.

The transformers are of the Berry type, and have been made by Messrs. Nalder & Harrison. The sizes are 30 kw., 20 kw., and 10 kw. In most cases they are placed in sheet steel cases, which are in turn placed in cast-iron road boxes, which have separate spaces for the high and low tension switches and fuses.

We illustrate some of the sections of the mains in use which have been laid by the British Insulated Wire Company.

Some of the high tension cables are laid in Doulton conduit, and some are laid in wooden troughs filled in with a hard-setting compound. The low tension cables are double steel armoured, and laid direct in the ground.

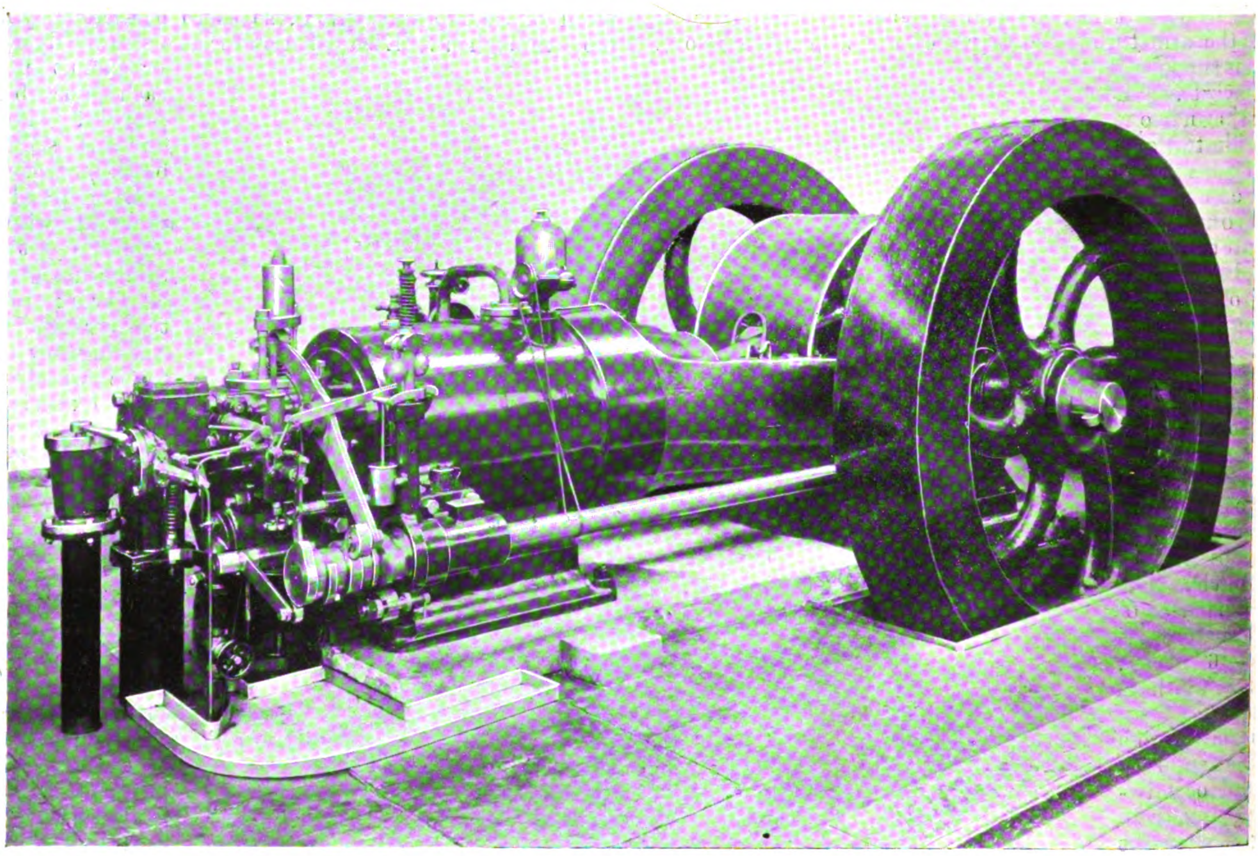
The arc lamp columns (which are supplied with overhanging brackets) have been supplied by Messrs. James Allen, sen. & Sons, of Glasgow, and the arc lamps are of the Crompton-Pochin type.

The demand indicator system is in use, and at the opening ceremony 3,600 8-C.P. lamps had been connected, which augurs well for the future prosperity of the works.

The principal contractors are as follows:—Boilers, Messrs. Babcock & Wilcox; engines and alternators, Messrs. Easton, Anderson & Co.; cables and street work, British Insulated Wire Company; switchboard, Messrs. Ferranti, Limited; transformers, Messrs. Nalder & Hilton; crane, Messrs. Isles, Limited. Mr. Trentham, the consulting engineer, is to be congratulated upon bringing the lighting of Torquay to a successful issue in the face of much opposition and difficulty.

100 H.P. GAS ENGINE.

It cannot be denied that much has been done during the past few years to develop gas engines for electric lighting. One of the latest types that has been specially designed by Messrs. Fielding & Platt for the driving of dynamos is one of 100 H.P., which was exhibited at the Brussels Exhibition, an illustration of which is given here. As far as we can learn, the cyclical variation in this engine does not exceed $\frac{1}{2}$ volt. This result is obtained by having an impulse at each cycle, no matter what the load may be, from no load to full load. The method in which this is carried out is very satisfactory, so that, even when running absolutely light, the charge is stated to be fired with the greatest certainty.



Fielding & Platt 100 H.P. Gas Engine.

The cylinder has a diameter of 20 inches, with a stroke of 27 inches, the crankshaft being 8 inches in diameter in the main body, whilst the crankpin is 11 inches in diameter, the main bearings being 14 inches in length, and the crankpin 10 inches. The crank is balanced by a pair of counterweights strapped to the crank throws, and continuous lubrication of the crankpin is provided for by an annular oil channel, into which the oil is dropped from a fixed sight-feed lubricator. The engine was designed for driving two dynamos, one from each fly-wheel, the latter weighing about 5 tons each.

The engine is fitted with Fielding's self-starter, the action of which is as follows: The crank being placed at an angle of about 15° above the near dead centre, gas is admitted to the combustion space, and an outlet opened near the flame of the Bunsen burner, which heats the ignition tube; this outlet permits of the escape of air as the gas enters. As soon as the gas begins to escape along with the air, a blue flame is formed; and as the proportion of gas to air increases, the colour of the flame gradually changes to a yellow luminous flame. As soon as the flame indicates that the escape is practically all gas, the outlet is closed, and the gas shut off. All that is required now to start the engine is to admit compressed air, which, entering the clearance space, rapidly mixes with the gas, forming a highly explosive compound under a pressure of usually about 60 lbs. per square inch.

Before sufficient air can obtain admittance to form an actively explosive mixture, the piston is put slightly into motion for a short distance until the explosion takes place, whereupon the motion of the piston is greatly accelerated, and the engine is put into action with sufficient force to enable the ordinary cycle to follow on.

The compressed air is stored up by the engine itself into a small reservoir, the energy stored up in the fly-wheels serving for this purpose, the gas for the moment being cut off, and when required, a separate charging pump is fitted, worked either by hand or by power, but as a rule this is unnecessary.

TELEGRAPH AND TELEPHONE NOTES.

(*Continued from page 442.*)

The Bolinao Cable.—A telegram in the daily press, dated Singapore, March 23rd, stated that the telegraph steamer, *Sherard Osborn*, was leaving there for the Philippines for the purpose of transferring the Bolinao cable to Manila. The transfer will be permanent.

Direct Cable to Cuba.—The following is a translation of an article appearing in *El Imparcial re* the above cable:—"The Ministry of the Interior has reported favourably on the tender for the laying of a direct cable between the Peninsula and the island of Cuba. The cable will land at Cadiz, Santa Cruz de Tenerife, Nieques (an island situated 15 kilometres to the east of Porto Rico), and finally, at Havana. The cable will not, contrary to the interest of the nation, be laid to St. John, Porto Rico, as the company owning and working the cables in the lesser Antilles have exclusive landing rights for 40 years at that island, and for this reason neither the Government or any private company can establish telegraphic communication which they may consider necessary. The report has already been passed on by the Minister of the Interior to the Minister for the Colonies for the embodiment of Government rights and privileges, and the decree calling for tenders for the laying of the cable will soon appear." Another paragraph states:—"The Minister of the Interior had an interview with the Minister of the Colonies for the purpose of preparing the report asked for by the Council of Ministers on the cable between the Peninsula and Cuba. The report will deal with two proposals, one being for the construction of the direct cable, and the other for a branch cable from Havana to Hayti to connect there with the French system."

Another issue of the same paper states:—"The news that the Ministers of the Colonies and the Interior have been entrusted by their colleagues in the council with the decision regarding the matter of the direct cable to Cuba, and, further, that there are two proposals to be dealt with, viz, (1) offering to construct a direct cable, and (2) a branch cable from Havana to Hayti, there to be connected to the French system, has given rise to certain fears, which we find to have serious foundations, as by the latter scheme we should merely be ridding ourselves of the control of our communications by Great Britain and the United States to transfer it to the French. The *Nacional* states if the direct cable is not to be laid, rather than allow all the traffic to be handed to the French Cable Company, let the state of affairs remain as at present. Our contemporary asks for more light upon the subject from the Ministerial press, and we join in the demand, as we endorse their opinion."

Glasgow Telephone Service.—On 24th ult., the Corporation deputation had a private interview with the Postmaster-General, at Norfolk House, on the subject of granting a municipal telephone license for Glasgow. Various points were enlarged upon by the deputation, and the Duke expressed his desire to act impartially. He asked if the granting of a license conditionally might not be held to prejudice any opposition. The deputation replied that they were perfectly willing that the granting of a conditional license should be so safeguarded and hedged in as to leave most unfettered discretion to Parliament in dealing with the Corporation's proposals. In the course of the conversation the deputation repeated the decision of the Town Council under no circumstances to grant the telephone company the right to utilise the streets. The Duke of Norfolk assured the deputation that he thoroughly understood the position, that he would give it his careful consideration, and that he would communicate with them shortly.

Secrecy of Telegrams.—We understand that on 22nd ult. a notice was issued by the Postmaster-General to the postal staff, calling attention to a question recently addressed to the Secretary to the Treasury in the House of Commons upon the subject of the secrecy of telegrams. The construction of private apartments in postal telegraph offices was advocated as a means of greater privacy being secured to the public while handing in telegrams. The Postmaster-General enjoins the counter clerks to deal with telegrams in such a manner as to preclude them being read by the public.

The Telephone Service.—About 20 members of Parliament, under the presidency of Mr. Provand, met at the House of Commons on 24th ult., and decided to put down a motion in favour of the Post Office granting licenses to local authorities to work telephones of their own.

In the Commons on 22nd ult., Sir M. Stewart asked the Secretary to the Treasury, as representing the Postmaster-General, whether any judicial decision has ever been given that a telephone instrument is equivalent to a telegraph except as regards the Postmaster-General's monopoly of the right of conveying messages by wire.

Mr. Hanbury, in reply, said the decision that a telephone is a telegraph was given by the Exchequer decree of the High Court of Justice in the case of the Attorney-General *v.* the Edison Telephone Company. This case arose on the right of the Postmaster-General to a monopoly to conveyance of messages by wire. The exact words of the judgment, "For all these reasons we hold that the telephone is a telegraph within the meaning of the Acts of 1869 and 1863," are very wide.

A sub-committee of the Hull Corporation has been going into the question of the telephone charges and service generally, with the National Company's officials.

CONTRACTS OPEN AND CLOSED.

OPEN.

Accrington. — April 19th. The Corporation wants tenders for the supply and erection of three sets of steam dynamos, each set consisting of a triple expansion condensing steam engine of the inverted vertical type, 90 I.H.P., and of a shunt wound dynamo. Also a feed water heater, storage battery having a capacity of 750 ampere-hours, switchboard instruments, apparatus cables, wires, street boxes, connections, &c. For further particulars see our "Official Notices" this week. Consulting engineer, Mr. J. N. Shoolbred, 47, Victoria Street, S.W.

Ashton-under-Lyne. — April 5th. The Corporation invites tenders from firms willing to undertake the free wiring of premises in the Borough. Consulting engineers, Messrs. Lacey, Clirehugh & Sillar, 78, King Street, Manchester. See our "Official Notices" March 25th.

Bournemouth.—April 4th. The Corporation wants tenders for motor vehicles for the collection of house refuse, &c. Borough engineer, Mr. F. W. Lacey. See our "Official Notices" March 18th.

Derby.—April 12th. The Corporation wants tenders for the electric wiring of its Ford Street yard and premises. See our 'Official Notices" March 18th.

Derby.—April 11th. The School Board want tenders for the electric wiring of the Traffic Street Board School, Derby. Particulars from Mr. J. E. Stewart, Corporation electrical engineer. See our "Official Notices" March 25th.

Edinburgh.—April 23rd. The Midlothian and Peebles Lunacy Board is inviting tenders for the installation of electric light in the Asylum at Rosslynlee, near Edinburgh, including (1) generating plant, accumulators, switchboard, &c.; (2) wiring, fittings, &c. Particulars may be obtained on application to Prof. Bailey, Heriot-Watt College, Chambers Street, Edinburgh.

Leyton.—April 4th. The District Council wants tenders for the supply of two dynamos, one transformer, two gas engines and connections, and switchboards for extension of the electricity works. Electrical engineer, Mr. H. C. Bishop. See our "Official Notices" March 18th.

Manchester.—April 4th. The Lancashire and Yorkshire Railway Company is inviting tenders for various stores. The following are a few of the items:—5. Copper; 7. Copper tubes for boilers; 8. Copper tubing; 29. Signal and telegraph fittings; 30. Signal, telegraph and electric light wires. Samples may be seen and forms of tender and further particulars obtained at the Stores Department, Osborne Street, Manchester.

Shoreditch.—April 12th. The Vestry wants tenders for the supply and erection of arc lamps and accessories, also for electric light cable. Electrical engineer, Mr. C. N. Russell. See our "Official Notices" March 25th.

Switzerland.—April 30th. Plans and estimates are being invited, says the *Contract Recorder*, by the Government authorities of Fribourg, Switzerland, until April 30th next, for a projected electricity generating station to be established at Hauterine. Water-power is to be utilised, and the station will have a capacity of about 6,000 H.P. A premium of £120 will be awarded to the three schemes submitted which are considered to be the best. Plans and estimates are to be sent to the Department des Travaux Publics, Fribourg, Switzerland, from whence full particulars of the competition may be obtained.

The War Office.—April 27th. The Secretary of State for War is prepared to receive offers, competitive designs and specifications for the supply of portable electric search light apparatus. Particulars from the Director of Army Contracts, War Office, Pall Mall, S.W. See our "Official Notices" February 4th.

Victoria.—June 24th. The Council of the city of Hawthorne (Colony of Victoria, Australia) is inviting tenders for the supply and erection of buildings, boilers, engines, dynamos, transformers, mains, meters, arc lamps, poles; also running the plant for three years. See our "Official Notices" March 11th.

CLOSED.

West Ham.—The Town Council has accepted the tender of Messrs. H. J. Rogers & Co. (£712) for wiring the public buildings for electric lighting. The Council hopes to be able to supply electricity to consumers in September next.

FORTHCOMING EVENTS.

1898.

Friday, April 1st, 8 p.m.—Institution of Junior Engineers at the Westminster Palace Hotel. Paper on "Mechanical Refrigeration," by Mr. J. T. Burrell, of Peterborough.

Royal Institution. Lecture by Prof. Dewar on "Liquid Air as an Analytic Agent."

Saturday, April 2nd, 11 a.m.—Visit of the Institution of Junior Engineers to the Thames Iron Works, Blackwall.

Tuesday, April 5th, at 8 p.m.—Röntgen Society, at 11, Chandos Street, Cavendish Square, W. Paper by Mr. James Wimshurst upon "The Influence Machine and its Advantages for lighting X-Ray Tubes."

At 8 p.m.—The Institution of Civil Engineers. Paper to be read (time permitting) on "The Electricity Supply of London," by A. H. Preece, Assoc.M.Inst C.E.

NOTES.

In Honour of M. Gramme.—By royal decree on December 30th last, M. G. Gramme was nominated Commander of the Order of Leopold. On this occasion the international jury of the electrical sections of the Brussels Exhibition of 1897 decided unanimously to organise at Brussels a demonstration in honour of the celebrated Belgian electrician, and to celebrate his admission into the Order of Leopold by a banquet, to which electricians of all countries should be invited. The date of this celebration was fixed for March 27th, and it was to be commemorated by a medal, two impressions of which were to be struck, one in gold, and one in silver, to be forwarded to M. Gramme on the day of the banquet. Senator Montefiore Levi, founder of the Electro-technical Institute of Liège, honorary president of the Belgian Society of Electricians, and of the Association of Engineers from the Montefiore Institute, accepted the post of honorary president of the committee formed for the organisation of the demonstration, M. Mascart being the acting president. The subscriptions were received by M. Alfred Roosen, secretary of the organisation committee, Rue Vould, 64, Brussels.

Our Torquay Photographs.—The views of the central station and the operation of laying the mains given in our article on the "Electric Lighting of Torquay," have been prepared from photographs taken by J. C. Dinham, Torquay.

A New Departure in Incandescent Lamps.—Prof. Nernst, the well-known electro-chemist, has recently been experimenting with the view of discovering a better filament for the glow lamp, and has produced a lamp which is decidedly more efficient than the present filament. It remains to be seen whether the new filament will be more durable. According to recent theories of electrolysis, all electrolytes are more or less dissociated when dissolved in water, and it is these dissociated molecules which carry an electric current through the electrolyte. If none of the molecules of the electrolyte have been dissociated, no current will pass, except the E.M.F. of the current is exceedingly high. Dissociation of the molecules of electrolytes may also be brought about by heating them to a high temperature, and they become conductors of electricity in the same way as when they are dissociated by solution. It is this fact that has been utilised by Nernst in the construction of his new electric lamp. A thin rod of magnesium oxide, calcium oxide, or such like compound, is heated, in the first place, by a Bunsen burner to a red heat, and an electric current is then passed through it. If this current is sufficiently strong to develop enough heat to replace that which is given off, then, when the Bunsen burner is withdrawn, the current will maintain the rod at a white heat. A practical objection to this lamp is the preliminary heating; such lamps would, in fact, have to be lighted like the old-fashioned gas or paraffin lamps. The ingenuity of inventors may, however, yet overcome this difficulty. Since the temperature of ignition of the lamp depends on the electrolyte which is used, it is important to know which of these substances become conducting at the lowest temperature. With rods of equal dimensions, calcium oxide requires the oxyhydrogen blowpipe to bring it to the required temperature, while it is possible to start magnesium oxide by heating with a Bunsen flame. Nernst uses in his lamps magnesium oxide, which can be bought in the form of rods, and he recommends that the lamp should be ignited by the discharge of an induction coil. The ignition by the induction coil is not likely to be used in practice. Another method which has been proposed [*Zeit. f. Elek.*, Vol. 16, p. 103] is to embed a carbon filament in the magnesium oxide or other electrolyte made use of. When the rod is cold, the carbon filament will form a path for the current, and gradually communicate sufficient heat to the surrounding electrolyte to raise it to the conducting temperature. Platinum could not be used instead of the carbon, because it would fuse at the very high temperature developed in the Nernst lamp; and besides, all metallic threads would shunt too large a fraction of the electric current past the electrolyte. The efficiency of these Nernst lamps has been found to be extremely high, about 1·1 watts per candle-power; and it is estimated that in a vacuum the candle-power would be obtained with 0·7 to 0·8 watt. The life of such lamps as have been tried has not been very long. If it be true that electrolysis is taking place in the incandescent oxide, we should expect that the ions would accumulate at the ends of the rod; and if such were the case, it would not be favourable to the longevity of the lamp.

The Treatment of Battery Slimes.—An electrolytic process is now being worked in South Africa by the Crown Reef Gold Mining Company, for treating battery slimes, and thus removing gold which would otherwise be lost. The process seems to be working very successfully, if we accept the data given by J. R. Williams in the *Transactions* of the Chemical and Metallurgical Society of South Africa, 1897, July, pages 14 to 18. In this paper the results of two months' working are given, during which 6,640 tons of slime were treated with an assay value of 5·82 dwt., yielding 1,067 ozs. of gold with an actual extraction of 60·48 per cent., and giving a profit of £3,058. The cost of treatment per ton is 3s. 9·05d., in which we note that 0·40d. is included for electric light, and 2·75d. for power. After successive periods of treatment of three hours each, by electrolytic precipitation, a solution containing 2 drw. 12 grains of gold per ton assayed 1 dwt. 4 grains, 20, 12, 8, 4, 2 and 0·5 grains; whilst, after 24 hours, only a trace of gold was left.

Society of Arts.—On Wednesday evening Prof. S. P. Thompson read a paper before this society on "Telegraphy Across Space."

Telegraphing Without Wires.—The system of "telegraphing without wires," that is without *direct* wires between the two stations to be in telegraphic communication, recently suggested and experimented upon with so much success by Mr. Preece, Engineer-in-chief to the Post Office, has just been successfully applied to permanently establish telegraphic communication for the War Office between Lavernock Fort and the fort on the Flat Holm (in the Bristol Channel), a distance of 3¾ miles. On the mainland opposite the island, an ordinary pole line, three-quarters of a mile long, with a heavy copper wire, has been erected; the ends of the circuit terminates in the sea. On the island there is a similar line established, about half-a-mile long. The transmitting apparatus (on each line) consists of a contact breaker worked by a small dynamo, running at 3,000 revolutions per minute, and giving 250 makes and breaks per second, corresponding to the middle C note; the intermittent current is given by 10 Obach dry cells. An ordinary Morse key interrupts the circuit, and the receiving apparatus is an ordinary telephone receiver. The installation has been carried out under the direction of Mr. Gavey, Assistant Engineer-in-chief to the Post Office, assisted by Mr. Taylor. It has been found impracticable to maintain communication between the two forts by means of a cable, as the latter was continually broken by the anchors of the shipping.

Riveting by Electricity.—On Wednesday, before the Institution of Naval Architects in London, a paper on this subject was read by Mr. Holmes (secretary) for the author, Herr F. von Kodolitsch. The experiments of the author had extended over two years, and he had succeeded in bringing out a type of riveting machine quite capable of superseding the two systems already existing, namely, hydraulic and pneumatic riveting. There was no difference in the quality of the work done, but the quantity by the electric system was considerably superior. The machine he was describing closed 1,200 rivets in a day of 10 hours, when operated by three men and a boy. Specimens of the work done were exhibited. Mr. Hammond called attention to the fact that to use the electric riveter it was necessary first of all to lay down all the requisite electric plant. Mr. A. Denny stated that with the usual day and hydraulic machinery from 1,000 to 1,100 rivets could be closed, and he knew of one gang, where everything was arranged, which closed 1,500 rivets in the day. He thought that the use of electricity was bound to be economically applied in the building of ships at no distant date. Mr. C. Dutton thought the machine described by the author was not so portable as had been claimed. Our readers will remember that in the ELECTRICAL REVIEW for October 30th, 1896, we described and illustrated several applications of Herr Kodolitsch's universal electric drill in the arsenal of the Austrian Lloyd's Steam Navigation Company.

Hull Electrical Exhibition, 1898.—We have received a prospectus giving full details of the Electrical and Industrial Exhibition, which it is proposed to hold from May 19th to June 4th, at the Assembly Rooms and Lecture Hall, Hull. The principal objects of the exhibition are those connected with the electrical development in lighting, transmission of power, telephones, and the economical application of electrical energy to practical work, and in view of the extension of the municipal electricity undertaking, the present is considered an opportune moment for such an exhibition. Diplomas of honour, and gold, silver and bronze medals, will be awarded to deserving exhibits, and for this purpose a number of well-known gentlemen have consented to act as jurors and referees. These include Sir Frederick Bramwell, Sir Douglas Galton, Prof. Fleming, Prof. Ayrton, and Messrs. C. Bright, H. Graham Harris, W. P. J. Fawcus, S. V. Clirehugh, W. C. Johnson, Shelford Bidwell, E. H. Crapper, S. H. Valentine, and Mr. A. S. Barnard, the Hull Corporation electrical engineer. Early applications for space should be made to Mr. Joseph Davis, manager, 3, Assembly Rooms, Hull.

Marriage.—By last mail we learn that Mr. W. Elsdon-Dew, electrical engineer, Pilgrim's Rest, Transvaal, was, on February 26th, married to Miss Jessie H. G. Rankin, eldest daughter of John Rankin, Esq., Australia.

Magnetism and Diamagnetism.—At the Royal Institution on Thursday last week, Prof. J. A. Fleming gave the fourth lecture of his course on "Recent Researches in Magnetism and Diamagnetism." Resuming the study of the properties of diamagnetic bodies, the lecturer showed, says the *Times* report, two experiments illustrating some of the remarkable properties of bismuth. Righi found that a bismuth wire placed in a magnetic field, and transversely magnetised, suffered a great increase in its electrical resistance, and Profs. Dewar and Fleming proved this effect to be enormously augmented at very low temperatures. Another peculiarity of bismuth was its marked exhibition of the "Hall effect." If an electric current was sent through a bismuth plate which was transversely magnetised, an electromotive force was brought into existence at right angles to the direction of the current and the magnetic field, and showed itself by causing a displacement in the equipotential lines. This effect occurred to some extent in all metals, but was several thousand times greater in bismuth than in any other case. Passing on to consider the relations between magnetism and heat, the lecturer first performed an experiment which rendered evident the effect of change of temperature on permanent magnets. A permanent steel magnet suddenly heated first lost a certain portion of its magnetic strength, and then reached a more stable condition, in which it was said to be "aged," a result which could also be attained by plunging the magnet into liquid air. After the permanent state had been reached, the effects of change of temperature became more regular, and recent research had demonstrated that certain kinds of steel could be produced which had no temperature-change of magnetic strength after ageing. Prof. Fleming then exhibited a number of experiments to show that the ferromagnetic bodies, iron, nickel and cobalt, all changed at a certain temperature, varying for each, into the paramagnetic state, in which they were practically non-magnetic. This change took place in nickel at about 340° C., and a pretty experiment was shown, in which a star-shaped disc of nickel, balanced on a pivot in front of a magnet, was set in rotation merely by being heated at one place. The disc in this way was rendered magnetically lop-sided, and the magnet continually pulled it round into a fresh position. In conclusion, some interesting experiments were performed to prove that the temperature at which this magnetic transformation took place was also marked by the occurrence of several other important physical changes.

Large Continuous Current Dynamos.—The most powerful continuous current dynamo now known is that constructed by the General Electric Company at Schenectady for the Louisville Tramways Company. This dynamo, which has 22 poles, will produce normally 2,400 kilowatts, at an angular speed of 75 revolutions per minute. In cases of emergency its available power can be augmented one-third, and raised to 3,200 kilowatts. The external diameter of the crown bearing the field magnets is 5·7 metres; the breadth of this crown is 1·25 metres. The diameter of the armature is 3·8 metres; the diameter of the commutator is 2·9 metres; that of the shaft 58 centimetres; the length of the armature is 1·5 metres; that of the commutator, 55 centimetres. The armature and its collector weigh 38 tons; the entire machine, 80 tons. Before this dynamo had been made, the most powerful type was that of 1,500 kilowatts, working the intra-mural railway of the Chicago Exhibition in 1893. Dynamos of this type have been installed at Philadelphia, Boston, and Chicago for the service of overhead tramways or railways. The tramway station at Brooklyn contains four, and two others are in course of installation. When the two latter are at work, the Brooklyn station will be next to that of the Niagara Falls, the most powerful electrical station in the whole world; but it will not long hold the record, as in two years there will be at New York a station of 70,000 kilowatts, supplying the whole tramway system of the town.

To our Readers.—As next Friday is Good Friday, our issue will be published on Thursday morning, and all matter for that number should reach this office a day earlier than usual. Advertisers, contributors, and correspondents, please note!

French Import Duties on Lead and Accumulators.—By an Act passed March 3rd, 1898, the import duties on lead, its rich ores and its various compounds, were modified or completed in accordance with the following table:—

Numbers.	——	General per 100 kg. in fr.	Tariff minimum per 100 kg. in fr.
239	Minimum	8.50	5.15
	Litharge and other oxides	8.75	5.30
225A	Salts of lead and chemical products with undenominated lead base	5 % *ad valorem* + 2.40 fr. per 100 kg.	5 % *ad valorem* + 2 fr. per 100 kg.
256	Acetate of lead ...	11 50	7.60
262	Carbonate of lead (white lead)	8 50	5.60
266	Chromate of lead ...	25.50	18 50
576	Pipes and all kinds of other work in lead ...	8.50	6.50
576A	Electric accumulators.	21 50	16 50

The Automobile Club of Great Britain.—This club intends, at Easter time, to make a tour on motor vehicles. The party will start from the club house on Thursday afternoon next, and journey through the southern counties, stopping at Guildford for the Thursday night, Winchester for the Good Friday night, Chichester for Saturday night. Worthing for Easter Sunday night, and Tunbridge Wells on Easter Monday night, and from thence returning to London. The carriages will in all cases be driven by amateurs. Fifteen owners of motor carriages have already notified their intention of joining the tour.

Obituary.—We regret to record the death of Mr. Stephen Alley, senior partner of the well-known firm of engineers, Messrs. Alley & Maclellan, of Glasgow. Mr. Alley's death occurred last week at his residence, Langside House, Glasgow.

A Coolgardie paper dated January 29th, records in very touching terms the death and funeral of Mr. Hubert Musgrove-Musgrove. By profession Mr. Musgrove was an electrical engineer, and was for some years representative in Australia of the Electrical Power Storage Company, but he was also an accomplished amateur violinist and a fluent linguist. Mr. Musgrove arrived in Western Australia a little over four years ago, and was well known and highly respected. He was only 37 years of age. Previous to going out to Australia, Mr. Musgrove carried on business in Glasgow for many years under the title of Norman & Son, and after converting the business into a limited company he became associated with the Electrical Power Storage Company. Latterly, however, Mr. Musgrove became interested in gold mining.

Burning or Barging of Refuse.—At a meeting of the Battersea Vestry last week, an important declaration was made on the subject of the disposal of refuse. For some time the Battersea Vestry endeavoured to destroy the parish garbage by destructors; but nine months ago this method was discontinued, and the refuse was consigned to Kent. Mr. West reported that the working of the new system was at first beset with considerable difficulties. There was, for instance, only one barge for conveying away the refuse, and a considerable quantity had still to be dealt with by the dust destructor. Notwithstanding this, however, the system had been a great success. It was estimated that, as compared with the cost of utilising the destructor, there would be a saving of £2,000 a year. Although only nine months had elapsed, and although the difficulties had been great, yet £1,600 had already been saved. He had no doubt that the estimate of £2,000 would be considerably exceeded.

Appointments.—Mr. Bates, of London, has been appointed electrical engineer to the Birkenhead Corporation by the Electrical Committee at £300 per annum.

The Co-operative Wholesale Society has appointed Mr. A. A. Blackburn, of Leeds, to the position of electrical engineer of their large works near Manchester.

The Electrical Installation at Oldham County Court.—In the House of Commons on Tuesday, Mr. Ascroft asked the First Commissioner of Works whether he was aware that local firms were not allowed to tender for the electrical installation recently put in the Oldham County Court offices; whether there was any rule which prohibited fully qualified firms tendering for such work, and whether he would consider the advisability of allowing all such firms in the future the opportunity of tendering for local work undertaken by the Board of Works. Mr. Akers-Douglas, in reply, said that there is no rule that prohibits qualified firms tendering for the work to which the question refers. In the present case the work had to be executed in a very short period of time for departmental reasons, and tenders were obtained from two well-qualified firms, who could be relied upon to do the work in the time required. Whenever circumstances permit, local firms will be invited to tender for works in charge of the Board.

Parliamentary Committee on Electrical Energy.—Yesterday (Thursday) Viscount Cross presided over the first meeting of the Joint Committee on Electrical Energy (generating station and supply) at the House of Lords, the members of the Committee being, besides the chairman, Earl Spencer, Lord Knutsford, Lord Monkswell, Lord Balcarres, Mr. Ashton, Mr. Kimber, and Sir Leonard Lyall. The points to be considered by the Committee we have already stated. The Committee sat in private, and decided to adjourn till April 21st, when Earl Morley and Sir Courtenay Boyle will be called as witnesses.

Lectures.—Mr. J. E. Stewart, manager of the Derby Electric Light Station, delivered a lecture on "Some of the Uses to which Electricity from the Corporation Supply can be Put," at Victoria Street Church Schoolroom, Derby, on Thursday last week.

Before the East of Scotland Engineering Association at Edinburgh on 22nd ult., Mr. R. W. Hogarth read a paper on "Recent Developments in Electrical Engineering." Electric traction and electric welding were dealt with.

The War Office and English Copper.—We must congratulate the War Office upon at last discovering that there is such a thing as English electrolytic copper. Up to the present the War Office have obtained their supplies from America, but we understand that four of the principal copper smelters in this country have been invited to send samples of their products to be tested by the War Office authorities.

London County Council Electricity Meter Tests.—On 29th ult. the L.C.C. finally approved of the revised rules and scales of fees for the testing of electricity meters and other services rendered by the Council under the Electric Lighting Acts and Orders.

Testing Accumulators.—As we go to press, Mr. Albert Campbell writes: "In the reply to my letter in your last issue your correspondent states that, when the voltage of a motor car battery has fallen from 50 to 45 volts, more current must be taken than at the start; but he does not assure us that this *can* be done in practice. His proposed test at constant watts does not, therefore, seem to correspond to anything possible in practical working."

Appointment Vacant.—The Dewsbury Corporation is wanting an electrical engineer (salary £250) to take charge of the electricity works. April 9th is the latest date for sending in applications to the town clerk.

Who Is It?—According to Wednesday's *Daily Telegraph*, an inmate of Spalding Workhouse Infirmary, who has just been removed to the workhouse at Docking, in Norfolk, has had a remarkable career. He was a son of a former Alderman of the City of London, who died worth £40,000. He was himself educated at Christchurch, and was a scholar and expert electrical engineer, but ultimately had to seek refuge in the infirmary at Spalding Workhouse.

Personal.—Mr. Lewis J. Steele, who was Mr. Gisbert Kapp's assistant at Messrs. Johnson & Phillips, and who has since acted as chief designer to them, is severing his connection with this firm after eight years, to take up the appointment of chief electrician to the well-known firm of Messrs. Veritys, Limited, at their works, Aston, Warwickshire.

CITY NOTES.

Another Mutual Improvement Company.

The prospectus of another Mutual Telephone Company, whose aim is to improve the telephone service of Manchester and other places, has been issued. It is frankly admitted that it will be necessary, before any new service can be started, to obtain a license from the Post Office; but the organisers of the company do not feel inclined to make this application till at least £80,000 has been subscribed. The prospectus seems to base its claim for public acceptance mainly on the grounds that the company will introduce important improvements, and that hundreds of public bodies have passed resolutions in favour of the company. The scale of charges suggested is curious, and worth noting. Non-shareholders, within a mile radius of the Manchester exchange, will pay £6 10s. for each telephone; holders of five shares, £5 15s.; and holders of 10 shares, £5 5s. It would be interesting to know how many shares are necessary to obtain a telephone for nothing; or following the sliding scale still further, at what number of shares does the company begin to pay the shareholder for having a telephone.

The Brockie-Pell Arc Lamp Company.

It cannot be denied that the results of the 17 months' working of this company have been unfortunate. We are not going to say that the directors have not had stupendous difficulties to contend with, and many of the troubles that have been experienced are not likely to occur again; but there have been unsatisfactory incidents disclosed in the short career of the company that are regrettable in the extreme. Considering that nothing had been done in the way of organising a factory when the company was formed, the prospectus ought to have been expressed in more moderate language. Salaries and directors' fees are items that do not seem to be quite in accordance with the period of trial and error through which the company has passed. However, the shareholders are well advised in adopting the report and putting their trust in the future.

Electric Supply Company of Western Australia.

The prospectus of this company, with a share capital of £100,000 in £1 shares, was brought before the public in the early part of this week. Some of the directors are well known in the electrical world, the chairman being Mr. Bennett Fitch, a director of the St. James's and Pall Mall Electric Lighting Company, and three directors are on the board of the British Insulated Wire Company. Much is made of the fact that the objects of the company are to take over from the Westralian Electric Lighting and Supply Company, Limited, the existing system of electric lighting now being worked in the town of Coolgardie, Western Australia. It must be always a satisfactory feature to potential shareholders to know that they are taking over an established undertaking "already earning profits," but naturally it is assumed that an established business which requires a share capital of £100,000 to purchase and to work must be something exceptional. We will examine the established business as far as we can in a moment. In the meantime we would note that, though prosperity in Western Australia is a matter at which all right thinking men should rejoice, we are obtuse enough to suggest that the increase in the revenue of the colony which is made much of by the prospectus has very little connection with the electric lighting of Coolgardie. Now let us go a little closer into the business and concessions which are to be acquired by this company. Coolgardie seems to be very much of a mushroom town, and owes its sudden rise to the proximity of the Western Australian gold mines. It is only five years since the first settlement was made, but in November, 1897, the population of Coolgardie and district is given at 20,000. Truly a remarkable increase! The company acquires what is, no doubt, valuable freehold land in one of the main central streets of Coolgardie, on which works are built and electrical machinery erected. The concessions acquired include the sole right to supply electricity in Coolgardie for 25 years, and rights to carry electric cables to the gold mines. No doubt those are valuable privileges, and are worth something. That is not all, however, for the electric lighting business which is to be acquired has been working since July 10th, 1897, and the gross receipts are stated to be equivalent to £9,500 per annum. For these various items the sum of £70,000 is to be paid, which, at least, shows that the vendors have confidence in the value of the business.

No details are given of the size of the electric lighting plant, or of the original cost, and, indeed, there is a marked absence of information as to the value of the assets to be acquired for £70,000. It argues a large measure of faith in the public to propose a company, with a capital of £100,000, with such ill-defined assets and property as shown in the prospectus of the Electric Supply of Western Australia.

Metropolitan Electric Supply Company, Limited.

Sir Eyre M. Shaw, K.C.B. (chairman), presided on Tuesday morning over the eleventh ordinary general meeting of the above company, held at Winchester House.

The Chairman said: In rising to move the adoption of the report and accounts, I desire as usual to offer a few remarks, though I think that these accounts are given in sufficient detail to obviate the necessity of detaining you very long in explaining them. Dealing first with the capital accounts as shown in Statements 1 and 2, you will see that the only capital raised during the year has been £62,500, the balance of the £125,000 new capital issued in 1896, and which from June 30th, 1897, became part of the ordinary share capital of the company. Statement No. 3 deals principally with the expenditure on capital account amounting during the year to £93,795 16s. 10d., with a grand total of £850,831 19s. 9d., and a balance of £29,597 18s. 10s., which is now practically expended, a matter to which I shall have to refer later on. The principal items of expenditure have as usual been the continually extending mains, which account for £38,869 12s. 5d., and the expenditure on transformers and meters for the supply of the increasing list of our customers, who now number about 6,000. These two items, transformers and meters, with their connections, absorb £15,823 4s. 2d., making with the mains an expenditure of £54,692 16s. 7d., or considerably more than half of the total sum expended during the year. The remaining items of any importance are lands, £12,801 8s. 5d. being the cost of purchase of our new site for generating works at Willesden; buildings, £9,445 18s. 11d., represented by extensions at Amberly Road, Sardinia Street, and Manchester Square; and machinery, £15,367 16s. 1d., which has been expended on account of equipment of those extensions, an equipment which when completed will materially increase our facilities for supplying our customers. We will now turn to the revenue account, which shows the result and cost of our working during the year, and from this account it will be seen that the income from current is steadily increasing, giving a total revenue of £138,267 14s. 6d., as against £116,459 4s., an increase of about £22,000, or 19 per cent. The expenditure to earn this larger income also shows, as will be expected, an increase, but not to so great an extent, being for cost of generation £58,604, against £52,619, an increase of £5,985, or 11½ per cent., principally due to the increased consumption of coal and oil, and a total revenue expenditure of £79,546, against £70,267 in 1896, being a total increase of £9,279, or 13 per cent. as compared with 19 per cent. increased income, as already stated. The increases shown in distribution have arisen from the extensions of mains and developments of the system of low pressure distribution, while the growth of management expenses has been caused partly by necessary additions to the company's staff, in order to cope with the rapidly increasing work, and partly by the larger amount of the directors' fees. With regard to these fees, I think it right to remind you that some years ago the board agreed among themselves to take a very considerably reduced remuneration from that allowed by the articles of association, until the company should be earning substantial dividends, and that even at the present time the full amount allowed by the articles is not drawn. As I informed you at our recent extraordinary general meeting, the number of new customers continues at even greater rate of increase than at any former period in our history, and there are many indications tending to point to a still more rapid growth in the immediate future. Believing as we do that to be truly a success the electric light must be regarded less as a luxury and more of a necessity, we have, after the most careful consideration, decided to make substantial reductions in our rates of charge from the commencement of the present year, which, though they may affect our revenue to some extent for a little time, will, we feel convinced, in the long run amply justify our policy by the extended business which it will bring to us. This continual increase, while it is extremely satisfactory as pointing to the continued growth of our business, involves us in the obligation of making adequate provision for our future requirements. I have already informed you of the reasons which led us to procure a most advantageous site at Willesden on which it is intended to erect large generating works, the existence of which will relieve us from any anxiety for many years to come. By gradually extending these works as occasion may arise—and there is ample space at our disposal for doing this—we can place no limit to the amount of power which can be produced. Intimately connected with these extensions as affecting our cost of manufacture and distribution, which it is our earnest desire to reduce to their lowest possible figures, is the development which we have now in progress for changing our system of supply in those portions of our areas where the lamp density warrants the laying down of low pressure mains, and we have every reason to hope that a large portion of this work will have been completed before the close of the present year. The mention of these new works leads me naturally to the question of new capital. Before, however, dealing with this matter, I propose to lay before you, as briefly as possible, the result of our recent negotiations with the holders of the founder shares. You will remember that, at the last general meeting, an undertaking was given by me that efforts would be made to come to an arrangement with the founders for the extinguishment of their rights. We accordingly gave the subject our most careful consideration, and after taking the opinion of our financial and legal advisers, we prepared a scheme which had, as its basis, an allotment of 140 new ordinary shares at par in exchange for each founder share. The agreement embodying these proposals was sent to the founders, together with a circular, in which the views of the directors were fully explained. The meeting which was held to consider these proposals resulted in the appointment of a committee of the founders to negotiate with the directors, and the result of the deliberations of this committee is embodied in the following letter:—"The committee appointed by the holders of founder shares to report on the offer made by the board has very carefully and fully considered the directors' proposal, and has unanimously determined that the offer is inadequate, and should be declined. The committee is confirmed in this opinion by comparing the terms with those accorded to founder shareholders in other leading electric supply companies. The committee has ascertained that holders of a considerable number of founder shares prefer to remain as they are, and will not entertain any offer less favourable than the allotment of 300 ordinary shares at par." To this letter the board replied that this offer was not one which they could consider themselves justified in recommending the ordinary shareholders to accept. As the result of another attempt to effect an arrangement, we have lately received a further letter from the founders' committee suggesting that the founders might accept an allotment of 250 ordinary shares, but the directors are still of opinion that these terms are far too high, and that the ordinary shareholders would be unwise to accept even this reduced basis of settlement. We very greatly regret the failure of these negotiations, for it would manifestly have been to the best interests of the company as a whole that they should have succeeded. In our circular to the founders we indicated that in our opinion the ordinary shareholders could not be asked to pay a premium on any issue of new shares, seeing that the effect of this premium would be, as we think, unreasonably to improve the position of the holders of the founders' shares at the expense of the ordinary shares. To this opinion we adhere, and unless within a very short time we are able to come to terms with the founders we shall probably issue a large portion of the new capital to the existing shareholders at par, though it is our intention to postpone dividends on these shares until the new works can fairly be expected to be earning their proper proportion of revenue. We have been informed that at least one of the founders intends to attempt to restrain us by legal means from adopting this course on the ground that by doing so we are prejudicing the rights of the founders. Well, gentlemen, much as we regret the possibility of this course being taken, we think it best that once and for all the discretion of the board in matters of this kind should be clearly defined. One other point connected with this subject, and I have done. It is best raised by reading to you from a letter we have received from Mr. Orrell, in which he says:—"Permit me to point out to the directors that the item 'Premiums on debenture stock and new shares,' &c., £35,429 9s. 7d. in account No. 3, capital account, is clearly not an item of capital account, but of revenue, and is a net profit, and should be treated as such, and be placed in Account No. 4, which, after deducting 10 per cent, in accordance with Art. 132 of the company's articles of association, is available for dividend, and should be paid to the shareholders. I hereby give notice to the directors that I object most strongly to this sum of £35,429 9s. 7d., less 10 per cent. being placed to reserve funds without the consent of three-fifths of the holders of the founders' shares being obtained, and it is my present intention of moving at the general meeting that the accounts be rejected and amended in manner above stated, and the full dividend paid. It is with very great regret that I feel compelled to take this step, which is most distasteful to me, but there is no other alternative, after the expression of the views of the directors contained in their letter of January 20th, 1898, with regard to the rights of the founders' shares, and the expressed intention of the directors to issue to the shareholders *pro rata* a large amount of ordinary shares at par, which I am advised by Mr. Charles Jenkins, Q.C., would be a breach of trust on their part. What security have the founders' shareholders that if the net profits fall short at any future time the directors will not appropriate this £35,429 9s. 7d., to augment the dividends on the ordinary shares? I trust the directors will give the founders some assurance that in issuing the new capital they will obtain the best price which can reasonably be obtained for the new shares, and I feel sure that the consent of three-fifths of the holders of the founders' shares will be obtained to place the whole of the premiums to a reserve fund for the benefit of the company; but in this matter I speak for myself only." I think you will agree with me, gentlemen, that Mr. Orrell has succeeded better than I could ever have ventured to do in justifying the policy of the board, by pushing to its extreme limit the consequences of issuing shares at a premium. He asks us to place the whole of the premiums already received (less 10 per cent.) to revenue account, and a little further on he requests us to give the founders an assurance that the board will obtain the best price they can get for the new shares, feeling sure (though he only speaks for himself) that the founders will agree to the placing of such future premiums to reserve. With regard to the sum of £35,000, this has not been treated, and in our opinion ought not to be treated, as a revenue profit for any dividend purpose whatever, and the same remark applies to any future premiums. If Mr. Orrell's contention be valid, that it is the duty of the board to treat premiums as profits divisible as dividend, after deduction of 10 per cent. as reserve, it will be seen that, the dividends being immediately forced up above the 7 per cent. limit, the founders will obtain a very large proportion of such premiums at once, while the security of the ordinary capital in respect to its future repayment will be proportionately diminished. Of course, whatever Mr. Orrell may say, the holders of founders' shares cannot treat premiums both as revenue profits, and as reserve as well, but it is clear that in either case the issue of shares at a premium will be more to their benefit than to that of the ordinary shareholders. With these remarks, gentlemen, I beg to move the following resolution:—"That the report and accounts for the year ended December 31st, 1897, presented to this meeting be and are hereby approved and adopted, and that in addition to the interim dividend of 5s. per share paid on October 15th, 1897, a further dividend of 7s. per share on the whole of the original ordinary shares, and of 6s. per share on the new shares of the company be and the same is hereby declared, such dividends to be payable on March 30th, 1898, to all holders on the company's registers on March 19th, 1898."

Admiral Sir John Hay seconded the motion.

Considerable discussion followed, and several speakers expressed the hope that every effort would be made to arrange the matter amicably with the founders.

Mr. Orrell moved and Mr. Baldwin seconded an amendment that the report be not adopted; but the Chairman pointed out that was simply a negative to the motion for the adoption of the report.

The report was carried by a large majority.

Willans & Robinson.

Mr. M. Robinson presided on Wednesday afternoon at the ordinary general meeting of the shareholders of the above-named company held at the City Terminus Hotel, Cannon Street. After the secretary had read the notice convening the meeting, the directors' report and accounts were taken as read.

The Chairman moved the adoption of the report and statement of accounts, and in so doing said he thought he might safely state that, in view of the many difficulties they worked under last year, the accounts were equally satisfactory for the past and promising for the future. If the great strike passed them by, so far as concerned the relations between the company and their own workpeople, which were never better, yet many firms upon whom they depended for assistance in the form either of stores or of finished engine parts, or of tools for their works, had their shops brought wholly or partly to a stand. These labour troubles had reflected heavily upon the company, causing some of their capital to remain idle, and keeping down their output of engines. Tools ordered over a year ago were still undelivered, and thus a part of their capital had been idle for a year, drawing interest while producing no engines. They were, however, gradually surmounting the many troubles entailed by the strike, and he had no doubt that they would agree with him that the balance-sheet now submitted was even more satisfactory, as the outcome of a difficult time, than if it represented a period when all had gone well with them. The moderate increase in the dividend now recommended might have been paid before, but the fixed policy of the directors was to make sure of every step before taking it. Depreciation had increased by over £1,100 for the half-year, and this item they must expect to increase further, as their new works were gradually completed. To the debenture sinking fund they had carried the usual contribution of £2,000, and to the reserve fund proper the increased sum of £1,500, making no less than £6,500 reserved out of the profits during the 12 months. The prospects of work before them were all that they could desire. It was no longer doubtful that electric traction was about to receive a great development in this country, and in this the Willans engine would play a leading part. Already an engine to indicate up to 1,500 horse-power was under construction for traction work, and they had been called upon to prepare designs for an engine of 2,500 horse-power. The size of the engines they made had increased to a startling extent. This development threatened to go beyond the utmost anticipation of the directors, and to involve additions to their plant beyond what the present capital provided. The question, however, was not immediate, but it was well to mention it. Fortunately at Rugby they were in a position where extensions, when necessary, could be made rapidly and economically. They hoped that the relations between the company and their workmen would in the future be even better than they had been in the past, for in pursuance of a long-desired scheme for binding their old hands more closely to them, they had instituted, since the close of the strike, a system of long-service bonuses, which they thought would give their men a strong inducement to remain with them. He was glad to say that this offer had been received with much satisfaction by their men. Having called attention to certain items in the balance-sheet and loss account, he said he might anticipate a question, which would otherwise doubtless be asked, as to the success of their recent small issue of shares—3,000 preference and 3,000 ordinary shares were to be issued, but owing to the effect of fractional holdings, only 2,838 preference and 2,854 ordinary shares were provisionally allotted, subject, that was, to acceptance. The numbers accepted were 2,447 preference and 2,296 ordinary, and the balance was applied for 10 times over by their own shareholders alone.

Mr. A. Holland seconded the motion, and observed that the shareholders had abundant reason for gratification, for the business had grown very rapidly.

The motion was carried, and a further resolution to pay a dividend at the rate of 8 per cent. on the ordinary shares was agreed to.

Mr. M. H. Robinson and Capt. Sankey, the retiring directors, were re-elected.

Brockie-Pell Arc Lamp, Limited.

The directors in their report state that they regret very much that the result shown by the accounts is not more satisfactory. This is due principally to the long period taken in equipping the works with the various machines, and making the numerous patterns and special tools required in the manufacture of the lamps. The first 100 lamps, made entirely at the company's factory in Tabernacle Street, were not completed until the end of July last, so that the business has only been in full swing for a period of from five to six months. As showing the estimation in which the company's lamp is held, it will be satisfactory to shareholders to know that the whole of these 100 lamps were erected in the principal streets of the city of Glasgow, to replace those of other makers. Amongst the numerous customers of the company during the period under review, may be mentioned several departments of H.M.'s Government, corporations, vestries, exhibitions, railways, &c. The orders received from month to month have shown a steady increase. The total number of "Brockie-Pell" lamps supplied to the public in 1897 exceeded that of 1896, thus showing continued progress. In order to save inconvenience to the public during the time the factory was being equipped, the directors allowed the late makers to continue the manufacture of the lamps for some months, and to execute the orders they had received upon payment of a royalty to the company. The directors also agreed to take over from them the stock of lamps left upon their hands after such orders had been provided for. It will thus be seen that the company has not had the benefit of any manufacturing profit on the greater part of the business transacted since its formation. The engineering strike, which lasted about six months, caused a considerable amount of trouble and loss to the company. Great difficulty was experienced in obtaining delivery of material required by the factory, and orders were kept back by customers in consequence of their finding it impossible to procure the necessary machinery for operating the lamps. All the preliminary expenses have been written off, and also a portion of the outlay on furniture and tools. After lengthy negotiations the directors signed a contract in October last for the sale of the French and Belgian patents for £3,000 in cash, and shares in a company to be formed. £500 has been received on account. Mr. Brockie has taken out several new patents in 1897 for further improvements in arc lamps and accessories. These belong to the company, and it is anticipated that they will prove of value, and create an extension of business. The company has also a considerable interest in a patent granted to Mr. Brockie for an automatic lathe, worked on an entirely new principle, which will probably prove a valuable asset in course of time.

Lord Suffield presided over a crowded meeting of shareholders of this company, held on Tuesday at Winchester House. The chairman went through the various items of the report which is given above. He said it was not until the end of 1896 that they were able to enter the premises they had secured in Tabernacle Street. In the meantime, however, Mr. Brockie had not been idle, and had been able to obtain machinery from the Continent for the purpose of carrying on the work. It was not, however, till March of 1897 that work was commenced upon the various special tools they required. With a view to saving time, a considerable number of those tools were made to their design by others; but notwithstanding this help, week after week passed, and they appeared to get no nearer to the desired end. They knew that Mr. Brockie was doing his utmost, and considering the enormous amount of detailed work that required his personal supervision, there was no reason to be dissatisfied with the length of time taken to bring the factory into working order. When the first 100 lamps were completed by their own men, namely, at the end of July last, that left practically only five or six months in which to make any manufacturing profit. Paragraph No. 7 showed continued progress in the sales of the lamps. Of course, they had not had the full benefit of the increased sales, and had to be satisfied with receiving royalties only. The new patents granted to Mr. Brockie last year included some important improvements in the construction of arc lamps and accessories in connection with them, which they fully believed would add to their business, and practically extend the time of the monopoly. Before putting the resolution, they would no doubt like to hear something of the prospects of the company for the current year, and he had much pleasure in saying that the volume of business at present in hand was very satisfactory. The value of unexecuted orders amounts to between £8,0 0 and £9,000, although they have not yet reached the end of the first quarter of the year.

Sir F. D. Dixon-Hartland seconded the motion. In doing so he said he could not but feel that the accounts were very disappointing, but at any rate they were honest accounts, showing the exact state of the facts. There had been no attempt to keep anything back. He did not think that anybody who was not a director of the company could have had the slightest idea of the work, the anxiety, the trouble that had been caused to the board. They had, to a certain extent, been environed by difficulties which were unforeseen at the time the company was brought out, but he believed that at the present moment they were on the road to success. They took over a business which had been carried on by Messrs. Johnson & Phillips. They were informed that the works would take about four or five months, but in reality it was nearly 12 months before they were got into working order. They had had to make all the parts, and all the tools for making the parts, and that took a considerable time. Another difficulty was, that Messrs. Johnson & Phillips knew that they had got a good thing, and were most anxious not to give it up. At first they said that Mr. Brockie and Mr. Pell had no right to sell the patents to anybody else, that they had a legal right to keep the patents as long as they existed, and that all Mr. Brockie and Mr. Pell could do was to give a concurrent right to this company. Thanks to the energy of the solicitor, the directors were able to get over those difficulties, and at last Messrs. Johnson & Phillips gave up that contention. Then it was found that they were continuing to manufacture the lamp, and for the sake of peace and quietness an undertaking was taken from them that they would make no more of the lamps. The company bought the whole of their stock of lamps. Of course, all this was not done without an immense amount of thought and labour, and he was sorry to say that they had now moved for an injunction against Messrs. Johnson & Phillips for infringing the patents. In a letter which they had written, Messrs. Johnson and Phillips said that there was only a 2 per cent. profit on the manufacture of the lamps, but if that were so would they fight so hard, or would they have paid 7½ per cent. upon the gross list price of the lamps? The board had put an end to dual management, and now had one responsible managing director, who would take sole charge of the work so far as the commercial part was concerned. He had very little doubt that before long there would be good profits for the shareholders. It had been suggested that the directors had helped to rig the market, but he did not believe that one of them had bought or sold a single share. They had nothing whatever to do with the market. Their object was to make the company a success, and whether the shares were up or down it was not for them to consider.

Mr. Clement thought the company was floated on conditions that were entirely unjustifiable. No doubt there was good reason in the delays that had arisen. He asked whether they had guarantees for payment of the Belgian rights?

Mr. Skipworth: So far as he could see, their assets were not worth 60 pence, and that was all they had to show for their £60,000. How was it that they had only got £500 for the Belgian and French patents? He moved as an amendment: "That the directors' report be received, but that the same be not adopted, pending the report of a committee of investigation to be now appointed by the shareholders."

Mr. Waugh said he had confidence in the directors, who held nearly two-thirds of the shares, and he did not see why a committee should be appointed.

Sir F. D. Dixon-Hartland, in reply, said the whole of the amount on the 5,000 shares had been called up, but the time was not yet up for payment. With regard to money to go on with, there was about £1,000 to come from the shares. Then £3,000 was expected in July for the patents. There were also book debts, and the company was not going to manufacture £8,000 or £9,000 worth of lamps without getting something for them. The directors, therefore, hoped that with a little borrowing from the bankers they would be able to get through until such time as greater profits could be made. The patents were examined by an eminent firm of patents agents, and therefore it must be presumed that they were perfectly good. The factory was leased for 21 years. With regard to the foreign patents, some gentlemen approached the directors and said: "We are prepared to give you £3,500 in cash for your patents for France and Belgium; we are then going to float a company for those countries, and then we shall give you one-fourth of the shares." The board were not going to be satisfied with the output for the last five months; they hoped to double and even quadruple it, and then the working expenses would drop in proportion, and there would be a chance of making profits. The directors were quite willing to draw only two-thirds of their fees until the company proved a success. If at the end of another 12 months, satisfactory results could not be shown, other men might be elected on the board.

Mr. Skipworth withdrew his amendment, and the motion for the adoption of the report was then agreed to.

The retiring director, Mr. H W. Maynard, was re-elected; the auditors, Messrs. Mellors, Basden & Co., were re-appointed, and the proceedings terminated with a vote of thanks to the chairman.

Direct Spanish Telegraph Company.

The Marquis of Tweeddale (chairman) presided over the ordinary general meeting of the shareholders of the above company, held at the offices, Winchester House, on Tuesday, and in moving the adoption of the report, said he must express the sincere regret of the directors, which he felt would be shared by everyone connected with the company, at the death of Mr. Ettinger. Turning to the accounts they would observe that the balance to the credit of revenue account was £12,975 6s. 4d., and after adding £5,000 to the reserve fund, the directors recommended that the balance be distributed as follows:—10 per cent. on the preference shares, and 4 per cent. on the ordinary shares, absorbing £5,486 4s. Half of the amount was distributed in October as an interim dividend. The traffic receipts showed a decrease of £2,927. With regard to that decrease, only £674 was applicable to the first half of the year of 1897, when the same rates as in 1896 were in force. The remainder of the decrease took place in the second half of the year, and no less than £1,974 was due to the reduction in the rates agreed to at the international telegraphic conference, and to the mode of counting words and figures agreed to at that time, which came into force on July 1st. Without that reduction, the traffic for the year was only £983 less, which would have been very satisfactory, considering the very exceptional traffic they enjoyed in 1896. The working expenses were £223 8s. 11d. in excess of the year 1896. The increase was on account of salaries, amounting to £204 2s. 11d. Their former chairman, Sir John Pender, alluded to that matter some years ago, and pointed out that it was absolutely necessary that some arrangement of the sort should be made if they expected to secure the services of good men. There was also a small increase of £39 for repairs and renewals of instruments and landlines. The company's cables, and the landlines in connection with them, have continued in excellent working order during the year. At the last general meeting he referred to the litigation connected with the Bilbao breakwater, and said that the case would be tried before the tribunal in Madrid in April. The decision, as they probably were aware, was adverse to the company. The decision and judgment was based on points of law, and it was final, and the directors had, therefore, transferred the balance of revenue, £2,489, to the reserve fund towards payment of the cost of removal. The directors, in the exercise of their judgment, had appointed Mr. F. Johnson to the board. He was an able man of business, and happily a good deal younger than some of them, and would therefore, he hoped, have a prosperous career in connection with the company. As they knew, the leading telegraphic companies thought it right to celebrate the Jubilee of the Queen by granting bonuses to their employés, and the board felt that it would not be fair to make any exception to the employés of that company, who were in no way inferior in zeal to the employés of other companies, and so the bonus was granted to them. It was equal to 10 per cent. on the annual salary of members of the permanent staff with five years' service, and 5 per cent. on the salaries of those with less service. The sum was not a very important one, and he was sure that it would act as a stimulus to the employés of the company. He might mention that since January 1st of that year, up to the present date, the traffic was in excess of the corresponding period. The receipts were not quite so large, but that was due to the reduction to which he had referred. They began the year, therefore, on the whole, very prosperously, and he trusted that prosperity would last.

Mr. J. D. Pender seconded the motion.

Mr. Stimpson suggested that the board might see their way to pay a larger dividend.

The Chairman said they wished the dividend might be larger, and now they had got rid of the Bilbao expense, he hoped the accounts would show better.

The report was adopted.

The Guildford Electricity Supply Company, Limited.

The directors in their annual report state that they are calling the ordinary general meeting for 1898 earlier than in previous years, in order to present to the shareholders the accounts for the year ending December 31st, 1897, as they are desirous that the company's financial year may in future coincide with the calendar year, which is the period for making up the annual accounts required to be furnished to the Board of Trade. The number of installations connected with the company's mains is increasing, and now amounts to 52.

The directors are well satisfied with the result of the first complete year's working, and are gratified to think that the stage of remunerative business has now been reached, the revenue account for the quarter ending December 31st, 1897, showing a profit of £67 6s.

The subscribed ordinary capital has now reached £7,670; but, as it has been decided to increase the plant and extend the mains at once, further subscriptions for ordinary shares, to be paid in full on allotment, are invited from the existing shareholders.

Shareholders are reminded that the ordinary shares are entitled to the first profits in each year to an extent sufficient to pay a dividend of 6 per cent. thereon, before the founders' shares receive anything. The ordinary shares take also three-fourths of any surplus profits over 6 per cent., the founders' shares being entitled to the remaining fourth. Also, that the company holds a provisional order, granted by the Board of Trade and confirmed by Act of Parliament (57 and 58 Vict., C. cxv.), for supplying electricity in the municipal Borough of Guildford, and that under this order the company has a practical monopoly in the town for 35 years from July, 1894.

The annual general meeting of the company was held last Thursday at Guildford. Dr. F. R. Russell, chairman, presided, and said as they met only so recently as three months ago, he had little to add to what he then told them of the progress of the company. During the last quarter of last year they made the very fair profit, considering the company had only been running a year, of £67. Of course, that did not make up a profit on the whole year in their favour, because in the first two quarters of the year there was a loss. The last quarter, however, paid very handsomely. The company had now reached the maximum expenditure, and they could double the number of lights without spending any more money, except in the way of coal. But it was absolutely necessary during this year that they should add to their plant, and also lay some extra cables, and they must during the year raise further capital to the extent of £3,000 or £4,000 at least, or even more if they could get it. Since that report £430 in new shares had been paid in. He concluded by moving the adoption of the report and balance sheet.

Mr. Wheeler seconded.

Mr. Money-Kent gave some figures respecting the accounts, the report and accounts being then passed.

Bournemouth and Poole Electricity Supply Company.

Lord Rathmore, who presided on Monday last at the statutory meeting of the Bournemouth and Poole Electricity Supply Company, held at Winchester House, stated that the company's liability to the vendor company in respect of the purchase price had been discharged, and the purchase completed. An application had been made to the Stock Exchange for a special settlement and quotation, and the directors were daily expecting a notification that the same had been granted.

Evered & Co., Limited.

The report and balance-sheet shows, after providing for debenture interest, amounting to £2,416 13s. 4d., a net profit of £25,146 19s. 8d., making, with £7,288 11s. brought forward from 1896, the sum of £32,453 10s. 8d. to be dealt with. An interim dividend at the rate of 7½ per cent. per annum to June 30th, 1897, has been paid, absorbing £6,402 18s., and the directors propose to pay a dividend at the rate of 7½ per cent. per annum for the remaining six months, which will absorb £6,402 18s., and to pay a bonus of 2½ per cent. per annum for the year, £4,268 12s. The directors state that there has been an increased amount of business done, which they deem very satisfactory. This year the full amount of paid-up capital ranks for dividend. Further provision for increased trade has been made in the way of additional buildings at both works.

Mr. A. H. Griffiths has resigned his position as managing director in Birmingham, and Mr. R. B. Evered, the chairman of the board has undertaken the sole managing directorship, assisted in London by Mr. G. J. Evered, and in Birmingham by Mr. R. G. Evered.

British Electric Traction Company, Limited.

The directors in their report for the period from October 26th, 1896, to December 31st last, state that the company was registered in October, 1896, and 20,000 of the 30,000 ordinary shares offered for subscription were allotted. The subsequent issue of the remaining 10,000 ordinary shares produced a net premium after payment of expenses of £1,218, which amount has been applied in reduction of preliminary expenses account. Since the closing of the books an issue has been made of 10,000 6 per cent. cumulative preference shares of £10 each, at a premium of £2 10s. per share. The proceeds of this issue will be brought into the next account. The gross profits amount to £14,422, and after deducting the proportion of general expenses chargeable to revenue, and also the expenses incurred in connection with schemes not proceeded with, there remains a net profit of £9,804, which the directors propose should be carried forward to next account. Arrangements for the adoption of electric traction at the following among other places are in various stages of progress:—Coatbridge and Airdrie, Cork, Crewe, Dudley, Stourbridge and district, Gateshead-on-Tyne, Hartlepool, Lake District, Kinver, North Shields, Tynemouth and district, North Staffordshire, Oldham, Ashton, and Hyde, Kidderminster and Stourport, Middleton and district, Paisley and district, Potteries district, South Staffordshire, Swansea, Wolverhampton and district. Provisional arrangements have also been made and negotiations are pending in regard to a number of other places; but it would be premature, or inexpedient, to refer to them in this report. In some of the above cases agreements have been made for the purchase, or leasing, of existing tramway undertakings, while for other undertakings Parliamentary powers, or orders under the Light Railways Act, have been secured or applied for. In some instances the company has acquired the majority of the shares of existing tramway companies, and controls the business of such companies with a view to the adoption by them of electric traction. In a few cases the arrangements have been made in co-operation with other parties. With regard to South Staffordshire, the existing electric tramways are being worked by the company, and are a source of income. Contracts have been placed with responsible parties for the work of construction, and electrical equipment at Dudley, Stourbridge, Hartlepool, Kidderminster, and Stourport, North Staffordshire, Oldham, Ashton and Hyde, and Potteries, and the work is being proceeded with.

The Direct United States Cable Company, Limited.—The board have resolved upon the payment of an interim dividend of 3s. per share, free of income-tax, being at the rate of 3 per cent. per annum, for the quarter ending March 31st, 1898; such dividend to be payable on and after April 26th next.

Globe Telegraph and Trust, Limited.—An interim dividend of 2s. 6d. per share has been announced.

TRAFFIC RECEIPTS.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending March 25th, 1898, were £2,379 14s. 7d.; corresponding period, 1897, £2,207 19s. 5d.; increase, £171 15s. 2d.

The City and South London Railway Company.—The receipts for the week ending March 27th, 1898, were £1,066; week ending March 28th, 1897, £974; increase, £92; total receipts for half-year, 1898, £13,891; corresponding period, 1897, £13,791; increase, £100.

The Dover Corporation Electric Tramways.—The receipts for the week ending March 26th, 1898, £111 9s. 8d.; total receipts to March 26th, 1898, £1,277 18s. 7d.

The Dublin Southern District (Electric) Tramways Company.—The receipts for week ending Friday, March 25th, 1898, were £414 11s. 1d.; corresponding week last year, £476 19s. 10d.; decrease, £62 8s. 9d.; passengers carried, 69,266; corresponding week last year, 72,768; aggregate to date, £4,793 9s. 0d.; aggregate to date last year, £5,146 13s. 8d.; decrease to date, £353 4s. 8d.; mileage open, 8 miles. Cars, 1898, 211; 1897, 278. Miles, 1898, 18,979; 1897, 19,865.

The Liverpool Overhead Railway Company.—The receipts for the week ending March 27th, 1898, amounted to £1,303; corresponding week last year, £1,336; decrease, £33.

The Western and Brazilian Telegraph Company, Limited.—The receipts for the week ending March 25th, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,622.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, March 23rd.	Closing Quotation, March 30th.	Business done during week ended March 30th, 1898. Highest.	Lowest.
137,400*l*	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	...	...	100 —104	100 104	...	...
25,900	Amazon Telegraph, Limited, shares...	10	...	...	...	7 — 8	7 — 8	...	...
125,000	Do. do. 5% Debs. Red.	100	...	...	...	93 — 96	93 — 96	...	...
923,900*l*	Anglo-American Teleg., Ltd.	Stock	£2 9s.	£2 13s.	3 %	59 — 62	59 — 62	60½	58
3,038,020*l*	Do. do. 6 % Pref.	Stock	£4 18s.	£5 6s.	6 %	109½ 110½	110 111	110⅞	108⅞
3,038,020*l*	Do. do. Defd.	Stock	...	...	...	11⅞— 12¼	12½ 13	12½	12⅜
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	...	...	16¾ - 17½	16½ 17	16$\frac{11}{16}$	16½
75,000*l*	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	...	...	112 —116	112 - 116	...	...
44,000	Chili Teleg., Ltd., Nos. 1 to 44,000	5	4 %	4 %	...	3 — 3½	3 — 3½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	...	187 —192	185 190	...	...
918,297*l*	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	106 —108	104 —106	106⅞	105
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	2 %	...	$\frac{1}{16}$ — $\frac{3}{16}$	$\frac{1}{16}$ — $\frac{3}{16}$	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	...	6½ - 7½	6½— 7½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	...	14½ - 15½	14½— 15½	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 11	10 — 11	...	...
30,060*l*	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	4½%	103 —106%	103 -106%	...	...
60,710	Direct United States Cable, Ltd.	20	2½%	2½%	...	10¾ - 11½	10¾ - 11½	11½	10⅞
120,000	Direct West India Cable 4½% Reg. Deb	100	...		...	98 —101	99 —101	100½	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	...	17¾ - 18¼	17¾ 18¼	18⅞	17⅞
70,000	Do. 6 % Cum. Pref.	10	6	6%	...	18½— 19½	18½ - 19½	19	18⅝
89,900*l*	Do. 5 % Debs., repay. August, 1899	100	5 %	5%	...	100 —103	100 —103	...	...
1,302,615*l*	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4%	...	128 - 131	128 —131	129	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7%	...	18¾— 19½	18¾— 19½	19	18⅝
25,200*l*	{ Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326 }	100	5 %	5%	...	99 —103	99 - 103	...	...
100,500*l*	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5%	...	100 —103	100 - 103	...	...
320,000*l*	Do. 4 % Deb. Stock	Stock	4 %	4%	...	128 —131	128 —131	...	...
35,100*l*	{ Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343 }	100	5 %	5%	...	99 —103	99 - 103	...	...
46,500*l*	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5%	...	100 —103	100 —103	...	...
300,000*l*	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4%	...	102 —105	102 —105	...	...
200,000*l*	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 5,000	20	4 %	4%	...	107 —110%	107 —110 %	107	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	...	11⅝ - 12½	11⅝ - 12½	11⅞	11⅝
180,042	Do. do. 6 % Pref.	10	6 %	6%	...	17½ - 18	17½ — 18	17⅝	...
150,000	Great Northern Teleg. Company of Copenhagen ...	10	10 %	10%	...	29½ - 30½	29½ - 30½	...	...
160,000*l*	Do. do. do 5 % Debs	100	5 %	5%	...	100 —103	100 —103	...	...
97,000	{ Halifax and Bermuda Cable Co., Ltd., 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	95 —100	95 —100	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10%	...	52 — 55	52 — 55	52	...
100,000*l*	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6%	...	106 - 109	106 —109	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	...	...	2 — 2½	2 — 2½	..	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5½%	5½%	6 %	6½— 6¾	6 — 6½	6⅜	5⅞
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 18	16 — 18	...	...
15,000	Do. 6 % Cum. 2nd Pref. ..	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5¾ - 6¼	5½ - 6	6½	5⅝
1,329,471*l*	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	102 —107	102 —107	103½	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	⅝ — ¾	⅝ — ¾	...	...
100,000*l*	Pacific and European Tel., Ltd., 4 % Guar Debs, 1 to 1,000	100	4 %	4 %	...	105 —108	105 —108	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	8 — 9	8 — 9	8	...
3,381	Submarine Cables Trust	Cert.	...	...	...	140 —145	140 - 145	140	...
58,000	United River Plate Teleph., Ltd.	5	4 %	...	...	4 — 4½	4 — 4½	...	...
146,733*l*	Do. do. 5 % Debs.	Stock	5 %	...	...	105 —108	105 - 108	107½	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	nil	...	3½ 4½	3½ 4½	...	...
213,400	Do. do. do. 5 % Debs.	100	5 %	5 %	...	101 - 104	99 102	101½	...
64,269	Western and Brazilian Teleg., Ltd.	15	3 %	2 %	...	11⅞ - 12¼	12 - 12½	12	11⅞
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	...	7½ - 8	7¾ 8¼	8	7⅞
33,129	Do. do. do. Def. Ord ...	7½	1 %	...	...	4½— 4¾	4½ - 5	5½	4$\frac{9}{16}$
369,521	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	106 —109	106 —109	108½	107
88,321	West India and Panama Teleg., Ltd.	10	½%	1 %	...	½— ¾	½— ¾	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	7½— 8	7½ - 8	7⅞	7⅝
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	5 — 7	5 — 7	...	...
80,000*l*	Do. do. 5 % Debs. No. 1 to 1,600 ...	100	5 %	5 %	...	105—108	105 - 108	108	106
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7%	...	105 —110	105 —110	...	...
160,100*l*	Do. do. 6 % Ster. Bonds	100	6 %	6%	...	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	1895.	1896.	1897.	Closing Quotation, March 23rd.	Closing Quotation, March 30th.	Highest.	Lowest.
30,000	Charing Cross and Strand Electy. Supply ..	5	5 %	6 %	7 %	13½ - 14½	13½ — 14½	13¾	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6½ - 6¾	6 — 6½	6½	...
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 16,277 ...	5	5 %	5 %	...	10¾— 11½	10½ — 10¾xd	10⅞	10⅝
60,000	Do. do. do. 4½ % Deb. Stock Red.	Stock	4½%	4½%	...	115 —117	115 —117	...	...
50,000	City of London Elec.Lightg. Co., Ltd., Ord. 40,001– 90,000	10	%	7 %	10 %	26 — 27	25½ - 26½	26	25⅝
10,000	{ Do. do. Prov. Certs. Nos. 90,001 to 100,000 £2 pd. }	10	...	...	...	12½— 13½	12½— 13½	...	...
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17½ - 18½	17½— 18½	17⅝	17½
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	129 —134	129 - 134	...	...
30,000	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1– 30,000	10	nil	nil	nil	14¾ - 15½	14¾ - 15½	15	14⅝
20,000	Do. do. do. 6% Pref., 40,001—60,000	10	6 %	6 %	6 %	15¾— 16½	15½ - 16	15$\frac{13}{16}$	...
17,400	Edmundsons Elec. Corp., Ltd., ord. shares 1—17,400 ...	3	...	...	...	3½— 3¾	3½— 3¾	...	...
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5		...	...	11 — 12	10½ - 11½	11½	11½
10,000	Do. do. 7 % Cum. Pref. ...	5	...	...	...	11¾ - 12¼	11½— 12	11⅞	11$\frac{13}{16}$
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	4 %	5 %	6 %	21 — 22	20 — 21	21	20½
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem. ...	10	...	...	3 %	20½ - 21½	20 — 21	21½	21
220,000*l*	Do. 4½% first mortgage debenture stock ...	..	4½%	4½%	4½ %	117 — 121	117 —121	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	2 %	4 %	6 %	19½ - 20½	19½ - 20½	20⅛	20$\frac{1}{16}$
31,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord.	5	7½%	10½%	14½ %	18 — 19	18 — 19	18⅝	18½
20,000	Do. do. 7 % Pref., 20,001 to 40,000	5	7 %	7 %	7 %	10 - 11	10 — 11	...	...
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	4 %	107 —110	107 —110	...	...
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2⅜— 2⅝	2½— 2¾	2⅝	2½
79,900	Westminster Electric Supply Corp., Ord., 101 to 80,000	5	7 %	9 %	12 %	17 — 18	17 — 18	17⅝	17

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked ∥ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation. March 23rd.	Closing Quotation. March 30th.	Business done during week ended Mar. 30th, 1898. Highest.	Lowest.
30,000	British Electric Traction	10	...	...	...	16½—17	16—16½	16⅝	15⅞
90,000	Brush Elec. Enging. Co., Ord., 1 to 90,000...	3	...	...	...	1⅞—2	1⅞—2	1 15/16	1⅞
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	...	...	2¼—2½	2¼—2½	2⅜	2¼
125,000*l*	Do. do. 4½ % Perp. Deb. Stock... ..	Stock	...	...	...	110—114	110—114	...	...
50,000	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	102—105	102—105	...	...
19,894	Central London Railway, Ord. Shares	10	...	...	...	10½—11	10½—11	10⅞	10½
129,179	Do. do. do. £6 paid	10	...	...	...	6¼—6¾	6½—6¾	6½	6⅝
59,254	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1½—2	1½—2	...	...
67,680	Do. do. Def. do. £5 pd. ...	...	...	...	...	4⅝—4⅞	4⅝—4⅞	4 13/16	...
630,000*l*	City and South London Railway	Stock	1 3/16%	1 3/16%	1⅞%	66—68	66—68	68	67⅞
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	nil	...	...	2—2½	1⅞—2¼	1⅞	...
99,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 99,261	5	5 %	5½%	...	2½—3	2¼—2¾	2⅝	2½
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5½%	...	4—5	4—5	...	...
194,023	Do. do. do. 4% Deb. stock Red. ...	100	...	...	...	103—105	103—105	103	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	5 %	6 %	...	2⅝—2⅞	2⅝—2⅞	...	...
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343	2	7 %	7 %	...	3⅛—3⅜	3⅛—3⅜	...	...
111,100	Do. do. 4% Perpetual 1st Mort. Deb. Stock	Stock	...	...	...	106—108	106—108	106¾	106½
91,196	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,863	2	...	...	...	½—¾	½—¾	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	...	...	...	⅜—⅝	⅜—⅝	...	...
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	10½%	...	...	9—11	9—11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	8 %	10 %	12 %	22½—23½	22—23	...	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½—19½	18½—19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½%	110—115	110—115	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	21½—22½	21½—22½	21⅞	21½
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	104—108	102—106	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	2⅞%	2⅞%	3¼%	10⅝—10¾	10⅝—10¾	...	...
18,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15¾—16¼	15¾—16¼	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	15 %	15 %	36—39	35—38	36½	35
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102—105	102—105	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	...	...	135—138	135—138	135¼	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7%; 1890—8%.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

* Birmingham Electric Supply Company, Ordinary £5 (fully paid) 10½.

House-to-House Company, 4½% Debentures of £100, 108—110.

Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 16¾—17¼; 1st Preference Cumulative 6 %, £5 (fully paid), 8¼—8¾. Dividend, 1896, on Ordinary Shares 7 %.

London Electric Supply Corporation, £5 Ordinary, 4—4½.

* T. Parker, Ltd., £10 (fully paid), 14—15.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8—8½. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount 3 per cent. (October 14th, 1897).

THE NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

The Practical Operation of Multiphase Currents. By T. Hawkins, Member. March 14th, 1898.

(*Continued from page 422.*)

In a power installation, the generator is the part which is usually well protected, and gets the best attention. If a continuous current machine is used, the brushes will, at intervals, require to be adjusted and renewed, and the commutator trued up and kept clean; still there is always a skilled attendant at hand to keep the machine in order. It is, however, the motors, scattered in many instances over a considerable area, which have often the greater strain and harder work to do, and yet have less attention where the three-phase system to my mind has the advantage, especially where motors are only required to run at one constant speed.

As regards the line, a saving of copper is effected by using the three-phase instead of the continuous current system, but there must be three wires if the former be used, which brings the cost of the distribution on a low pressure system to about the same.

At the works of the General Electric Company, Limited, at Manchester, there is a three-phase power plant. The generator has an output of 100 H.P. at a pressure of 190 volts, and runs at 450 revolutions per minute, giving 45 cycles.

The following is a list of the motors:—

No.	H.P.	Speed.	Geared to.	Kind of gearing.	Starting device.
1	24	910	Shafting	Belt	Liquid resistance in stator.
1	18	910	Shafting	Belt	"
1	9	910	Shafting	Belt	None.
1	3½	910	Boring machine	Belt	"
2	3½	1,360	Shafting	Belt	"
1	3	1,360	7 ft. radial drill	Worm gear	"
1	2	Variable	Lathe	Belt	Resistance in rotor.

The 24 and 18 H.P. motors are not working on more than ¾ load. Each motor drives a 120 feet length of main shafting at 300 revolutions per minute, the main shaft being loaded along its entire length by high speed lathes and other machinery. The other belted motors drive shafting in the erecting shop, and are loaded nearly to their rated capacity.

In addition to the above, there are three motors, 6 H.P., 4½ H.P., and 1 H.P., used on a 5-ton 3-motor crane. The reduction of speed is obtained by worm gearing running in an oil bath. This gearing is most carefully cut, the thrust of the worm being taken up by ball bearings.

The 6 H.P. and 1 H.P. motors are mounted on the crab and have only one speed, being switched in and out of circuit without the use of any starting device. The lifting and transverse motions are limited to one speed. The 4½ H.P. motor gives the longitudinal motion, and has two speeds: full speed and half speed. The higher speed is obtained by halving the number of stator poles, this operation being performed by a throw-over switch. The starting and reversing is done by a second throw-over switch.

For cranes above 5 tons, the lifting and longitudinal motors are equipped with a starting device, connected to the rotor through slide rings. Such an arrangement has not the peculiar property of the series-wound continuous current motor, of self-regulation of speed in accordance with the weight being lifted; but this is the only advantage that the continuous current motor has over the three-phase machine. This, I think, is fully compensated for by the less delicate and complicated equipment the latter requires. The three-phase motor will stand a heavy overload or sudden reverse without fear of damage.

Usually the lifting motor is designed for a maximum speed at heaviest load. This speed cannot be increased for lighter loads, but can be regulated at will under such a limit.

The Liverpool Grain Storage and Transit Company, Limited, have adopted a three-phase plant for their storage warehouse at Bootle. It has been running some 15 months, and there are at present nine motors, giving a total of 150 H.P. The generator has an output of 165 H.P., and is coupled direct to a Belliss engine. They have no reserve generator, and do not stock any spare parts for either generator or motors. An extension of this plant is now in progress, consisting of two 48-H.P., and one 60-H.P. motors.

This installation furnishes an example where lighting and power is taken from the same mains. There are about 200 lamps, which are connected across two phases, the lamps being arranged so that the current is distributed equally over the three circuits, so as to maintain the balance of the system.

Another method of combining lighting and power on a three-phase system is to run a fourth wire from the common junction, if the star connection be used. The lamps are connected between this fourth wire and any one of the three main cables, thus doing away with the necessity for balancing the three circuits.

For mining work, the multiphase system is specially adapted, and already a considerable amount of work has been done in this direction. The General Electric Company, Limited, have recently sent out, from their Manchester works, some three-phase plant for several South African mines, particulars of which may interest you.

The largest of these plants was one sent to the Vogelstruis mine:—The generating plant consists of two 150-kilowatt three-phase generators. They are belt driven, at a speed of 300 revolutions per minute, with a frequency of 30 cycles and a pressure of 950 volts.

Three triplex single-acting pumps, with plungers 6½ inches × 8 inches, coupled direct by means of single reduction gear to 35 H.P. motors. These motors run at 360 revolutions per minute. The pumps are designed to work at a crank-shaft speed of 45 revolutions per minute against a water pressure of 300 lbs. per square inch. They are of American design, and were made by the Gould Company.

yards; each conductor having a copper area of ·145 square inches. The total length of the branch cables is 830 yards; each conductor having a copper area of 0·118 square inches.

A plant exactly similar to the Knight Central has been sent to Witwatersrand mine.

The following is a complete list of the motors supplied to the above three mines:—

All motors—30 cycles, 950 volts.

No.	H.P.	Speed per minute.	Starting device.	How connected.
7	35	360	In rotor circuit.	Geared to pumps.
3	35	360	" "	Belted to machinery.
28	20	360	" "	Geared to pumps.
1	10	‡70	Switched into circuit without resistance.	Belted to machinery.
6	5	870		

The generators for these three mines are all of the inductor type, At full load they give a commercial efficiency of 91 per cent., and the rise in temperature, after long continuous runs, is 25° C. The

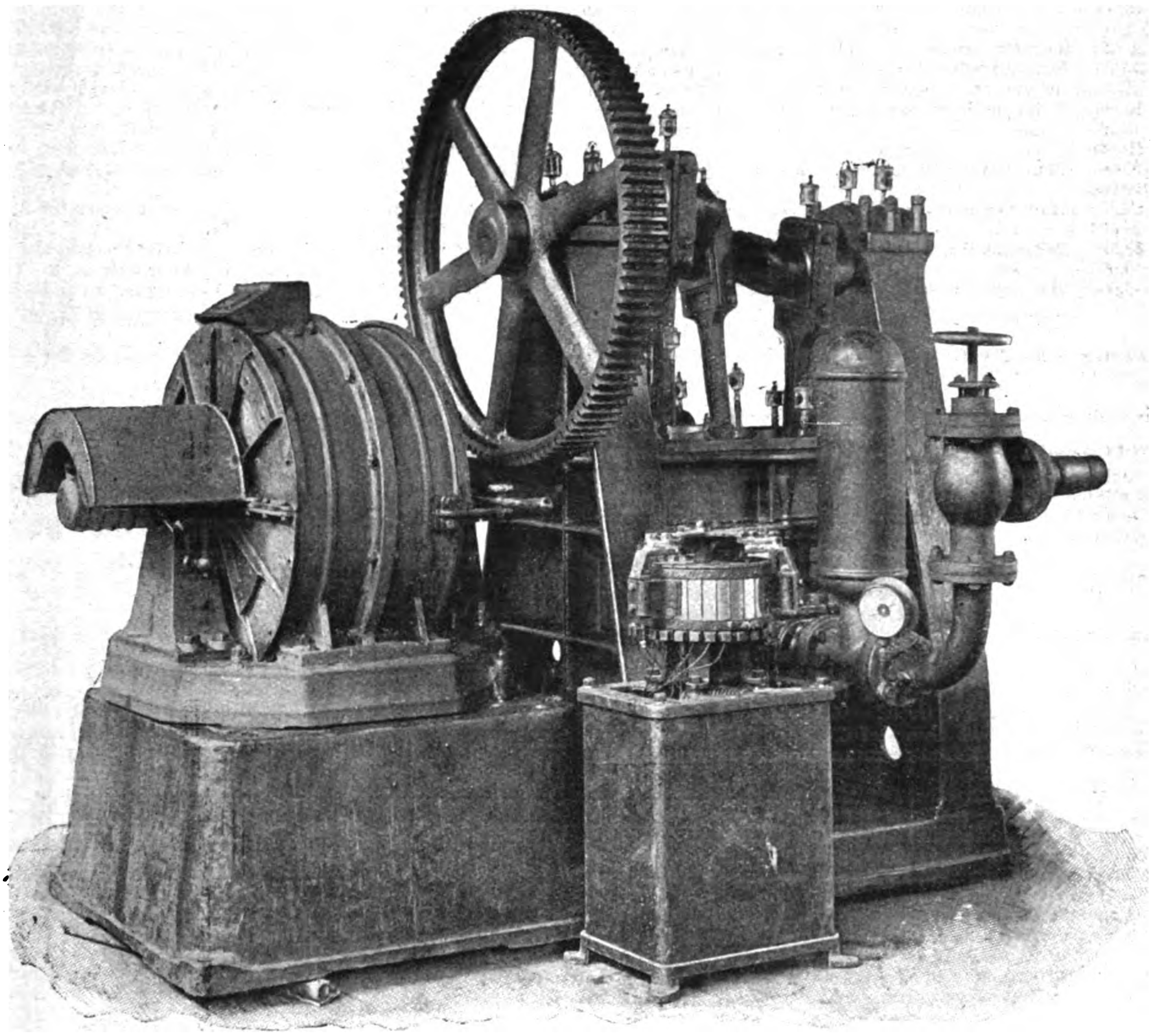


Fig. 4.—Motors of 20 H.P. with Three-Throw Pump.

Twelve triplex single-acting pumps, with plungers 4½ inches × 8 inches, of the same general design as the foregoing, coupled direct by means of single reduction gearing to 20 H P. motors, running at 360 revolutions per minute. These smaller pumps are also designed to work at a crank-shaft speed of 45 revolutions per minute against a water pressure of 300 lbs. per square inch.

The main cable is triple concentric, each conductor having a copper area of ·118 square inches. The length of this main cable is 1,866 yards. The branch cables are also triple concentric. There is one length of 430 yards, the sectional area of each conductor being ·047 square inches, and another length of 1,300 yards, with an area of ·0314 square inches for each conductor.

The above cables are lead covered and steel armoured.

Another plant was sent to the Knight Central mine, consisting of two 100-kilowatt generators, running at 450 revolutions per minute; the voltage and periodicity being as described for the Vogelstruis mine. There are three triplex pumps 6½ inches × 8 inches, and eight pumps 4½ inches × 8 inches, coupled direct by single reduction to 35 H.P. and 20 H.P. motors respectively.

The length of the main triple concentric cable for this mine is 900

main switchboard is so arranged, that the generators can be run in parallel.

As these mines are very wet, the motors were designed with water-tight and ventilated covers, as shown in fig. 4.

To enable the 20 H.P. and 35 H.P. motors to start up smoothly and gradually, they were supplied with starting resistances in the rotor. The 20 H P. motors were made in Manchester by the General Electric Company, Limited, and each machine was coupled to its pump, and tested separately at its full load for six hours, the rise of temperature being 25° C.

The York Gold Mining Company, of South Africa, have just installed a power plant, consisting of two belt-driven 50-H.P. three-phase inductor type generators, running at 750 revolutions per minute. These supply power to two 24-H.P. motors, the motors being coupled to Easton, Anderson & Goolden belt-driven pumps. They have one 3-H.P. motor connected to a centrifugal pump, and several small motors, which are belted to various kinds of machinery, and one 9-H.P. motor coupled direct to a continuous current dynamo, the output of which is 15 volts, 300 amperes, used for cyanide work.

(*To be continued.*)

PHYSICAL SOCIETY.

Ordinary Meeting.

Mr. Shelford Bidwell, President, in the chair.

Mr. A. A. Campbell Swinton read a paper and showed experiments upon The Circulation of Gaseous Matter in a Crookes Tube.

The stream lines within a Crookes tube are investigated by observing the direction and speed of rotation of a mica radiometer mill mounted on a sliding rod so that it can be moved along a line at right angles to the line joining the electrodes. The axis of the mill is at right angles to both these lines. If the mill is adjusted to a position between the flat plate and the cup electrodes, with its axis just sufficiently low to prevent equal and opposite simultaneous action on the top and bottom vanes, it rotates always in the direction indicating a stream from cathode to anode. The speed is greater when the flat plate is the cathode. If, however, the mill is now moved below this line, a point is reached at which rotation ceases, and below this neutral point the rotation is suddenly reversed. Reversal is only to be observed with high degrees of exhaustion; the rotation is never so rapid here as in the first position. The mill rotates, and the reversal may be observed, whether cup or plate is made cathode, and the direction of rotation below the neutral point is always opposite to that in the position above it. A small Wimshurst machine is as effective as an induction coil in producing these effects. The experiments are intended to establish the existence, at high degrees of exhaustion, of a true anode stream, *i.e.*, a stream that travels from anode to cathode just in the same manner as the cathode stream flows from cathode to anode. This anode stream is charged positively; it is exterior to the cathode stream; its velocity is less than that of the cathode stream, but its velocity increases as the vacuum is improved. It seems probable that, at high vacua, some portion of the positive electricity passing through the tube is carried by the positively charged atoms or particles that constitute the anode stream. At lower degrees of exhaustion, the discharge passes through the tube chiefly by interchange of charges from molecule to molecule—a Grothüs chain. At the very high vacua, however, when the mean free pass is considerable, there may be to some extent a regular and complete circulation of positive and negative atoms, some of which pass from anode to cathode and *vice versâ*, and deliver up their charges, not by interchange, but by direct convection, to the electrodes of opposite sign.

Prof. Boys said he did not feel altogether convinced by the experiments that the rotation of the mill was due to simple mechanical motion of the particles of matter between the electrodes. The weight of air left in the tube at such high degrees of exhaustion was extremely small; it was difficult to realise that its impact could produce the sudden mechanical effect observed at the moment of the reversal of the rotation of the mill.

Mr. Wimshurst thought it important to keep in mind the existence of mercury-vapour in the tube. He also referred to some experiments in which a bar of metal was used to explore a focus-tube, by observation of the changes of luminosity produced in different positions.

Dr. Chree said that if the rotations of the mill could be shown to indicate a velocity of the particles of the same order as that observed in Crookes's experiments, it was safe to assume the existence of a similar cause. This might be important in deciding as to the general truth of the bombardment theory of Crookes. He asked whether the rotation had been investigated within the dark space around the cathode.

Mr. Appleyard suggested that in tracing the cause of the rotation it would lead to simpler results if the vanes of the mill were made of some light conducting substance. Mica introduced difficulties owing to its retention of the charges.

Prof. Boys pointed out that this could be done by gilding the mica.

Mr. Campbell Swinton, in reply, said that the objection raised by Prof. Boys to the mechanical theory of the rotation would apply equally to the whole theory of electro-radiometry, including the case of the mill used originally by Crookes in the direct path of the cathode-stream. But it must be remembered that although the mass of matter present within the tube was very small, its velocity was proportionately great, it was of the order of 9,000 kilometres per second; hence the contained matter might be conceived as capable of producing the observed acceleration, and Crookes's bombardment theory might with safety be adopted as a safe working hypothesis. In the tubes used for these experiments the exhaustion was carried so high, that the negative dark space appeared to fill the whole tube. He had, so far, only tried mica for the vanes; but he thought it would be important to observe the result with a substance that did not retain the charges.

Mr. A. Stansfield then read a paper on Thermo-Electric Pyrometers.

In obtaining photographic records of the readings of thermo-electric pyrometers, the range of measurement is limited by the size of the photographic plate. For long ranges of temperature, the sensitiveness of the galvanometer must therefore be small. When it is desired to examine the temperature changes in detail, as for instance at the melting points and freezing points of metals, it is necessary to employ some device for giving a more open scale for the short temperature ranges that include those particular points. For this purpose two galvanometers are arranged in parallel, and so that they have their deflections recorded on the same photographic plate. The less sensitive galvanometer covers the entire range of temperature throughout an observation; the other is brought into use for magnifying special portions of the range. In this latter case part of the electromotive force of the thermo-couple is compensated by an opposing electromotive force, applied at two points of the circuit, from a battery of Clark cells in series with a high resistance. The recording apparatus consists of a photographic plate mounted on a float, that rises steadily when water is admitted into a cylinder. The source of light is a glow lamp, enclosed in a wooden box. A brass tube, with a rectangular diaphragm at the end nearest the lamp, cuts off all light except that from a selected piece of vertical filament. Light from this filament is reflected by the plane galvanometer mirror, and is focussed upon the photographic plate by a lens in front of the galvanometer; this method was suggested by Prof. Boys. The "cold" junctions of the thermo-couple are both inserted into a hypsometer. Very serious discrepancies exist between the indications of couples having nominally the same composition; they are too great to be attributed to accidental differences in the constitution of the alloys. Although with platinum alloys, coupled with platinum, 10 per cent. of iridium gives a more powerful couple than 10 per cent. of pure rhodium, the partial substitution of iridium for rhodium very considerably lowers its thermo-electric power. This result suggests that the change in the thermo-electric power of a metal depends upon the extent to which it is saturated with the alloying metal; thus 10 per cent. either of rhodium or iridium would, *per se*, more completely saturate the platinum than would 10 per cent. of a mixture of the two metals. The author discusses a series of curves derived from his experiments. He concludes that, thermo-electrically, there may be two classes of metals (1) the ordinary metals, for which the curve representing the first differential of electromotive force with respect to temperature is a straight line, and (2) the platinum metals, together with a few such as nickel and cobalt, for which the curve of that differential, multiplied by the absolute temperature, is a straight line.

Dr. Chree discussed the curves, and asked how far stirring affected the results; he was inclined to think that stirring was a mistake.

Mr. A. Campbell inquired whether the galvanometer kept its zero sufficiently well throughout the tests.

Mr. Stansfield, in reply, said he had also come to the conclusion that stirring was a mistake; and it was a mistake to use a large quantity of metal. The pyrometers were sensitive to about a tenth of a Centigrade degree. He had experienced great difficulty with the zero of the galvanometer.

The President proposed votes of thanks to the authors, and the meeting adjourned until April 22nd.

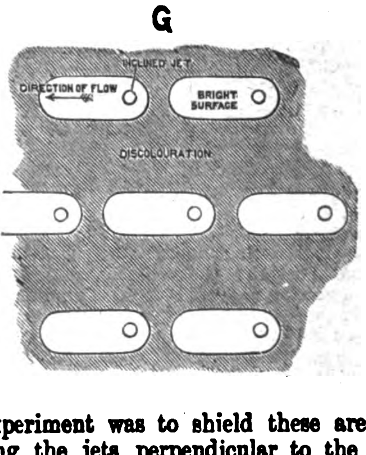
ON SOME RECENT INVESTIGATIONS IN CONNECTION WITH THE ELECTRO-DEPOSITION OF METALS.*

By J. C. GRAHAM.

(*Concluded from page* 358.)

It was thought that this might be cured by inclining all the jets towards the face of the cathode at an angle of 85°, instead of directing them perpendicularly against the face of the cathode. The result, however, instead of being an improvement, was much worse than before. This is shown in Diagram G.

G

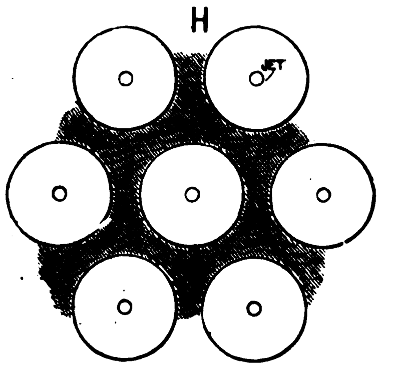


The next experiment was to shield these areas of interference, keeping the jets perpendicular to the face of the cathode. This was readily done by cutting a number of round holes out of a thin sheet of vulcanite, through the centres of which the jets played, as shown in fig. H.

A very beautiful deposit was obtained in this manner, at 3,000 amperes to the square metre. In this case the cathode was moved slowly to and fro in front of the jets to insure

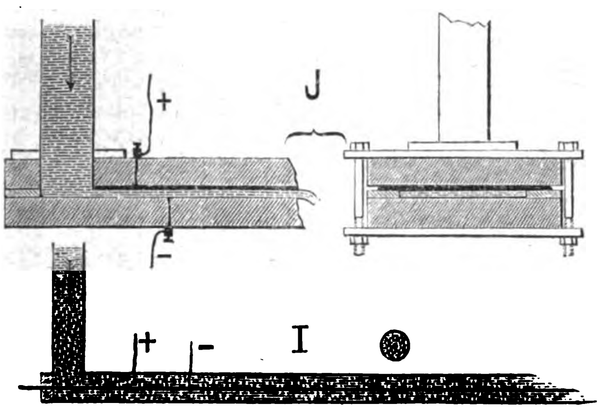
* Communicated to the Royal Society.

a uniformly thick deposit over the whole surface of the cathode.



Shield with Holes.

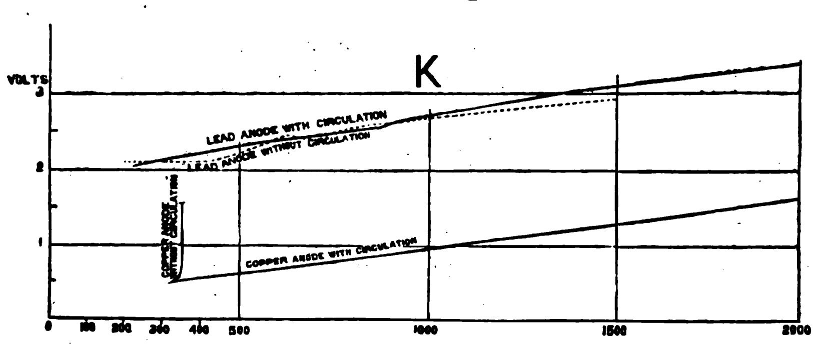
As a very rapid circulation of the electrolyte appeared to be the principal condition of success, two new forms of apparatus were devised, which are shown diagrammatically in Diagrams I and J. The one for producing the circula-



tion over a wire, the other for producing it over a flat surface.

Taking Diagram J, which shows the apparatus for depositing strips or sheets. The electrolyte was forced with great rapidity by means of a centrifugal pump, through the pipe, and through the space enclosed between the anode and the cathode, and thence back to the elevated tank to which the pipe is connected.

In order to ascertain the difference of potential between the anode and the cathode at various current densities both with lead and copper anodes, a number of observations were made, the results of which are shown in Diagram K.



Amperes per Square Metre.

The volts are measured vertically, and the amperes per square metre are measured horizontally. The continuous thick black line at the top shows the voltages with a lead anode, the thick red line lower down shows the voltages with a copper anode.

It will be noticed that in the form of apparatus used for these experiments, that the anode as well as the cathode was very energetically washed, and in order to further examine the effect of washing, a lead and a copper anode were tried in an ordinary tank where no circulation was taking place; all the other conditions of the experiment being as nearly as possible the same as when there was circulation.

The dotted black line at the top shows the voltages with the unwashed lead anode, showing that the washing has not much effect on a lead anode.

But with a copper anode the effect is most striking.

The current for this last experiment was in the first place taken from a single cell, through a resistance, and the curve is shown by the black line at the bottom left-hand corner of the Diagram K. It will be seen that the currents and voltages rose pretty regularly to about 300 amperes to the square metre: at this point the voltage began to rise more rapidly, and at 350 amperes the voltage began to rise rapidly, and in a few minutes rose from ·56 to 1·57, the current at the same time falling off from 350 amperes to 106.

This experiment was repeated with two cells, but the movements were so rapid that I have not attempted to plot them. The current at the commencement was 305 amperes and the volts ·44. The volts rose almost immediately to 1·42, the current falling at the same time. The volts then rose more slowly and at the end of half an hour had risen to 3·66, while the current had fallen from 305 amperes down to the insignificant amount of 30·5.

Lastly, in order to get a more extreme example of this phenomenon, the anode and cathode were coupled to the 100-volt main of the Kensington and Knightsbridge Company and the current taken through a water resistance.

A current of 122 amperes per square metre was allowed to pass and kept nearly constant. The voltage rose rapidly to 26 volts and remained pretty constant at that figure.

It should have been mentioned that the anode and cathode were well cleaned and rubbed bright with emery paper, before making each of the above experiments. The cathode was a square plate of copper having an area of 10 square inches. The anode was the same size, and they were placed about 1 inch apart in the electrolyte.

This tendency of the voltage to rise abnormally when a certain current density is reached, was not noticed with lead at all, and was not observable with washed copper anodes until about 2,000 amperes to the metre had been reached.

Some of the preceding experiments appear to point to the conclusion that so long as a path through the copper molecules can be maintained for the current, but little, if any, of the current will pass through the hydrogen molecules; the current will, in fact, follow the line of least resistance, and in order to see whether this was true of iron as well as of hydrogen, a dilute solution was prepared which contained iron and copper as sulphates in the following proportions:—

Water	100·0
Copper	·3
Iron	·1.

A current at the rate of 550 amperes per metre was passed, the electrolyte being circulated in the manner shown in Diagram J, and the deposited metal was analysed to ascertain whether any iron had been thrown down with the copper; not a trace was discovered.

This was repeated with half the amount of copper above mentioned in solution, viz.:

Water	100·0
Copper	·15
Iron	·1

The amperes being reduced to 330. Again no iron was found in the deposit.

A considerable number of experiments were also made for the purpose of ascertaining whether soda, potash, zinc, or aluminium, if present in large quantities in a solution of sulphate of copper, would alter the character of the copper deposit; so far as could be judged by the eye they made no difference, but the deposits were not analysed.

The fact that the current will pass through the copper molecules in preference to passing through the molecules of other metals, which may be in solution so long as a path through the copper molecules is maintained, appeared to offer a ready means of depositing copper in an almost pure state from the very impure solutions which are obtained by lixiviating certain ores.

The Rio Tinto Company in Spain produce very large quantities of such solutions, and they were good enough to send the author samples of some of their solutions. The strongest of these solutions was analysed by Mr. Swinburne and found to contain the following metals which were all assumed to be present in the form of sulphates.

Copper	11·09	Grammes per litre of the solution.
Iron	17·31	
Cadmium	0·22	
Aluminium	0·63	
Zinc	2·29	
Magnesium	0·24	

The solution, it will be observed, contained only about 1 per cent. of copper. From this solution the copper was thrown down without any difficulty in the form of both wires and sheets by the apparatus shown in Diagrams I and J. The current for the wires was about 550 amperes to the metre, and no difficulty was experienced in drawing the wire so deposited, nor did the wire show any signs of brittleness.

The current for the sheets was considerably denser than in the case of the wires, a perfectly good deposit being formed.

The author is also much indebted to the Tharsis Company who kindly sent him samples of the impure solutions of copper prepared by them from ores which they treat.

One of these samples was analysed by Mr. Swinburne, and found to contain the following metals, which were believed to be present in the form of chlorides.

Copper	32·54	per litre of solution.
Iron...	7·42	

Aluminium	not determined.
Zinc	
Potassium	
Sodium	

Although here, as with the Rio Tinto solutions, no difficulty was experienced in depositing the copper, yet it was found to be impossible to get a deposit of a good colour at any current density however small. The deposit instead of being a pale salmon colour as desired, was invariably of a dirty brown colour, and for some time this was supposed to be due to the presence of some other metal, but it was found that copper thrown down from a solution of pure chloride of copper was of the same dirty colour, and that the addition of sulphuric acid in very considerable quantities to a solution of chloride of copper made very little difference in the appearance of the deposited metal.

The discolouration, therefore, appeared to be due to the presence of chlorine, and to determine this point a saturated solution of sulphate of copper was taken, and to it was added commercial hydrochloric acid in the proportion of two cubic centimetres of hydrochloric acid to one litre of the copper solution. This amount of hydrochloric acid made hardly any perceptible difference in the appearance of the deposit. With three cubic centimetres a change became noticeable, and with six cubic centimetres of hydrochloric acid to one litre of saturated sulphate of copper, the deposit was about as dark in colour as if the whole of the copper had been present in the form of a chloride. In these experiments the current was at the rate of 1,000 amperes to the metre.

It, therefore, appeared that to treat the Tharsis solution effectively, it would be necessary to convert the copper into a sulphate and to get rid of the chlorine. This was economically effected in the following manner: soda or lime were added in quantities just sufficient to throw down the whole of the iron as a hydrated oxide, leaving all the copper chloride in solution. After the iron precipitate had been separated out, a further quantity of soda or lime was added to the clear solution, and the whole of the copper was thus thrown down as a hydrated oxide: this oxide of copper was then very thoroughly washed and dissolved by sulphuric acid, and from the solution so obtained the copper was easily thrown down as a perfect deposit.

One advantage of this method of working is that the dilute solution of chloride is converted into a saturated solution of sulphate.

The author is much indebted to Mr. Crompton, who very kindly allowed him to use his laboratory at Thriplands during all the earlier experiments mentioned in this paper.

AN ELECTRICAL HYPOTHESIS FOR THE SOLAR AND PLANETARY SYSTEMS, AND SOME OF THEIR ASSOCIATED PHENOMENA.

By DELTA.

IV.

The Atmospheric Electrical Potential.

Although Exner's determinations alone, absolutely prove, and with sufficient exactitude, the measure of the increase of potential at a strikingly high rate in proportion as the distance from the earth increases; this fact of immense and still unrealised importance, had already been discovered by Sassure and by Volta of immortal memory over a century ago.

Gay Lussac's Aerostatic Determinations.

The aerostatic experiments of the great chemist, Gay Lussac, in 1805 corroborated Volta's discovery.

Gay Lussac's temperature and other results have been plotted on the diagram, fig. 12, along with Exner's electrical

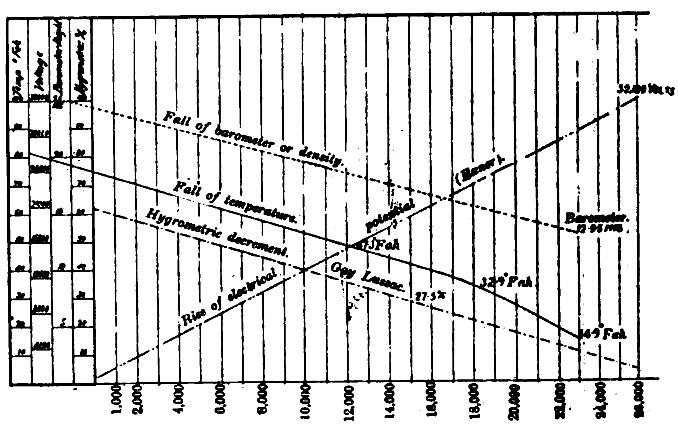


Fig. 12.—Distance from Earth in Feet.

Graphic diagram, showing the remarkable correlative evidence of the fall o the barometer, or density of the atmosphere, the reduction of aqueous vapour and the temperature, and the rise of the electrical potential—with the increase of distance from the earth.

determinations. It will be noticed that at the height of 23,040 feet above the level of the sea the temperature had fallen from 82° F., the temperature at the earth's surface to 14·9° at the altitude defined.

Gay Lussac found that the density of the atmosphere decreased at a height of 22,912 feet to less than half its value at the surface of the earth—the barometer had sunk to 12·95 inches.

The hygrometric researches proved that the aqueous vapour proportion fell from 62 per cent. at the earth down to 27·5 per cent. at an altitude of 15,190 feet.

He (Gay Lussac) also found at an altitude of 23,000 feet that the chemical constitution of the air had undergone no change.

If the writer's hypothesis is correct, it would mean that the fall of the barometer should proceed *pari passu* with the fall of temperature. The diagram shows that the fall is parallel, and is, therefore, consistent with the theory.

The Fall of Temperature with Increased Altitude.

The fall of temperature in Gay Lussac's aerostatic experiments is as follows:—

Temperature at the earth	= 82°	Fahr.
" at a height of 12,125 feet	= 47·3°	"
" " " 18,636 "	= 32·9°	"
" " " 23,040 "	= 14·9°	"

In the verbal demonstration of the solar electrical hypothesis it is, perhaps, unnecessary to say that the expression vacuum is merely employed to explain an imaginary condition of the extreme tenuity of the atmosphere, that will permit the transmission of high potential currents with a minimum of loss. It is well known that, in proportion as the atmospheric tenuity is increased (within certain not as yet well-defined limits), is the electrical resistance reduced; this can be proved by connecting the terminals of an electric collector machine with a so-called vacuum tube; it will be found that a far longer discharge can be obtained than if the terminals are divided by an atmospheric interspace of normal density. It is, however, not absolutely essential to assume such a rarefaction in order to obtain a miniature resemblance of solar electrical effect.

A Laboratory Demonstration.

Fig. 13 is a diagram intended to represent the remarkable luminous effect on two terminal spheres of a Voss machine, the experiment can be repeated by anyone.

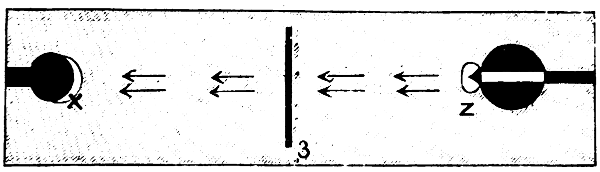


Fig. 13.—Voss Electrical Collector or Machine.

Diagram showing the luminous surfaces on two spheres, x and z, by the emission and reception of electrical energy of high potential.

An opaque diaphragm 3 can be placed so as to intercept any possible reflection, but the luminous effect is not reduced. The human hand placed in the position of the diaphragm will realise a sensible reduction of temperature, but will not be influenced by the flow through it of the electrical energy.

The high potential (brush discharge) current across an air interspace produces at the projection from the discharge sphere a luminous effect, which is repeated on the reception surface of another and *vis-à-vis* sphere. To prove that the second luminous surface is not merely the effect of reflection from the *vis-à-vis* luminous surface, one has only to place an opaque board so as to intervene between the two spheres, as shown on the diagram, there will still be the same dual luminous evidence. If the opaque board is replaced by the human hand a sensible cooling influence will be evident, but no electrical effect will be produced and the energy flow will not be appreciably affected. Both at and around the projection of the negative sphere terminal, which can be considered to represent the solar sphere, and at the surface of reception of the positive sphere terminal representing the earth, there will be noticed in the dark a luminous area, relatively great in proportion to the surface of the sphere; if a pointed projection was provided for the positive sphere and on the opposite side to the luminous surface, the electrical energy would be dissipated into the atmosphere by which it would be again collected by the Voss machine or other electrical collector, of which the solar sphere is an example. Now referring to diagram *a* of the positive sphere terminal, *x* is moved in a circular line around the negative sphere *z*, the electrical energy will follow this movement and take the direction of a radial line drawn across the centres of two spheres.

The only difference between the electrical solar hypothesis and this laboratory proof, is the fact that in the latter the interspace is of atmospheric density, but even then there is practically no luminosity in the interspace except in or about the surfaces of emission and reception of the electrical energy.

It may be suggested from the proof adduced, that in order to produce the luminous effects at the surfaces of emission and reception, it is not necessary that the solar and terrestrial luminosity is produced by the increased resistance of their respective atmospheres to the flow of electric energy. This is granted, but in order to satisfy the conditions enforced by the law of the conservation of energy, it is necessary to assume such a high rarefaction or reduced density between the sun and the planets as will permit the unimpeded flow of electrical energy, and we know, as a positive fact, *that the density of the atmosphere* does decrease in a now well-defined proportion to the distance from the earth's surface.

The Movement of the Planetary Bodies.

The hypothesis that the entire celestial or interplanetary and interstellar space is really an accumulator reservoir, or ocean of low pressure electrical energy, that will permit, as does the earth's atmosphere (which constitutes part of this electrical ocean), the flow through it of high intensity electrical currents, permits the application of the magnetic attraction theory to displace and fulfil the conditions of the Newtonian gravity hypothesis.

The author suggests that the rotation of the planets may be effected somewhat in the same way that an electric motor is rotated, and their high and generally compound rotation may give them their distinctive orbits. No doubt it could be demonstrated that a rotation could be given to a spherical body, which would propel it in a certain specific direction, and if the orbits of the planets were mathematically circular, this hypothesis would apply; but the fact that the orbits of the interplanetary and interstellar bodies do not generally assume this form, inclines one to the opinion that the orbit is the result of the attractive influence of the great central solar electrical body, and that the spherical rotation is the result of the electrical energy rotating the polarised planets in some way, as a current rotates an armature.

As far as the moon is concerned, it is suggested that the electrical attraction of the earth, added to the rotating influences set up by the solar electrical centre, may be some explanation of its peculiar orbit, surbordinate to the planet earth.

Saturn and its Rings.

The movement of the rings of the planet Saturn, in their particular and regular plane of inclination, may constitute the source of motion of this planet, assisted, as it would be, by the rotation of the planet itself.

The constitution of the rings is not yet adequately defined; the rings may be associated with an atmospheric annulus, by which the associated rings are illuminated.

The Cometary Orbit.

The cometary orbit will also be produced, it is suggested, in a somewhat similar way to that of the planetary bodies, but their particular form is apparently influenced by the contiguity of other planetary electrical conductors.

The strange feature of the cometary orbit, is the sudden reversal of the direction of cometary movement at the aphelion.

Law of Compensation of Electrical Energy.

It may be rightly argued that as the electrical energy is absorbed in generating luminous and thermal effects, and incidentally in maintaining innumerable other forms of energy that there will be a constant loss of the energy projected from the solar electrical supply stations.

There is the great absorption of energy in internal—or interterrestrial—electro fusion work which is always going on, as we know by the occurrence of volcanic eruptions, by the increase of temperature in deep borings, and by the contraction of the earth's skin. But it may here be remarked that although we may, by electrical resistance effects, raise metals to a state of fusion, if this action is performed in a *reducing atmosphere*, it doesn't necessarily imply that the metal is being burnt up or in any way altered; and, further, under such conditions the additional electrical energy that will be required to maintain the metal in a state of fusion is only that required to compensate for the loss of the heat that flows to that part of the surface of the earth, that is, in its rotation, removed from the direct influence of the sun's supply of electrical energy.

It is, therefore possible, that when the electrical energy was initially introduced to the conductor planetary body, there would then be an immense absorption of electrical energy in effecting internal fusion work, and at this time all the igneous effects noticed in the shell of the earth and producing contraction of the bulk of the sphere would be then effected. However, this is an aside from the subject of the article.

Becquerel (one of the very many illustrious *savants* by which France has enriched the world) suggested that the atmospheric electricity was the product of chemical changes always preceding and induced by chemical action. Here, therefore, have we the basis of the law of compensation of electrical and solar energy.

The proportion of solar electrical energy absorbed in stimulating chemical action will by electrolytic, electro-thermal, and other changes occurring both on the surface and in the interior of the earth, be exactly returned to the low pressure electric interplanetary ocean, and this great accumulation of energy will renew the solar centre in proportion to its supply of energy to planetary and other bodies in the celestial space.

The Atmospheres of Jupiter, Mars, and Venus.

The surface of Jupiter is enclosed in varied masses of flocculent cloud form. This planet has a highly reflective surface—so much so that the effect of its luminous atmosphere is incidentally reflected, and with a loss of 23 per cent. of the initial energy, so that the absorption by this planet of solar electrical energy is very slow.

Herschel identified the dark belts of the atmosphere of Mars as tracks of comparatively clear sky.

These dark belts, it is suggested, are composed of an atmosphere of extremely low density, offering little, if any, resistance to the flow of the high intensity electrical energy emitted from the orb of solar electrical supply.

An alternative explanation is that the dark belts cover the surface of emission from this planet of low intensity electricity and the light or luminous belts constitute the atmospheric surfaces of introduction to the planet Mars of the high intensity electrical currents.

Luminous atmospheric effects are conspicuous in Venus.

When this planet is at inferior conjunction or below the sun, its entire disc periphery is not uncommonly rimmed with a glorious halo of luminous rays, bent inwards, as if by the action of lens.

(*To be continued.*)

ALUMINUM AS A RIVAL OF COPPER AND BRASS FOR ELECTRICAL CONDUCTORS.*

By ALFRED E. HUNT, S.B., President of the Pittsburg Reduction Company.

(*Concluded from page* 321.)

The power of withstanding corrosion is greatly in favour of aluminum as an electrical conductor over copper. Copper does not change in dry air, but in moist air it becomes covered with a green layer of basic carbonate of copper, which, itself, has a corroding action, and does not coat and protect the underlying copper from further corrosion. Ammonia, in contact with copper, absorbs oxygen and the copper dissolved, in consequence of the formation of a soluble cupric-oxide and ammonia. This action is especially a source of trouble where copper wire is used in connecting rail joints in the tracks of electrical railroads, where the ground is often subject to ammoniacal solutions.

Aluminum, similarly, is not acted upon in dry air, and the corrosion in moist air is of the oxide of aluminum, alumina, a harmless salt, which forms an impenetrable coating on the metal, and protects it from further corrosion to a considerable extent. Ammonia solutions act on aluminum only upon the surface, attacking it, and leaving behind a more resisting surface coating of a brown colour containing silicon, which resists corrosion from dilute mineral acids and dilute solutions of organic acids, as well as moist and dry air. Subject to sulphur gases, such as locomotive flue gases, aluminum withstands corrosion better than copper.

If kept free from galvanic action with any other metals electro-negative to itself, aluminum is far less easily corroded than copper.

The difficulty of soldering or brazing aluminum is the chief drawback to its use as an electrical conductor. Aluminum can be soldered strongly, but it is a more difficult and slow operation at best as compared with copper, and there is much more rapid weakening of the soldered joint due to galvanic action between aluminum and the metals of the solder than with the less electro-positive metal, copper.

In many places the aluminum can be first coated with copper, and the soldering or brazing operation made on the copper surfaces thus formed.

Several forms of joints have been successfully used to avoid the necessity of soldering, the best forms being to use thin aluminum sheets to wrap the joints, and to twist or otherwise bind with the aluminum bars or wires to be joined. These wrapped and twisted joints with aluminum sheets can be left smooth on the outside when desired, can be made much stronger than the body of the conductors, and are really a more serviceable job than soldered or brazed work in many cases with copper. One very practical way of making joints of aluminum wire is to roll the thin aluminum sheet, of about 6 inches width, into two cylinders from opposite edges of the sheet. These double cylinders are very cheaply made on mandrels in a lathe. The ends of the wires to be joined are inserted in these cylinders from opposite ends, and both the wire and sheet twisted with pliers until a firm joint is secured, much stronger than the body of the wire. The joint can readily be made impervious to the air and moisture.

The C. McIntire Co., of Newark, N.J., have a patented joint which is made very much along the lines of this joint. Information regarding their patented form of joint can be obtained by correspondence with them as above. Also the American Electric Fuse Company, Chicago, Ill., make a very satisfactory joint.

Another disadvantage which handicaps aluminum in special uses for electrical conductors will be where the material has to be insulated, that the cost of insulation will be approximately one-third greater for the larger section required in aluminum over the cost for the smaller section of copper required for the given conductors; and where aluminum is to economically compete for insulated conductors the price of the aluminum will have to be further reduced to meet this contingency.

Aluminum is soon to be placed in an extensive line of conductors where this added extra cost of insulation will be determined by actual fabrication. The Pittsburg Reduction Company in this particular case agreeing to pay the added costs, in order that actual experience may be gained as to their relative amounts.

There are certain places where aluminum will be at a disadvantage over the smaller section of equal conductivity of copper, in ducts or conduits where space is a considerable item. In such cases, the use of aluminum would necessarily be prevented.

An ample field for the employment of aluminum for some time to come, however, seems open at the present time for bare transmission lines, especially for high potential long distance work and for long distance telephone lines, and for rapid transmission telegraph lines.

Aluminum, next to gold, is the most malleable of all the metals, and is much more malleable than copper.

Aluminum in ductility stands next to copper, and is easily drawn into all sections that are furnished in copper for electrical conductors.

Aluminum can be furnished fully as uniform in its composition as copper.

The metallurgy of copper is comparatively complicated, owing to the difficulty of converting its ores into the oxide free from impurities. In most of the copper ores used, sulphur, lead, and iron are contained, as well as small quantities of other elements, as arsenic and antimony. All of these elements in metallic copper very materially lower its electrical conductivity. The native pure copper of the Lake Superior region enjoys the preference, due to its uniformity and freedom from impurities, for many purposes, but for electrical conductors the electrolutic copper is most used.

Aluminum can now be furnished rivalling, for electrical conductors, at least 99·50 pure, it is granted not as yet, in purity of composition the best electrolytic copper used for the purpose of electrical conductors. When a fused metal is obtainable, undoubtedly it will more nearly rival copper for electrical conductors section for section.

Aluminum has been already in successful operation as an electrical conductor for some time. The first use in a large way was with the conductors for the electric current at the at the Niagara Falls works of the Pittsburg Reduction Company, where it has been used since the year 1895. The currents were of several thousand horse-power each and of very large volume and comparatively low voltage. Both in conducting power, freedom from heating effects, power of withstanding corrosion, ease of making, wear, and efficiency of joints, the aluminum conductors have given better results than copper used for the same purpose.

In the Chicago Stock Yards, a mile of aluminum wire of No. 11 gauge has now been in use for some time upon a telephone line that has been badly corroded out in copper wire, due to its being frequently subjected to sulphur gases from passing locomotives. The aluminum line is giving

* Advance proofs of this paper were courteously forwarded through the Secretary of the Institution of Electrical Engineers.

good satisfaction, and is withstanding corrosion much better than did the original copper wire subjected to the same influence.

If the theory be true that the passage of high voltage alternating currents of great frequency is largely upon or near the surface of the conductors only or mainly, then the larger section of the proposed aluminum conductors will make them especially adaptable for such currents.

On telephone lines it has already been determined that as good sound transmission is obtained with aluminum of equal section as with copper, in ordinary lengths of less than 10 miles of wire. No comparative results, however, have as yet been determined on long distance telephone transmission; but the evidence would seem to point that a much less section than 160 of aluminum to 100 of copper will give equally good results.

Aluminum is now being used to replace brass very considerably in the arts, as it is sold in the open market at rates which make it 10 per cent. cheaper, section for section, than brass.

For electrical purposes, the metal can be advantageously used to replace brass in a good many ways. Commercially pure aluminum as furnished to-day contains less iron than does commercial brass, and is, therefore, more non-magnetic than brass.

The electrical conductivity of aluminum is far superior, section for section, to brass. Almost every electrical apparatus of present construction in which an iron core—usually a laminated iron core—is used, in motors, generators, or transforming machinery, has spaces for ventilation, and the spacing is made by the means of drawn bars, flat rods or angles or tee-shape pieces. Brass has been almost invariably used for this purpose in the past—probably on account of its non-magnetic properties as compared with iron or steel. Drawn aluminum sections can be furnished at a price which is 10 per cent. cheaper than brass, section for section; and on account of the lightness of aluminum, it can be advatageously used.

Where a low electrical conductivity is desirable, as in parts that are moved in a magnetic field, to prevent the occurrence of eddy currents, aluminum can be alloyed with zinc and other metals that will lower its electrical conductivity to the desired point.

ERECTION OF OVERHEAD TROLLEY LINES.

By GEORGE C. SILLAR.

When erecting overhead trolley wires for electric tramways, care must be taken to allow sufficient dip in the wire to provide for the maximum reduction of temperature during the winter season, and so avoid overstraining of the wire.

To enable this to be determined readily, the accompanying diagram may be of assistance in saving time in calculations.

In plotting the diagram the following have been assumed:—

1. That the tensile strain of trolley wire is equal to 25 tons per square inch.

2. That the safe working strain is one-fourth the tensile strain.

3. That the elongation of the wire is 0·0018 times between the freezing and boiling points of water, or 0·0001 times for each 10° F. rise.

4. That the dip of a wire varies as the square of the span, which is not theoretically correct, but for all practical purposes it is so within the limits of span and dip met with in trolley wire erection.

It will also be recognised that for a given span, and with a given strain per square inch of section of wire, the dip will be the same for all sections of the same material.

Referring to the diagram, the curve on the upper part gives the rate of increase of dip for a copper wire, having been determined experimentally, as follows:—

The wire experimented upon was fixed firmly at one end while the other was passed over a pulley exactly 100 feet distant.

The wire was then loaded at the pulley end with a weight equal to one-fourth its tensile strain.

The dip under these conditions was then measured and taken to represent the minimum dip at 0° F., after which the length of wire between the points of support was increased by an amount equal to a rise of temperature of 10° F., and the dip again noted, which latter proceeding was repeated a sufficient number of times to allow for a range from

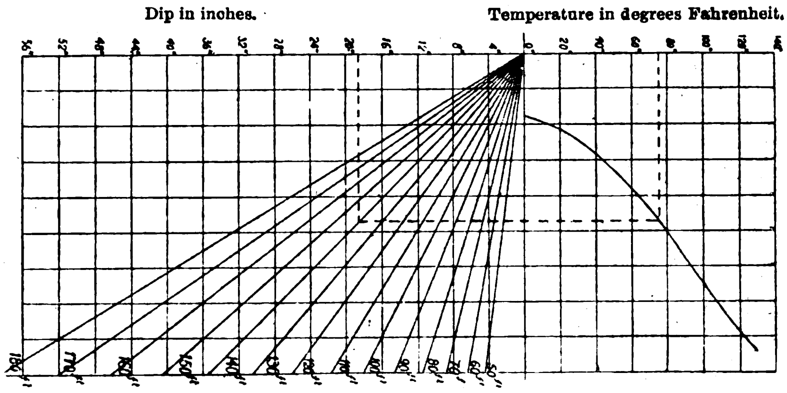


Diagram giving Dips for any Temperature from 0° to 130° Fah. at any Span from 50 Feet to 180 Feet.

zero F. to 130° F., these being assumed to be the minimum and maximum temperatures to be provided for in this country.

On the lower part of the diagram, diagonal lines are drawn representing the spans, and are arranged so that the distance between them on any vertical line varies as the square of span which they represent, consequently the dip for any one span being known the dip for any other span can be read off without trouble.

It will be obvious how the top and bottom sections of the diagram are intended to be used, but to take a concrete case assume that it is required to determine the safe minimum dip for a span of 140 feet at a temperature of 75°.

Starting from 75° on the temperature column, carry the eye horizontally till it meets the curve, from which point drop a vertical line to meet the diagonal line representing the given span of 140 feet.

Opposite this point on the left hand column will be read the dip in inches or 18·4 inches.

This sequence of operations is indicated by the dotted line.

THE UTILISATION OF MAGNETIC ACTIONS FOR THE DIRECT TRANSFORMATION OF HEAT INTO MECHANICAL WORK.

In a note presented to the Académie des Sciences on October 11th, and reproduced in full in *L'Industrie Electrique* for October 25th, 1897, No. 140, p. 456, M. Marcel Deprez, after many other writers, called attention to the possibility of transforming thermic energy into work by utilising the variations of the magnetic constants with the temperature and the remarkable magnetic properties of the alloys of iron and nickel recently discovered by our *collaborateur*, Ch. Ed. Guillaume.

M. Marcel Deprez's note* concluded with this seductive promise:—

"In a future paper I shall show how the same principle enables us to transform heat directly into mechanical work, and I shall describe the conditions under which these two kinds of apparatus, the thermo-magnetic motor and generator, would be capable of giving really practical and economical results."

We have looked in vain since in *Comptes Rendus* for the promised communication, but in the *Revue Générale des Sciences* of January 30th, 1898, we find an article by M. Marcel Deprez which supplies its place, and seems to imply that the thermo-magnetic motor and generator capable of giving really practical and economical results have yet to be realised, for the writer begins with the following declaration:—

* See Electrical Review, February 18th.

"A profound study of the question has led me to the conclusion that if these results are ever obtained, great difficulties will have to be overcome," and the object of the article is to show the nature of these difficulties.

The principle of the thermo-magnetic motor, to which M. Marcel Deprez applies the ferro-nickel alloy, consists in arranging a rod of this alloy in a magnetic field, and in making it revolve on an axis perpendicular to the direction of the field, and to this rod. It is rendered alternately magnetic or non-magnetic by cooling it and heating it in succession between the limits of temperature, at which the magnetic properties appear or disappear completely. For each revolution of the rod of ferro-nickel, two successive coolings and heatings must be produced, and the mechanical cycle will consist of four quarters of a revolution, two of which are motive, and are separated by two others that are non-motive, an action similar to that of a single-action engine with two cylinders, the cranks of which are fixed at 180°.

A first calculation shows the writer that by using a moderate magnetic field, of an intensity of 1,000 gauss, and a variation of temperature of 50° C., a variation for which the ferro-nickel is supposed to be magnetised or demagnetised completely, the efficiency would not exceed $\frac{1}{2000}$. In order to produce a quantity of mechanical work equal to 1 H.P.-hour (270,000 kgm., or 557 calories kg-d.), we should have to furnish 1,270,000 calories, representing the equivalent of 150 kg. of coal.

To give an idea of the dimensions to be given to the apparatus intended to revolve between limits of temperature not exceeding 50° C., the writer mentions the fact that in the furnaces of locomotives the heating surfaces do not, at the most, give off more than 200,000 calories per square metre per hour.

The second part of the article is devoted to showing how these conditions may be improved by increasing the intensity of the magnetic field and bringing it to 10,000 gauss, by employing a special mode of heating and cooling and by making the body which serves as a vehicle for the heat pass successively over a series of rods composed of alloys varying in the proportions of their composition and in their magnetic properties.

By using hypothesis after hypothesis, and assuming as extremely probable that the principle of Carnot is applicable to thermo-magnetic phenomena, M. Marcel Deprez arrives at finding—but not at demonstrating—that the efficiency might rise to 3 per cent., *i.e.*, to that of a steam engine of moderate power consuming about 3 kg. of coal per H.P.-hour.

Unfortunately, M. Marcel Deprez assumes the organic efficiency of the apparatus to be equal to one, which is excessive for one so heavy, bulky, and cumbersome as that of which he describes the principle; moreover, the rapid cooling and heating of the thermo-magnets must be obtained by the *mechanical* and alternating circulation of a liquid, which circulation, it seems, must absorb a power which is greater than that developed by the thermo-magnetic motor, and which is not taken into account at all.

The thermo-magnetic motor of M. Marcel Deprez seems, therefore, destined to be consigned to oblivion like the famous pyro-magnetic generator which Edison presented so triumphantly in 1888 to the American Association for the Advancement of Science.

In not presenting his second note to the Académie des Sciences, M. Marcel Deprez has shown his discretion, but we feel it our duty not to leave our readers too long in the expectation of a "thermo-magnetic motor and generator capable of giving really practical and economical results." They know now the opinion of the writer, an opinion based on "a profound study of the question."—E. H. (*L'Industrie Electrique*).

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1898.

Compiled expressly for this journal by W. P. Thompson & Co., *Electrical Patent Agents,* 322, *High Holborn, London, W C., to whom all inquiries should be addressed.*]

6,179. "Improvements in secondary batteries." O. Hamilton. Dated March 14th.

6,182. "A new medical electrical device." A. L. Burgess. Dated March 14th.

6,184. "Improved electric light for use as a search or signal light, for photographic and other purposes." E. M. Brown. Dated March 14th.

6,223. "Improvements in electric railways." C. M. White. (B. C. Seaton, United States.) Dated March 14th. (*Complete.*)

6,235. "Improvements in electrical insulators and method of making the same." J. W. Boch. Dated March 14th. (*Complete.*)

6,270. "Improved electrical lampholder." F. W. Heaton and H. Smith. Dated March 15th.

6,328. "A new and improved method of and apparatus for generating electricity." C. O'D. Barrows and C. H. Smith. Dated March 15th.

6,350. "Improvements in or connected with the manufacture of carbons for electric arc lamps." J. J. Waddington. Dated March 15th.

6,357. "Improvements in or in connection with electric motors for cars or other vehicles and in brakes therefor." W. P. Thompson. (T. von Zweigbergk, United States.) Dated March 15th. (*Complete.*)

6,360. "Improvements in or relating to electric light carbons." J. W. Strauss, J. G. Chapman, and H. Foster. Dated March 15th.

6,362. "Improvements in electric switches." T. Gillies and E. Hornidge. Dated March 15th.

6,371. "Improvements relating to the driving of sewing machines by electricity." H. Lea. Dated March 15th.

6,414. "Improvements in or relating to electric plug and ordinary switches." T. Topping. Dated March 16th.

6,451. "Improvements in apparatus for electroplating pins and other small objects." J. S. Morrison. Dated March 16th.

6,478. "Improvements in electrical connections for lamp-holders and other electrical appliances." R. F. Hall. Dated March 17th.

6,482. "Improvements in electric light advertising." E. Lightheart. Dated March 17th.

6,498. "An improved arrangement for forming or mounting the armatures of field magnets of small electro-motors." F. A. Darton and F. G. Phillips. Dated March 17th.

6,525. "Improvements in apparatus for electrolytic purposes." W. G. Luxton and The United Alkali Company, Ltd. Dated March 17th.

6,526. "Improvements in apparatus for electrolytic purposes." W. G. Luxton and The United Alkali Company, Ltd. Dated March 17th.

6,535. "Improvements in propelling barges and boats on canals and other water-ways by electricity." W. E. Kenway and T. V. Hughes. Dated March 17th.

6,559. "Improvements in electric arc lamps." G. C. Fricker. Dated March 17th.

6,605. "Improvements in telephonic inter-communication system." W. Aitken. Dated March 18th.

6,607. "A new or improved separator for the plates or electrodes of secondary batteries or accumulators." E. J. Clark. Dated March 18th.

6,619. "Improvements in microphones." L. M. Ericsson. Dated March 18th. (*Complete.*)

6,633. "An electrical charge conductor." F. W. Cooke and T. Ireland. Dated March 18th.

6,637. "Improvements relating to the electrolytic production of metallic alloys and to apparatus therefor." C. E. Acker. Dated March 18th. (*Complete.*)

6,649. "Improvements in dynamo-electric generators and motors." C. W. Atkinson and W. H. Johnson. Dated March 18th.

6,672. "An improved receiver for electro-magnetic waves." A. F. Eves. Dated March 19th.

6,695. "Improvements in electrical regulating apparatus." R. E. B. Crompton and S. W. Ashley. Dated March 19th.

6,704. "Improvements in switchboards for the control of high voltage electric circuits and apparatus." H. F. Parshall. Dated March 19th. (*Complete.*)

6,712. "Improvement in insulators." L. F. Rembe. Dated March 19th.

6,714. "Improvements in electric switches." E. M. French. Dated March 19th.

6,720. "Improvements in depressible rail systems for electrical railways." W. Grunow, Jun., and Z. Goodsell. Dated March 19th.

6,758. "Improvements in electric furnaces." A. M. G. Sebillot. Dated March 19th.

6,762. "Improvements in the means of and apparatus for transmitting pictures and the like by electric currents." W. E. Simpson. Dated March 19th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free,* 9d. *(in stamps).*]

17,583. "Improvements for electric condensers." C. S. Bradley. Dated September 4th, 1897. This relates to electric condensers, the object being to increase the safety of the condenser, wider dielectric strain of the abnormal voltage, increase its life, to preserve a uniform capacity, and reduce its heating extent. To accomplish these aims, there is an electric condenser having its condensing plates and dielectric enclosed air-tight in a metallic casing, hermetically sealed at the joints to exclude the moisture of the air and preserve the condenser's capacity unaltered. The plates are held by stiff side-plates and are kept under pressure in an air-tight casing by a strong metallic frame, which projects beyond the edge of the casing and has a large heat radiating surface. 4 claims.

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TRADING CORPORATIONS.

THE decision given by Judge Wightman Wood in the Leicestershire County Court a few days ago, in the case The Corporation of Leicester *v.* H. Warren Hill, is, we think, a very satisfactory one from all points of view. Our readers will, no doubt, remember that so long ago as 1895, we dealt with the question of local authorities trafficking in electrical goods, and to this and its cognate subject—the attempt on the part of such bodies to compete with wiring contractors—we have devoted attention from time to time since that date.

The judge in laying down what he believes to be the law on the subject, aptly remarked that this was a case of unusual importance to come before a court of limited jurisdiction. Although the action was ostensibly for the price of lamps and other fittings sold to the defendant, Mr. Warren Hill, the importance of the case lies in the motive that underlay the refusal to pay. Mr. Hill, in common with wiring contractors generally, feels very sore that his business should be injured by the powerful competition of local authorities, who, acting on the advice of certain officials, undertake to fit up premises and sell lamps and accessories as an adjunct to their public electricity supply. We imagine that so far as the sale, or giving away free, of incandescent lamps goes—or even the hiring out of arc lamps and motors—no one will make any serious objection to this action on the part of corporations or vestries, as obviously the consumers are likely to increase in number and importance if the undertakers adopt a truly progressive and energetic attitude in fostering their business and rendering as general as possible the use of electrical energy. The contractor benefits more than indirectly from such business-like pushing, because he has a greater number of potential clients, and it is his own fault if he does not get the orders for fitting up their premises and wiring to the apparatus which is let on hire.

When we come to wiring and installing, however, the aspect changes very materially. So long as the business of supply is assisted, it is to the interests of the wiring contractor to support the undertakers; but when those who hold statutory powers to supply not only do what they are fully entitled to do, but branch off into the domains preserved in most instances to the private individual, then we think that, morally, a wrong is done, and an act of injustice perpetrated for which there is very little excuse. The legal position may coincide with or differ from that dictated by elementary principles of fairness and justice, but it is hard to see how popularly elected bodies, whose revenue is derived from the inhabitants of a district generally, can explain their action without sophistry or an appeal to the principles which are of a class with those enjoyed by the members of Tammany Hall.

Coming back to the Leicester case, we find that the Corporation attempted to refute the argument that their dealing in fittings and installing was *ultra vires* by, firstly, quoting the Electric Lighting Act, which says the undertakers may "generally do all such acts and things as may be necessary and incidental" to electricity supply; secondly, by stating that the Board of Trade model form of accounts has an item, "By sales and repairs of lamps, arc or incandescent, or other apparatus." When it is remembered that it is customary in many towns for the Works, Highways, or Streets Department to take charge of and maintain the apparatus used for public lighting, *i.e.*, the standards, lamps, and street fittings above ground, it seems quite reasonable that provision should be made for any inter-departmental adjustment of accounts such as must occur if the electrical department purchases, erects, and then hands over the street lamps to another department or section of the local authority, after everything has been put in order and properly tested. It seems to us to be stretching the point to argue that because such a heading is provided, therefore one must assume that the purchase of the goods by outsiders and the general public is contemplated.

The first suggestion is very clearly dealt with in the judgment, "I am of opinion that the contention of the defendant that the Corporation acted beyond their legal powers in selling the articles named in the particulars is correct; and as to that part of the case, whether I am right or wrong, I have no difficulty in coming to a conclusion." To fully understand this it must be mentioned that the Corporation do not confine their sales of goods to consumers, but vend to the public at large, and yet we are told that selling lamps and fittings to private individuals who have no concern in, or connection with, the Corporation supply (except, of course, as ratepayers) is an act incidental to such supply!

The object of allowing the case to reach the County Court having been attained, there is not much technical interest in the actual judgment, although the legal aspect has its importance. "I am of opinion that the defendant having had the goods, cannot be allowed to refuse to pay for them on the ground that the Corporation went beyond their legal right in selling them, and could not be held to their contract to deliver them had they refused to do so. The defendant has got what he bargained for, and in my judgment he must pay the price, notwithstanding the flaw to which, I think, he has rightly called attention in the legal capacity of the Corporation to carry on their business." So we now know that the first Court holds the Corporation to be wrong in trading; but if people buy goods from the municipal shopkeepers, they must not expect to get off without leaving something in return therefor. And the Corporation had to pay the costs they incurred in bringing this action.

Much might be said about this case as typical of what is done, but we think it best to refrain from pressing home obvious truths. There is, however, a very interesting side light thrown on this matter by examining the action of Mr. Steinitz at West Ham. As a former Corporation engineer of Leicester, he knows the whole of the facts. We believe it is correct to say that his conviction is that Corporations make a mistake when they enter upon such work. We certainly draw the line between Corporations and companies, but how few of the latter have retained or done any good by a wiring department! The House-to-House Company at one time executed contracts, but found it best to leave alone what others could do better—better from the financial point of view—while the most noted success was the Liverpool company which not only did ordinary housework, but undertook the fitting up of the ss. *Teutonic* and *Majestic*.

The wiring contractor is the best friend the supply station engineer has from the business point of view (we have frequently said our say regarding their technical relations), and it is folly to expect that a municipal body can do work as cheaply as a contractor in these democratic days when trades unionism is rampant. Let "the cobbler stick to his last," and the corporation to its supply. Assuredly, the woes of the supply engineer are legion, without adding to them the pettifogging worry of customers' lamps burnt out, fuses blown, fittings damaged, &c. As a local authority neither needs nor benefits by making a profit on trading, it is only by some curious mental kink that the enticement of taking up installation work can be felt. One would think that the cleaner hands were kept of everything after the consumer's meter, the better, and the more time could be spent in and on the station and distribution. That this is the view of most of our municipalities is made evident by the careful way wiring is left alone, and the consumer plainly told that the undertakers do not supply light, but "units." The only other rational course is to go, not half-way, but the whole way, and wire every comer's premises, put in the lamps, and be responsible for the supply of light—as some even now would have us do.

When one sees the name of a Corporation appearing amongst a list of tenderers for a wiring job miles away from its own *locale*, it is high time that a definite ruling as to what may and may not be done under the Electric Lighting Acts should be given.

American Iron Manufacture.

THE July number of the *United States Consular Reports* contains a paper contrasting American methods of iron manufacture with English methods, the conclusion being that American competition is possible because of the huge size of the plants employed, the latest new furnaces at Duquesne belonging to the Carnegie Company having an output of 200,000 tons annually, or 40 times the average British output. There may be differences which enable American furnaces to be so much larger, but we imagine not sufficient to account for so very much as practice shows in the above. Similarly, there are several rolling mills capable of rolling 50,000 tons of rails per month, which is probably threefold the yearly production of any one mill in Great Britain. These differences enable the long hauls in America to be paid for. English railways, too, charge seven times as much as American railroads for carriage, so that there is but little advantage in the English short hauls. Successful men in America are more apt to use other people's capital than they are in England, where caution is more marked and old plant is apt to be continued in use too long. British caution has its advantages, of course, when bad times come, but caution may be overdone. We think a change is coming. The strike which has brought to the surface so vast an amount of information has had an educational influence we hope both on masters and men. Foreign competition has become appreciated, and before there is another strike most likely the men will learn that production and not restriction is the secret of success. There is ample margin for economy in English manufactures, in railway carriage, in mineral royalties and in more productive labour, while on the employers' side there must be no weakness in giving way to demands that are opposed to principles of economic science, and there must be a better recognition of education and ability. The sons of the wealthy must either be compulsorily dismissed from all control of works, or they must prove their fitness to control. The interference in shop management by the A.S.E. might possibly have been more strenuously resisted if brains had been better treated. For years English trade has been lashed round the miserable circle of laziness on the part of men and unscientific mastership by the sons of successful fathers. Men in command are often so ignorant of anything outside the run of news in a morning paper that they are unable to grasp the significance of a new process or a new machine. They succumb to the most gaseous traveller who can tell the most brazen fables, and they have no ears for the man who offers them a fortune, because they cannot discriminate between wheat and chaff. English trade wants purging at the source and at the sea. It is not all at the workman's end that the mischief is made. America has hardly had time to produce a second and third generation of the idle ignorant rich, and is not hampered in the same way.

SMALL ELECTRIC MOTORS.*

By JOHN DENNIS.

I see by your "Notes and Queries" columns that a great many readers are interested in small electric motors, such as you give instructions for the making of in your paper.

The greatest problem, however, seems to be the economical running of the same with a battery current.

It is time and money thrown away to attempt to use them continuously with a primary battery alone; but by using a storage battery, charging the same from gravity cells, we obtain good results.

As I have had a plant of this kind running almost continuously since January, 1894, my description of the same, giving the original cost and actual expenses per year, will perhaps be of interest to your readers who may wish to instal a similar one.

The plant consists of 12 6 × 8 gravity cells, placed in the cellar, connected in series, with two No. 14 insulated wires going through the outer cellar wall, then up to the attic, and through the storage battery, the distance being about 50 feet each way, which will make 100 feet of wire. The storage battery is of the chloride type, four cells connected in series, each cell composed of three plates, 7¾ × 7¾ inches, placed in a glass jar. To prevent accident, I enclosed the glass jars in a lead-lined box, using paraffined wood strips on the bottom, around and between the cells.

At first I had the connections inside the box, but soon found that they corroded with the splashing of the acid; so I soldered on rubber covered wires, then covered the joints with rubber cement and rubber strips, bringing them through the box and making all my connections on the outside. This works admirably. Another advantage of having them in a box this way is, that it prevents evaporation and it is not necessary to look at them for six months; then, if the acid is below the plates you can fill over them with a little water. Of course, there are the closed rubber storage cells which a person may get, but the cost is a good deal more. By having my storage battery in the attic in this manner, I am able to conduct my working wires to any room on the second floor, using No. 10 wire. If there was any apparatus on the first floor, wires could easily be carried from the charging wires in the cellar up through the floor to the same.

The principal part of the work is to run two sewing machines for family use, one of which is operated by the "Simple Electric Motor," with a cast field and segmental commutator on the shaft. This is inclosed in a box or cabinet on casters, and stands at the right-hand side of machine, the shaft being long enough to come through one side and the end of same running in a small hole bored in the iron frame of the sewing machine, between which and the box is a small pulley on the shaft, with a belt running to the pulley of machine. There is a switch placed on the wall to cut off the current when not in use; also a foot switch placed on the treadle and made out of an ordinary window burglar alarm. This leaves both hands free to work with. Three resistance coils, consisting of No. 18 iron wire coiled on brass rods covered with asbestos, are placed inside the motor box, underneath the cover, and connect with a three-point switch on top of the box. When connection is made by the foot, and the switch is not on any of the points, the motor is running in series; and if the storage battery is highly charged, or if the work is light, it will be very satisfactory. Should the work be heavy, however, or the battery low, by switching on the points we allow more current to go through the armature, thereby getting more power.

I have made the "Simple Motor," the "Parkhurst," and the "Hand Dynamo," but the best one seems to be the "Simple Motor," that is, it seems to have more power for the amount of current passing through.

In another room I have the "Parkhurst" motor running a Singer sewing machine, connected somewhat similarly; only instead of the motor being in a box, it stands on the table of sewing machine, the resistance being in the base.

I have also a fan which I use occasionally in the hot weather, two small incandescent lamps of 4 candle-power, and an alarm clock which rings a bell and lights a lamp at the same time.

I have had no trouble whatever with the storage battery since first starting. The gravity cells I test about once a month. If they are above 25° Baumé, I take out three glasses of zinc sulphate from each cell, add more blue vitriol if necessary, clean off the zincs and fill up with soft water.

I have a simple galvanometer in the circuit which I can switch on or off, and from the amount of deflection of the needle can readily tell whether they are charging all right or not. One can cast his own zincs by making a pattern and casting in common fine sand, saving about one-half the cost.

If there are two parties living in one house, one can easily rent out power to the other for, say, 50 cents per month, or he could run wires across a short distance to his neighbour. I think the plant would furnish enough current for three family sewing machines; that is, to charge continuously, always having the gravity cells connected up. Below I give approximate cost per year for this way. At present I let mine charge till they use up 25 lbs. of blue vitriol, then I disconnect them from storage battery, take out the zincs, clean and dry them, and let them stand till storage battery gets low, then charge up again.

First cost, 4 storage cells at $5 25 each	$21.00
" " 12 gravity cells without zinc	4.20
" " wire, &c.	5.00
" " lead and material for box	4.00
Total	$34.20
Annual expense charging continuously:—	
240 lbs. blue vitriol at 5½ cents	$13 20
72 lbs. zinc at 5 cents	3.60
	16.80
Copper deposit sold	70
Total	$16.10

(This divided between three would only be a little over $5 per year each.)

To charge them as mentioned in latter part of article would be about $10 per year.

* *Scientific American.*

HANDY ACCESSORIES IN A CENTRAL STATION.

To the casual observer it may seem that the duties of a central station engineer begin by lighting a fire in his boiler and end in sending out current to his customers; with the occasional use of the oil can on rods, levers, and bearings. Certainly to the uninitiated visitor to an electricity works these operations seem to be the principal aim of the men on duty. The chief engineer may have been partly responsible for this impression when he carelessly remarks "we put some coal in at one end and send electricity out at the other; a few drops of oil make things go smoothly, quite simple you see."

Just as there are moments when a policeman's life is not a happy one, so there are times when the apparently serene chief has his trials, and he is wise who has prepared himself, as far as possible, by every means in his power to meet all contingencies. To successfully supervise an electricity works one must be rich in resource and quick in cases of emergency.

A few handy tools or appliances in convenient and recognised places often save a lot of time and trouble. The ability to put things straight quickly when they have gone crooked is great, but the gift of "looking ahead" for causes which may develop into serious faults and cause disaster is much greater. Frequent testing of machinery and mains, examinations of engines and boilers, are all done with this primary object in view. The caulking of a boiler stay or seam, the tightening of a "big end," the adjustment of a piston or valve, the overhauling of a dynamo, the inspection of switch gear and connections, are each as necessary as the dropping of the oil in the aforesaid bearing.

It is sometimes very convenient to be able to make substantial temporary connections at the switchboard promptly, and these connections can be utilised for a variety of purposes, for instance, an engine may get on the dead centre; a little current turned into the generator would materially assist in getting over the difficulty. It may be advisable to take current from the switchboard for many purposes, and unless some means is provided it becomes a tedious and hazardous job to connect cable to the terminals or connections. Nothing can be more convenient than to attach to each end of a short length of flexible cable a dummy switch connection cut from a sheet of copper. This switch blade should have a projection to which an insulated handle could be fixed, and a second projection placed at right-angles to handle, to which the flexible cable is securely soldered.

The switch blade should be the same thickness as the real one, otherwise the jaws of the switch would be spread and the good contact of the switch destroyed. It is not difficult to see that a few of these devices will readily find a use. Some should have switch blades at each end, while others might have only one end so provided, the other being adapted to connect to the binding screw of a measuring instrument or similar device.

Our old friend the water rheostat is almost too well known to need mention. It is nearly as handy as a screwdriver or a pair of pliers, and will serve almost any purpose. For testing purposes it is invaluable. It is most useful used as a regulator when charging accumulators or testing arc lamps, shunting circuit breakers, operating motors for temporary purposes or supplying a load for dynamo and motor testing, temporary loads for synchronising, and many similar uses.

If, for example, it were desirable to rotate one of the machines as a motor, if the main switches consisted of two single-pole switches as they should, it would be the simplest matter to bridge one of the switch jaws with the rheostat by means of a pair of flexible connections as above described. The current could be varied at pleasure by manipulating the rheostat. Indeed, without this device or its equivalent the operation would be impossible.

An oil barrel, after cleansing, forms a cheap and convenient vessel in which to place the plates and liquid. A metal plate fixed to the bottom of the barrel, and a similar plate suspended in the barrel forms the simplest arrangement. From each of these plates must be taken a cable, that from the fixed plate may pass through the bottom of the barrel a suitable watertight joint being made to prevent leakage of the liquid. The suspended plate should be hung by the conductor, so that in case of a fracture the circuit would be automatically broken and all danger of a short circuit removed. As an additional safeguard two strips of insulating material about one inch in thickness should be placed permanently on the top side of the fixed plate. This would prevent the plates touching should the suspending conductor be slackened out too much by accident. It is well to have this apparatus placed outside, as the boiling and bubbling causes offensive fumes. It is easy to lead the suspending cable over pulleys to a convenient spot, preferably near the switchboard, when a small arc lamp winch can be utilised for raising or lowering the plate as required. A little sulphuric acid added to the water lowers its resistance and allows more current to pass. The exact amount of acidulation is best determined experimentally.

A rheostat constructed on these general lines will be found very useful and will facilitate many operations, which without such a device would be laborious and unsatisfactory.

STARTERS FOR GAS ENGINES.

By W. H. BOOTH.

THE gas engine, though a more efficient machine than the steam engine, has yet many countervailing disadvantages, which have been a great hindrance to its progress and popularity. Some of these are perhaps inherent to its principle; others are not. One of the difficulties with a gas engine is that of starting. A steam engine will usually start when the crank is off the centre and the cylinder is warm; the fly-wheel will carry the crank past the next centre and movement will continue. Not so with the gas engine. In its smaller sizes it is easy to start when in order, because the attendant can pull the fly-wheel round sufficiently to secure a first explosion, or even help it to the second explosion. But a man unaided is not able to start a gas engine of even moderate power. Gas engine makers have overcome this difficulty by the use of starting devices. These are various, ranging from a store of compressed air pumped up by the engine itself on previous runs, or a hand-pumping device to fill the cylinder and exploding by the timing valve, to various other contrivances more or less simple, and suitable for engines of moderate dimensions. But for large engines there is good reason to doubt the convenience and desirableness of these self-starters, especially of that order which depends upon a stored pressure of air pumped up by the last run of the engine. It seems to the writer that gas engine makers have striven too much after originality, and rather neglected well established and sound precedent. Until a comparatively recent date, factory engines were never provided with any kind of starting or moving gear, other than the ordinary rack and bar. Engines in pairs were, of course, self-starting, in so far as they were as a rule arranged with cranks at 90°, an old fashioned arrangement, by the way, which has ceased to secure universal approbation, more especially with compound engines, in the steam distribution of which, the 90° arrangement is apt to introduce an undesirable element. With the introduction of rope gearing, however, and the growth of the average pair of engines from 500 to 1,000 or 1,200 I.H.P., the old barring arrangement ceased to be practicable.

If only to facilitate the putting on of the ropes when the engines were first started or of new ropes as required, some more powerful means of revolving an engine slowly became necessary, and this was found in the small barring engine, a little pair of engines as a rule which were so arranged to gear into an internal toothed ring within the rim of the large rope-drum, that, when the main engines began to run with their own cylinders, the little engine was automatically thrown out of gear by the over-running of the large wheel. Every maker of large steam engines applies these small engines, and a large pair of engines is not considered complete without its small barring engine. Here is the complete precedent for the starting of the large powered gas engine. A gas engine, very small compared with the size of the main engine, will be of ample power to turn the large engine slowly round so as to draw in and compress its charge of gas and air and give the first explosion. Such small engines do not even require to be of a particularly economical type. They are required to be themselves set in motion by hand, and to render this easier, the compression may be kept moderate and less dilute mixtures of gas and air be employed. A run of a minute or two is all that is required to turn the main engine to the ignition point. It is not even always necessary that the starting engine should be able to exert a power sufficient to compress the charge in the main cylinder, for the main engine, once set revolving, will have a store of fly-wheel energy to assist this if gas admission be delayed, and the exhaust be kept open until the fly-wheel has acquired its maximum desired starting velocity. This system of starting has the advantage that the fly-wheel being in motion the stress upon the crank and other parts will not be so severe as when a first powerful explosion operates upon a piston at rest. For this reason it is well that the starting engine should not be unnecessarily small. The more quickly it is able to revolve the main engine the less will be the stresses put upon this. As with its prototype, the steam barring engine, so the gas starter may be arranged to throw out of gear when the main engine accelerates under its own energy, and the throwing-out gear may be coupled with a shut off valve to stop the gas supply, so that the little engine ceases to move as soon as it has fulfilled its duty.

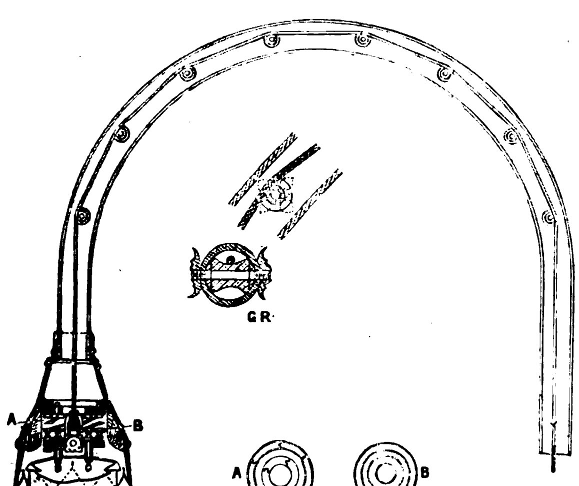
In a central station with numerous engines in line, an obvious method of starting is by a shaft extending the length of the line of engines, and operated by an electric motor or a small gas engine, or an engine may be started by its own dynamo, which supposes, however, a source of electricity. In single engines and on ordinary work, the small gas engine seems to present itself as the most satisfactory method to adopt. Where poor gas is employed, and mis-fires are likely to occur at starting, the use of a starter of the stored pressure type might prove exceedingly inconvenient should the store of air be used before a start were effected. With the barring engine the main engine can be simply kept moving until a fair start is secured. Failures to start may occur, with starting systems involving a pressure in the cylinder, by leakage past the piston. This is not likely to occur with a continuously revolving engine, as the loss of pressure is but slow though sufficient to render ineffectual all attempts to start an engine from rest.

Up to the present, gas engines have been chiefly employed in their larger sizes for producing electric current. Their initial duty is simply the acceleration of the fly-wheel; further duty only comes upon them after they are running. Put to perform all the work that is now performed by steam engines, other difficulties, hitherto not encountered, would be met with, notably, the necessity if roped direct to line shafts, of starting under an almost full load. The piece-workers of textile factories put the belts upon the fast pulley of the machines almost at once, and a steam engine has to start against a very large resistance. It seems probable that the future large gas engine for this class of work will require to be slip-coupled either to its driving pulley or by means of friction couplings on the driven pulleys so as to permit of speed being attained before resistance is put in. Possibly before this necessity arises all our factories will be electrically driven, as they should be, from distant sources.

HOISTING GEAR FOR STREET LAMPS.

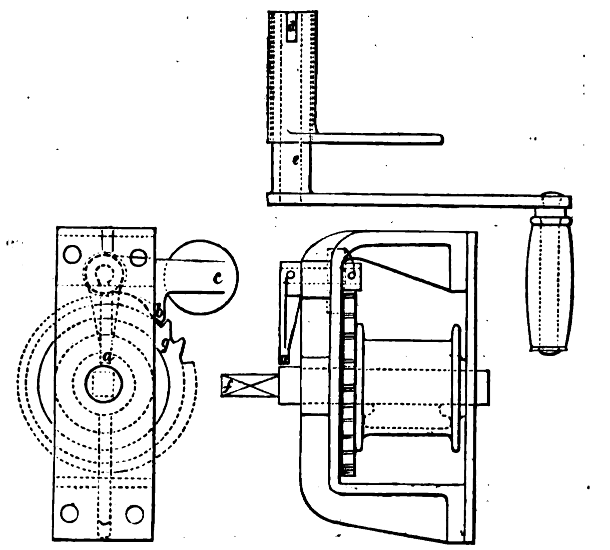
A somewhat interesting arrangement has been devised by Messrs. W. J. Davy and G. Thomas Davies, for lowering and raising street arc lamps. Primarily it consists of a winch placed in the base of a lamp-post, which can be operated by means of a handle without opening the door of the lamp column.

Some 10 months ago an arc lamp, post and gear, fitted with this hoisting arrangement, was supplied to the Bath Corporation, and although it was the first of its kind, it has, we believe, worked without a hitch, and the contacts are as



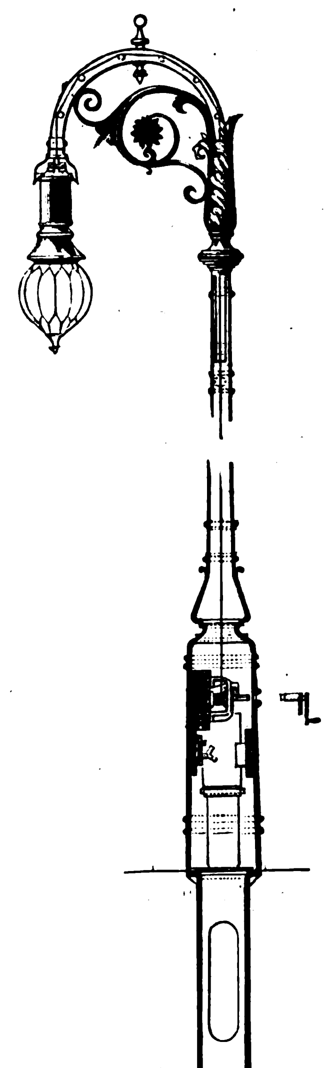
R, Guide rollers; A, Plan of contact springs; B Plan of contacts.
General Arrangement of Winch and Handle.

good, electrically and mechanically, as when first supplied. The means of making electrical connection are shown in the detail drawings. Two discs of porcelain or stoneware are separately mounted, the one on the top of the lamp, and the other inside the hood of the post. Upon these discs are fixed two insulated concentric rings of brass. The disc on the lamp has rings with plain surfaces, and they are connected to the terminals inside the lamp. The disc in the hood carries rings, to which are fixed a number of phosphor bronze helical springs, similar to a multi-threaded screw, in their arrangement. These springs are so arranged that they are right and left handed, and have a range of from $1\frac{1}{2}$ inches to 2 inches for compression. When the lamp is



General Arrangement of Hoisting Gear and Contacts.

hoisted into place the springs rub upon the plain surfaces of the concentric brass rings on the head of the lamp and rub in opposite directions, thus ensuring good contact.



Arc Lamp and Post fitted with Hoisting Gear.

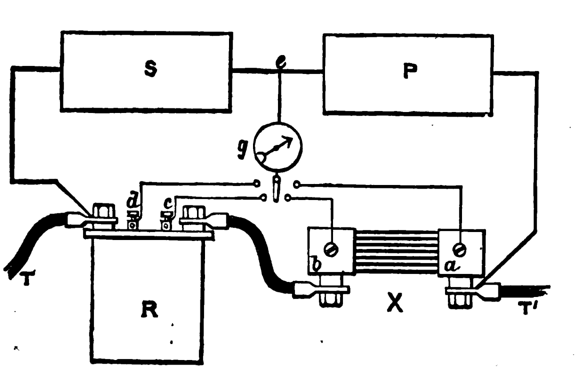
The lamp is guided centrally, first by the flexible steel rope passing between suitable guides centrally between the discs of porcelain, and, secondly, the head of the lamp rides between hard wood blocks in the hood, so arranged that the lamp remains in a fairly rigid position when in place. Even in a heavy gale the contacts are stated to show no sparking, and the surfaces are as smooth as glass. The cables pass around the bracket tube beneath the wire rope rollers, and are then fixed to their respective terminal sockets on the concentric brass rings. The Bath lamp-post was fitted with transformer, switches, and fuses, and worked off a 2,000 volts primary circuit to 50 volts on the secondary.

The winch is designed with a tail on the pawl spindle, and the handle has a loose sleeve. This sleeve has a notch in its end which can engage the tail on the pawl spindle. The vent-hole in the post just allows the handle to pass into the winch chamber. When the handle is shipped upon the spindle of the winch barrel, the small handle is pushed in to engage the tail, and by turning the handle slightly, the pawl is thrown out, and the lamp may then be lowered. It is impossible for anyone to lower the lamp with an ordinary handle without opening the door.

THE PRECISE COMPARISON OF VERY SMALL RESISTANCES.

A METHOD of measuring very small resistances, devised by Messrs. Alfred E. Muller and Herman Wallau, is described by Mr. S. Sheldon in a recent number of the *Electrical World*. The method is as follows:—

The unknown resistance, X, which may be assumed to be supplied with branch potential points *a b*, is connected by heavy conductors in series with a standard branch resistance, R, of the Reichsanstalt pattern having potential points, *c d*. From the two free terminals, T T′, of these resistances are shunted two 10,000 ohm resistance boxes, S P, adjusted to the same normal temperature and wound with wire of the same or negligible temperature coefficient, and connected in series. From the point of connection, *e*, between the two boxes connection is made to one terminal of the galvanometer, *g*, the other terminal being connected successively with the



potential points *a*, *b*, *c* and *d*. At the outset all the plugs are removed from the box S, and all are in place in the box P. After connecting T and T′ with a source of heavy current, plugs are transferred from one box to the corresponding holes in the other box (this keeps the total resistance in the two boxes constant) until no deflection is observed in the galvanometer. This operation is repeated for each of the potential points *a*, *b*, *c* and *d*. Representing the resistances in the box S, on the occasion of each of these balances by S_a, S_b, S_c, and S_d, respectively, we have the following expression for the value of the unknown resistance:

$$X = \frac{S_a - S_b}{S_c - S_d} R.$$

This method serves also to determine the resistance of a storage cell when the terminals, T and T′, are connected to a source of alternating currents, and when a telephone is substituted for the galvanometer. It is probable that by employing an electro-dynamometer instead of the galvanometer, whose fixed coil was connected to the main circuit before it reached the terminal T, according to the method recently advocated by Prof. Rowland, the resistance of an accumulator could be determined with extreme accuracy.

THE COST OF GENERATION AND DISTRIBUTION OF ELECTRICAL ENERGY.

(*Continued from page* 432.)

WE now come to what Mr. Hammond has made the main subject of his paper, viz., the summarising and analysing of the works' costs and costs of management of all the existing electric supply undertakings which are operating under the Electric Lighting Acts, and the deductions which may be made from the great mass of statistics which have been tabulated. Tables are published of the costs per unit sold for each undertaking from 1890, or from the time of starting if later than that date, down to 1896 and, in some cases, 1897; other tables show for each item of the costs the order of merit of these undertakings for the years 1894 to 1896 inclusive, and also the record costs for the same three years in stations of various outputs; and, finally, there are tables giving the load factor and the proportion of the units generated which were sold, used on the works or in distribution. These tables contain a very large amount of useful information, and from them the author of the paper makes various deductions, referring in turn to each of the factors which are of importance as affecting the cost of production, and discussing the probabilities of reaching costs as low as those which result from combining in one works the record costs obtained for each item in any of the undertakings, or as the ideal costs given by Mr. Crompton in his 1894 paper.

In discussing the conditions which tend to produce low costs, Mr. Hammond gives to output the credit of being the most important factor in the reduction of the cost per unit, and assigns the second place only to load factor, stating as his reason that without a good output the most favourable load factor is useless. In this we are quite unable to agree with him, and, although we fully recognise the advantages of having a large output, we think that the tables published by Mr. Hammond show clearly that he has overestimated these advantages; and that if a good load factor needs the help of a large output, this latter is even more in need of the good load factor, if we are ever to approach the ideal figures mentioned in the paper. It is quite true that an examination of the figures for successive years of any individual undertaking shows that, almost without exception, an increased output has been accompanied by a lower cost; but it by no means follows that the increase of output is of itself the prime cause of this reduction, as during the early years of any new undertakings we may reasonably expect that improvements in the plant and in the methods of working will continually be made. To take an example from the costs quoted by Mr. Hammond, we find that the output of the Westminster Company in 1893 was 1,704,615 units, and in 1897 it had increased to 4,855,781 units, and that in this latter year the works' cost per unit was only 57 per cent., and the total cost 63½ per cent. of the corresponding costs in the earlier year. We also find that the output of the Edinburgh works in 1896 was 1,721,557 units, or practically the same as the Westminster 1893 output; but can we expect that if this output is increased to say 4½ million units there will be a similar percentage reduction in the costs? If so, we shall have to congratulate the management on having arrived at a works' cost of ·361. and a total cost of ·72d. per unit, which seems too good to be true; and we think it is fairer to assume that the Edinburgh works, which started some four years later than those at Westminster, have benefited by the experience gained during that time, and were able therefore to start with costs much nearer the ultimate minimum than was the case with the older undertaking.

An examination of the tables shows also that many works with comparatively small outputs hold a very good place in the order of merit; and that if we take the average of the costs of all works for every year in which their output has been more than a 1,000,000 units, these average costs are not very high up in the order of merit. The actual figures are, for fuel ·882d., for oil, &c., ·155d., for wages ·560d., for repairs ·410d., for works' costs 2·007d., and for total cost 2·876d.; or excluding from the list the works using the alternating current system, we get, for fuel, ·676d., for oil, &c., ·118d., for wages ·505d., for repairs ·382d., for works' costs 1·681d., and for total cost 2·522d.

One point which strikes us as especially worthy of notice in comparing the costs per unit sold of any one undertaking in successive years, is that, although in most cases substantially lower costs of fuel, stores and wages are obtained with an increase of output, the cost of repairs and maintenance shows no such regular diminution; and that in the items of rent, rates, taxes and management, which we have been accustomed to treat rather as fixed charges and where we should, therefore, expect the largest decrease, we find that the cost per unit decreases more slowly than the works' cost, and in many cases even shows an increase. For example, at Bradford, although the first seven years' accounts show an increase of output which is nearly eight-fold, the costs per unit of rent, rates, taxes and management are respectively ·94d., ·61d., ·38d., ·42d., ·52d., ·76d. and ·78d. for these seven years; and at Glasgow, with a five-fold increase from 1892 to 1896, the costs of these items for the five years are respectively ·84d., ·71d., ·78d., ·82d. and ·60d. With companies we find a similar state of affairs, as the City of London Company with a ten-fold increase of output in five years has actually increased the cost of these items from ·97d. in the first to 1·50d. in the fifth year; the Metropolitan Company, whilst increasing its output from 1½ to 4 million units, has spent the same amount per unit on these items in the first and last years under consideration; the St. James's Company spent 1·17d. per unit when their output was 1,000,000 units, and ·92d. per unit with an output of 3,000,000; and the Westminster Company, who spent 1·99d. per unit in its first year with an output of 600,000 units, steadily reduced this to ·80d. in its fifth year with an output of 2,800,000 units, but increased it to ·85d. in its sixth year, and to ·90d. in its seventh year with an output of over 4,000,000 units.

It would appear, therefore, that mere increase of output, though having no doubt a good effect on the costs, does not influence them to the extent we might expect from Mr. Hammond's statement; and this is especially the case in those items that are frequently spoken of as fixed charges. If we now consider the effect of an improved load factor, we find that Mr. Hammond gives a table showing the reduction of costs that might be expected at Bristol, if those works were blessed with a load factor of 50 per cent. instead of the 12·99 per cent. which was the load factor for 1896. From this table we find that he estimates that with the same maximum demand in both cases, the four-fold increase of the load factor would reduce the total costs from 2·50d. to 1·00d., a reduction of 60 per cent.; but in the table of costs of various undertakings in successive years we look in vain for any instance of a similar reduction due to a four-fold increase of output, except in the case of the comparison of an abnormal first year's working with that of a subsequent year. It may, of course, be said that Bristol is a favourable case for a considerable reduction, as an improved load factor would naturally have a greater effect on an alternating current transformer system than on a direct current system, owing to the importance of the transformer losses at low load factors, and also because the 1896 consumption at Bristol of 16 lbs. of fuel per unit sold would appear to offer a considerable margin for reduction.

Even if this be so, and the reduction of cost estimated by Mr. Hammond for this particular case be larger than could be effected in other works, a consideration of the conditions under which a four-fold output is obtained (1) by improved load factor without increase of maximum demand, and (2) by increased maximum demand without change of load factor, will at once show that the reduction of cost in the former case should be immensely greater than in the latter. In the first case the increased efficiency of the plant owing to the better average load and the relatively smaller stand-by losses in the boilers will make a considerable reduction in the coal bill; whereas in the second case the larger output will not make much difference in the average output of the machines, and as the number of boilers under steam at the time of maximum load will be increased in proportion to the demand, the stand-by losses will practically still bear the same proportion as before to the total fuel consumption. Again, in the first case, as there would be no increase in the number of boilers or machines to tend at the time of maximum demand, it would be unnecessary to increase the number of men in the heavy shift, and any increase in the wages bill will be due chiefly to the small increase in the number of men that may be necessary in the day time; whereas in the second case, at the time of maximum demand, boilers and machines of four times the output will be at work, and at all hours of the day the number of boilers and machines in service will be increased in much the same proportion, so that the labour bill will be considerably augmented. The difference in the charges for repairs and management may not be very great in the two cases, but the balance would, we consider, be in favour of the good load factor; but the second case must certainly be debited with heavier charges for rent, rates and taxes, owing to the greater space occupied by the plant. Although it is not included by Mr. Hammond in his consideration of the question, one of the most important differences between the two cases would be that due to the items for interest and redemption; as, in the second case, the capital expenditure would have increased in proportion to the output, whereas in the first it would have remained practically stationary.

With regard to the third factor which tends to reduce costs, viz., reliability of plant, we agree with Mr. Hammond that too much stress cannot be laid on its importance, not only on account of the lower costs of repairs and maintenance which naturally result therefrom, but also because immunity from breakdowns and interruptions of service is absolutely essential to the success of any undertaking which depends on extending the use of electrical energy. This is so important, in our opinion, that we should always be prepared to sacrifice something in efficiency, if to obtain this latter it was necessary to diminish in the slightest degree the reliability of the plant; and we consider that any extra expenditure that may be necessary to ensure that spare boilers and generating plant shall always be ready at a moment's notice to be put into service is always justifiable, although it may make the cost per unit sold somewhat higher.

Mr. Hammond next refers to the engineer factor which has undoubtedly a very great influence on the cost of production, as a great deal of the reduction of costs shown in the tables in this paper is, in our opinion, due to the care and attention bestowed by the engineers on the details of th working of the plant under their care. It would be most interesting and instructive if we could get to know how much of the reduction of costs, attributed by Mr. Hammond to increased output, is really due to that cause, and how much should be credited to the engineer factor; and we hope that some of the engineers of central stations will be able in the course of the discussion to give us practical information concerning the methods of working which they have found most helpful to the reduction of costs, and tell us to what extent they have been able to reduce some of the losses which exist in all stations.

(*To be continued.*)

ELECTRIC HAULAGE ON RAILWAYS AND TRAMWAYS.

By W. H. BOOTH.

Surely, if slowly, electric traction is making headway in this very backward country. New tramways are rarely proposed, says the *Practical Engineer*, which are not intended to employ mechanical traction in some form, but as our contemporary remarks, engineers are looking to the conversion of existing horse tramways for a large amount of future work, and are endeavouring to secure concessions for such undertakings, but local authorities are often proving difficult to deal with, being apt to take an exaggerated view of their position, and to refuse to entertain proposals which must be to their benefit for fear someone will make a profit. The city of Bristol is quoted as an instance, having now on hand a controversy with the tramway company. Corporation officials have compiled figures which show a working expense per car mile very considerably below that of horse traction; electric traction being 5½d. as against 9½d. for horse traction. Electric traction is thus practicable, economical, and undoubtedly convenient.

The *Practical Engineer*, however, rather looks to the heavy equipment work of railways as affording the principal work for engineers as soon as, or before, all the tramways have been converted.

We do not ourselves look forward to the speedy ousting of the steam locomotive from main line work, but for short railways like the overhead line at Liverpool, electricity must come quickly. The Baltimore and Ohio tunnel is proof of the entire possibility of heavy work being done, while the bad condition of our own Underground seems to point to the speedy necessity of an electrical equipment, if only to save it from the bankruptcy so long courted.

Locomotive expenses on the Liverpool overhead line are stated to be under 3¾d. per mile, as compared with 6d. to 6½d. on ordinary railways, and 11d. on the Underground. Metropolitan locomotives weigh 46 tons 12 cwt., the following train weighs 90 tons. The horse-power is 380 on the level at 25 miles per hour, and to attain to a speed of 15 miles per hour, requires 30 seconds. There are 14 trains circulating on the 13 miles of the inner circle; seven trains on each line at 10 minutes intervals. A seven minutes' electrical service, with a seven minutes' interval only, is estimated to cost £350,000. If all this be looked on as new capital, its cost at 4 per cent. will be £14,000 annually, or, say, £40 a day. With 14 trains now making the 13 miles circle, the present daily train mileage of circle trains only is about 2,500. This does not include the extra trains to Gloucester Road and Kensington, &c. At a saving of 3d. per mile, the daily saving would be thus over £30, and would still leave 8d. per train mile for further reduction to the Liverpool figure of 3¾d. It is thus quite possible in locomotive expenses only to save all the interest on new capital, and we can scarcely doubt that the increase in receipts would be sufficient to pay a very satisfactory sum towards sinking fund and dividends.

Mr. Fox's proposal to use motor trains* (*of the Liverpool type*) for the circle working and electrical locomotives* (*South London system*) for trains coming in from outside seem reasonable and good. Considering what has been accomplished in America, it seems to us that Mr. Bell, of the Underground, is rather begging the question in raising so many objections and difficulties, and talking of *the* question to be solved being to provide sufficient electrical energy where required to do the duty demanded of it. We presume that when Mr. Bell wishes a train to start from the Mansion House, he provides a locomotive as a persuader, and another locomotive if a second train has to start at the same time from Blackfriars. If he wants to start electrical trains from anywhere, he will have to provide electrical energy to do so, as all other electrical railways have done. There would then be nothing to prevent these trains from moving, which seems to be the burden of his song to the shareholders. We do not think Mr. Bell need have troubled to go several times to America before being able to conclude that electricity would solve the ventilation question. If any journey to America were necessary, surely one by an engineer, and not by a managing director, would have sufficed.

What a shockingly poor opinion of his shareholders Mr. Bell seems to possess if his statements to the Parliamentary Committee and to his shareholders are correctly reported. The question of electrical traction is being looked at far too narrowly and with an ultra cautiousness. Americans have found that convenience, cleanliness, and rapidity of service and acceleration have made things pay. The same advantages would equally pay in England, if our railway managers understood their business.

* The bracketed remarks are not Mr. Fox's.

THE TELEPHONE SITUATION.

The discussion in the House of Commons on Friday evening last, and the decision expressed by Mr. Hanbury, were both based apparently upon the impression that "something must be done," which is very satisfactory, provided that the "something" is the right thing, and does not result from the anxiety to do the wrong thing rather than nothing at all. The appointment of another Select Committee, though open to the suggestion of a further shelving of responsibility, may, nevertheless, be regarded as a fairly satisfactory measure. It will avoid action in haste, and provide a tribunal before which facts may be laid, and their bearings accurately gauged. The re-opening of the telephone question at this stage is the result partially of public discontent, of which some is real, but much is unreal, because formed upon interested or incorrect information. We may take as an example the comments of our contemporary the *Economist*, which in its last week's issue stated that the telephone subscription in Berlin is £2 10s. per annum. There can be no possible doubt of the desire of our contemporary to improve the position of London business men, or of its anxiety to do so by the fairest possible statement of the facts. We should have regarded these figures as a misprint had we not ourselves received a statement in which they appear with, however, the qualification that there is a further charge for every call made. We have heard of instances in one of the "cheaply telephoned" countries of the Continent where a subscriber pays as much as £80 for one year's use of the telephone, although the subscription, as quoted by our contemporary, would be given as about £3. Telephone rates, like everything else, must be considered in the aggregate, and so considered, English rates are not excessive. Relying, again, on figures at hand in the Glasgow Report (p. 11), the Commissioner states that Mr. Gaine proved the cost of each message in Glasgow to be ·57d., or practically one halfpenny per message. In our report of the Glasgow inquiry, we showed from the evidence of several subscribers that the rate of subscription is not the cause of serious complaint. There was evidence there, and there is evidence in general that a good service is highly appreciated and willingly paid for. The reduction of rates, if it can be done upon a commercially sound basis, should be strenuously striven for; but the evidence as to its practicability is of the most flimsy character, and we are glad to note that Mr. Hanbury, although bearing in mind the advantages resulting from an extension of telephone service amongst small traders, did not in general hold out any useless hopes of reduction of rates, so as to imply a less payment by subscribers in the aggregate. Another consideration which needs to be borne in mind, is the mistake of drawing too wide conclusions from limited evidence. Mr. Hanbury recognises this by saying: "In a good many parts of the country there is not, so far as I know, very great complaint; but in several large towns, in Glasgow, and even the metropolis itself, complaints have been made of inefficient service, and in the case of Glasgow that complaint has been proved to be true by our own Commissioner."

It would have been fair to add the qualification made by the Commissioner, that the inefficiency was due to the dog-in-the-manger policy of the Corporation, although we cannot ourselves consider his qualification to explain the entire cause. We should be rather disposed to inquire in what respect the Glasgow system differs from that in use in other parts of the country, or why it is related by one witness that he used the telephone in Liverpool and New Zealand, and experienced none of the difficulties that existed in Glasgow.

In the words of the Commissioner: "The method of working the system at the exchange office is known as the 'call wire.'" It may be assumed that in introducing this system in Glasgow the Telephone Company were desirous of giving what they regarded as the best system for the purpose, but we are justified in recalling our own criticisms on the system, when the present electrical adviser of the Corporation proposed its introduction into London.

The persistent efforts which were made to set aside our conclusions will be in the recollection of some of our readers. We were informed with a view to a settlement of the prolonged controversy that the National Telephone Company had decided to introduce the system in Glasgow, and we remarked that we regarded its introduction there as an experiment, the success of which we should be glad to chronicle. It is impossible to read the evidence and report without observing the extent to which the adoption of this system is responsible for much of the discontent and many of the complaints, although the points were not emphasised by the electrical experts on either side. The Commissioner says: "If a number of people are impatient and all bawl through the call wire at once, great confusion and annoyance may be caused to the operator. But this need not exist if people deal with it in a businesslike way and give place to each other." This argument was used in our columns by advocates of the system, and the undesirability of relying upon it pointed out. The imperfections of the system had their bearing upon the result of the inquiry, though the Corporation in its desire to extend their municipal functions and, as they suppose, improve the communications of the inhabitants, would doubtless, under any circumstances, have made an effort to obtain municipal powers. It will be for the Select Committee *in futuro* to determine "whether it is fair that competition should be allowed to take place," and "whether the municipalities are the best form of competition." It would not have seemed to us out of place if these points had been preceded by one other, and that is, whether any competition is desirable. It is of more importance than the question of fairness. Existing agreements provide for competition either by companies or the Post Office. The introduction of a municipality in the place of the other defined competitors is not in itself unfair, but might readily become so if the municipality adopted the methods of the Glasgow Corporation, who seek to fetter its competitor by its municipal powers, whilst competing with it by the use of public funds. Neither the British public nor the British Parliament will, we think, permit one combatant to have the use of a mailed fist whilst the other combatant has his arms pinioned behind his back. It is sought by various specious means to discredit the Telephone Company, to suggest that its own proceedings justify otherwise unjustifiable methods. Reference is made to the maintenance of the monopoly by the purchase of competitors. The purchase of many of the undertakings referred to in the debate was nothing more than an amalgamation of family interests amongst whom there was no competition at all. The amalgamation was avowedly undertaken with a view to have the strength of a bundle rather than the weakness of a series of sticks. The only important extinction of a competitor in recent years was the purchase of the New Telephone Company.

Since we protested vigorously against the Treasury minute which made it possible to the new company to reap a harvest practically without sowing any seed; since we foretold the result which actually took place, we may recall our observations to the effect that the benefits would be greater under a monopoly than through competition. We have no hesitation in saying that by acting in self-defence, so as to exclude competition, the Telephone Company has acted in the best interests of telephone subscribers. Competition by the Post Office occupies a different category to any other. The Post Office has—what no municipality has, or, apparently, can get—the skill to do the work, and the right to undertake it. Such right has been reserved generally, and has been promised to be exercised specifically in cases of inefficient service. The case for the municipalities is probably understood by Mr. Benn as well as anybody. In his examination of Mr. Preece before the Select Committee of 1895, it was apparent that he was under the impression that a series of municipal plants would be of help to the Post Office in 1911. We hold it to be not so much a matter of doubt, but almost a certainty, that the reverse would be the case. The country would have to pay for the mistakes of localities, and the localities would have suffered serious inconvenience in the meantime. Competition by the Post Office itself, though to be regretted, may be necessary, and the circumstances under which it may become necessary, were clearly defined by Mr. Lamb before the same committee in his answer to Sir Charles Cameron's question, No. 5,261: "Of course, I do not know what may happen at that time (1911), but I should say the reasonable thing to happen would be this: that at a given date which would give the Post Office sufficient time to supply a system of its own in the event of the negotiations falling through, the Post Office would approach the National Telephone Company, and say: 'What is your price for your plant?' It would ascertain by examination whether it was in a fair condition, and if the National Telephone Company were reasonable, the Post Office would pay a reasonable price, and in my opinion, would be supported by public opinion in doing it. If, on the other hand, the National Telephone Company feeling secure, and thinking the Post Office could not supply itself in any other way, held out for unreasonable terms, the Post Office would immediately proceed to supply itself with another system, and as soon as the license expired, would be able to bring it into operation."

"By the (chairman): Or before?—Or before, if necessary. If the company was unreasonable?—Yes."

If Mr. Hanbury's statement be read in the light of this answer, its bearing will be apparent, and much of the pernicious nonsense which is talked and written about the relationship of the National Telephone Company and the Post Office will be seen to have no foundation. It is readily admitted by the most prominent agitators, that a Telephone Exchange system is at the very least a commercial necessity. By whom has this been demonstrated so far as the United Kingdom is concerned? By the adventurous men who embarked their capital and skill in the enterprise and obtained a charter of limited duration. The National Telephone Company are their successors in the direct line, and they are entitled to consideration for their acumen and the just reward for their venture. Their work is one which will be undertaken by the Post Office on the expiry of their license, and may be acquired earlier. The terms for such acquisition can best be settled to the advantage of the country by the high contracting parties. Meddlesome interference by others can only end in loss, and may produce disaster. Let Mr. Hanbury bear this in mind, and the promised Select Committee may be useful.

CORRESPONDENCE.

Supply Current for Electro-Plating.

Probably the simplest method and cheapest apparatus to construct to reduce the supply pressure would be to use a resistance of steel wire spirals. The objection to this is the

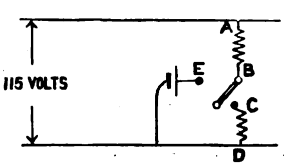


Fig. 1.

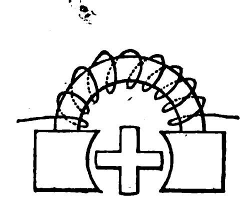


Fig. 2.

great waste in resistance heating, but perhaps this might be arranged, and serve the purpose of heating the room or adjacent room. Connect them as follows, fig. 1:—

Make A, B of 7·53 ohms value,
and C, D of ·14 " of wire capable of carrying 15 amperes without undue heating.

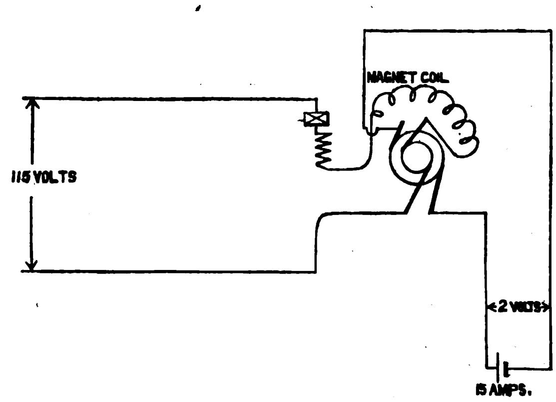


Fig. 3.

Connect B to C to warm the room,
" B to E to warm the room and electro-plate at same time.

The most economical method in working would be to employ a small continuous current transformer, which might be made on the lines of horse-shoe magnet and shuttle armature series machine, fig. 2, with four-part and eight-part commutators.

Let motor run between 2,000 and 3,000 revolutions per minute. Put in on one side (supply side) about 35 volts, 2 amperes, and take out about 2 volts, 15 amperes, fig. 3. Lose about 10 volts in magnet and 7 or so in armature. Wind about ¾ lb. of No. 22 on magnet, and ¼ lb. of No. 24 on armature for primary, and ¼ lb. of No. 18 on armature for secondary. Make a resistance to carry 2 amperes and of about 40 ohms, more or less according to voltage motor gives.

Of course, a secondary battery of 113 volts might be placed in opposition to 115 volts, but if a battery is available, it would be certainly used direct.

N. C. Woodfin.

P.S.—I don't think it is practicable to make such a small motor to work much above 30 volts, or even less than 2 × 80, or 160 watts would be wasted in dead resistance, whereas in previous method 1,695 watts or over 2 horse-power would be wasted.

Your correspondent, Mr. R. T. Dick, is evidently under the delusion that he is inviting the consideration of engineers to an original problem; I may, therefore, state for his benefit, and for that of the "others" he mentions, that his difficulty could in all probability be solved by the contractor he employs to wire his premises, certainly by the borough engineer.

However, as I have a few minutes to spare, and as I expect he will not hear from very many "eminent" engineers, I beg to offer my humble solution.

For a continuous current supply there are three possible methods:—

1. Have a battery of 55 cells, charge them in series, then do your plating with them in parallel.

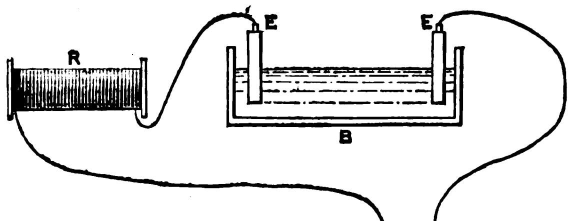
2. Use your 15 amperes at 115 volts and reduce the voltage by a liquid or wire resistance.

3. Procure a small motor generator, that is, a dynamo having two windings on the armature, one for 2 volts and the other for 115. This is by far the best and cheapest, besides being a continuous process.

You want, say, 15 amperes × 2 volts × 9 hours × 6 days = 1,620 watt-hours, say the efficiency of your machine were only 75 per cent. (but it would be more), then the watts required come out 2,160, say, 2 units per week, and the Brighton charge for power I think is 2d. = 4d. per week.

C. B. Nixon.

As the voltage of the supply mains has to have a drop of 113 volts it is only necessary to put a resistance of 7·5 ohms in series with the bath and the mains. The resistance of 15 ozs. of German silver wire of No. 18 B.W.G. is equal to



R, Reel with 7·5 ohms resistance; E E, Electrodes; B, Bath; S M, Supply mains, 115 volts.

7·5 ohms. This must be wound on a reel and each turn must be separated from one another, as per sketch, the reel to be a good insulator, and preferably covered with asbestos on account of the current heating the coil of wire.

J. S. Barnes.

Knots.

Seeing that the knot question is still vigorous, I should like—now that it has got away from its original lines—to add a few remarks in support of the telegraph engineer and electrician.

I venture to think there are many of us who, recognising that a knot is a *velocity*, have always preferred to use "N.M.," or "naut." in abbreviation for "nautical mile."

It appears to me that any importance that may be attached to such a matter applies more in particular to printed publications and especially text books.*

Presumably Mr. Little's remarks are mainly intended for the benefit of the student class and for academic circles; he surely does not aspire to make a fully equipped "cable" engineer change his method of expression!

Though it is improbable that the mis-use of the term "knot," as a measure of length, has ever given rise to confusion or actual misunderstanding, most of us will fully realise that all misapplications of terms are undesirable, if only on account of the future generation and for purposes of clear insight.

Considering that a knot signifies one nautical mile per hour, "knots *per hour*" is, of course, not only redundant but ridiculous. Nevertheless, it is an expression which is used every day—just as "knots" are for length—by many past-masters in matters nautical who do not, I presume, happen to have come at close quarters with the subject.

I am sorry that Mr. Little has marshalled forth some of the literature on the subject, for I fear it may only have the effect of extending a discussion—with doubtful profit—by a shower of quotations from Raper, Norie, Bedford, and other authorities.

Charles Bright.

Blasting.

An accident occurred at our works on February 24th last with electric blasting detonators, 25 of which exploded with violence, injuring one person, named George Joyner, contractor for mine sinking, he having to be taken to the hospital immediately, and there remained in a critical condition for three weeks. The detonators exploded with such violence that all the windows were blown out, and frightfully injuring the man's breast and hands, also causing him to lose his left eye. The cause of the accident was as follows:

The contractor, whose duty it was to test all detonators by means of a magneto machine designed specially for such work, before the detonators were sent into the mine for blasting. He was testing one, which was in a bundle of 25, the one under test exploding, and firing the remaining 24, the cause of which was the abundant heat and force of the explosion by the one detonator, and the following should be a caution to all who are entrusted with the testing of electric detonators:—

1. When testing a detonator by means of a magneto machine, the difference of high and low tension detonators must be ascertained before put to test.

2. If the detonator is a high tension one, then do not test on the magneto.

3. In all cases a low tension tester being a high tension generator, thereby firing a high tension detonator.

4. Never test a high tension detonator on a low tension tester, else the result will be serious, due to the high tension detonator being fired.

5. Never test more than one detonator at a time.

6. Always have the detonator under test away from any one, and enclosed in an iron box.

7. A low tension detonator is fired by means of a continuous current at a potential difference of about 2 volts, the heating effects of the current causing a thin platinum wire of high resistance to get incandescent, the wire igniting a small quantity of fulminate of mercury, thereby causing the detonator to explode.

8. A high tension detonator is fired by means of an alternating current at a potential difference of about 150 volts from any alternating current source, such as a magneto, the alternating current forming a small arc which ignites the fulminate of mercury. If the contractor above mentioned had not tried to test high tension detonators on the magneto, all would have been right.

J. S. Barnes,
Electrician.

[We fail to follow the reasoning of our correspondent.—Eds. Elec. Rev.]

* By the way, a speaker, might say "naut" and yet be reported "knot."

Electric Railways.

I wish to express to you my appreciation of your "Editorial," in your issue of August 6th, 1897, reviewing my article on "Electric Railways," in the *Western Electrician*. It has been my intention to write you before, but press of business had driven the matter from my mind.

It is gratifying to note the large expansion of electrical railway enterprises abroad, and from our experience on this side of the water, I think it safe to predict success for conservatively managed enterprises in this line, not only in Europe, but throughout the world. The study of the financial side of electric railroading is a problem well worthy the engineer as well as the financier, and our experience is showing very accurately what to expect and what not to expect from this class of investments. We have learned, I think, how far to go in expensive construction and also the limit in cheap construction. The relation of capital and interest charges with maintenance cost and revenue returned, are now pretty carefully worked out and applied in considering investments.

G. W. Chance.

Philadelphia, Pa., *March 21st*, 1898.

Corporation Wiring and Fittings Departments v. Private Wiring and Fitting Firms.

Under the above heading, and with respect to the case of the Leicester Corporation *v.* Warren Hill, a report of which appears in your issue of this week, and also at the same time taking into consideration the decision arrived at by the electrical firms of Sheffield—whose early action at the critical time ought to be admired—could not the correspondence section of your paper be used to obtain the views of electrical firms in various towns.

Of course, Messrs. Warren Hill's case seems only to apply as it reads to an "over counter," or retail shop trade; but does it? It upholds and is relative to a recent article which appeared in the Review, "Municipal Wiring, &c." As mentioned in this article, the contractor was a good friend to the supply company and corporation electric department, and he could still be a greater friend if treated as such, instead of as a competitor who is doing them no good. The established contractor and the man who knows his business has quite enough to fight against in doing proper work at a fair price and competing against so-called electrical firms—who are sometimes started by persons who have no electrical knowledge worth calling, either theoretical or practical, who have no reputation, experience, conscience, or any other good qualities; their mode of business being, get the work at any price, do it in a way, turn the switch, the lamp lights, get the money and clear out. How many installations have been carried out on a system like this, without any regard as to workmanship or material, and have been a success? Surely Corporation Electric Light Departments are not formed to make profit on retailing fittings and wiring contracts; they should find looking after the supply of current a far more interesting item, and the reduction in price per unit to make it more general—the contractor will act as a canvasser without commission from them. Plenty of Corporations Electric Departments, who have the ratepayers in mind, are supplying current only, and it will be found that they are doing more to interest the cause of electric lighting and bringing it as much, if not more, into general use than the parties who must have something more to do. Perhaps they are considered to be more enterprising than those who supply current only, as it may be thought the more profit the Corporation make (and you may depend they don't work without a profit); if they do they must arrange matters extremely well to work to any extent without profit or loss; but isn't it a case of taking out of one pocket and putting in the other? Some people may think that by excluding them from wiring, &c., the electrical firms want to make a large profit and have it all to themselves, but competition in this business is too keen, and all the intended consumer has to do, is to get the work done at a proper rate to include proper workmanship and material, and carried out in a proper manner.

Now, regarding the latter part—the manner in which the work is carried out; every electric department (corporation) issues a set of rules for the benefit of the contractor, and if they only inspected the work while it is being carried out—not when it is completed as in some cases—the consumer would be under no difficulty and have no doubts regarding the work.

Trade unions and societies have and do exist, and in several cases have done more to ruin their cause and business generally. Could not a meeting be called at some central town to discuss the matter so that something could be done, and a committee formed to fully investigate a matter which is of interest to the electrical engineer and ratepayer?

E. L. Liley, Assoc. N. S. Elec. Engineers.

[Our correspondent expresses himself badly, but his meaning is fairly clear. We deal fully with the subject in our leader pages.—Eds. Elec. Rev.]

A Plea for "Six-Wheelers."

With reference to your interesting article on "Transportation," will you permit me to express a doubt as to whether the disappearance of the horse necessarily means the possibility of our streets accommodating 50 per cent. more vehicles than at present? This is often given as one of the advantages to be looked forward to in the development of motor traffic; but a little consideration will show that the process of removing the shafts from a vehicle and filling up most of the interior with propelling apparatus does not leave very much space for carrying and therefore profit-earning capacity.

Rather, perhaps, should we expect the successful motor-vehicle to be at least as long as a horse and van taken together, with six wheels instead of four—namely, central driving wheels and leading and trailing wheels acting as steerers. This arrangement, while providing ample length and accommodation, gives a *steering* length only half of the actual wheel base.

It is to be regretted, however, that so far makers of self-propelled vehicles have looked to the *cart* rather than to the *locomotive* for their inspiration.

In regard to electric vehicles, a further point suggests itself in the theoretical possibility of utilising the descent down a hill as a means of replenishing the charge in the cells, but it is unnecessary to dwell upon the great economy that may be looked for in this direction, if certain practical difficulties can be overcome.

Alfred J. Allen.

London Institution, *April 4th*, 1898.

The Institution Discussion.

On page 427, third paragraph of the right hand column of your issue of April 1st, 1898, my remarks have been summarised in such a manner that anyone reading them would think that the smashes I mentioned had occurred at Brighton. I need hardly say that this is not the case.

I mentioned Brighton as an example of a large single station, and pointed out that Mr. Wright differed from my views as to the policy of always generating a large supply from two stations. I then went on to an entirely different matter, which was the recent smashes that have occurred due to water in cylinders and which in several cases have caused breakdown of the coils of high pressure generators. This point is, of course, quite distinct from the single station question.

R. E. Crompton.

Gas Driven Plant.

I observe in your last issue a letter asking for particulars of gas driven plants. I have erected a very large number of gas engines for electric lighting, and in almost every case, certainly in 19 out of 20, I have driven the dynamo direct from the gas engine without the intervention of the counter-shaft.

Henry J. Rogers, M.I.M.E., A.I.E.E.

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STORAGE BATTERY TRACTION IN BERLIN.

In an article by Mr. E. G. Fischinger, published in the *Elektrotechnische Zeitschrift* of March 24th, some details are given of recent experiments made with a storage battery car on the Berlin-Charlottenburg tramway system. The electrical part of the car has been carried out by the A. G. Elektricitatswerke vor. O. L. Kummer & Co.; the accumulators were supplied by the Watt Accumulator Works, and the car bodies and revolving underframes by the Dessau Gas Tramway Company. It is to be noted that the latter company also supplied the car bodies and underframes of the other storage battery cars now in operation on the same tramway. The total weight of the particular car in question, which is equipped with two shunt motors and provided with four axles, is as follows:—

	Kilogrammes.
Car and underframes	8,400
Battery of cells	6,840
Two motors and toothed gearing	1,500
Steering apparatus and other appliances ...	380
Total weight without passengers	17,120

Thus it will be seen that when fully equipped and without any live load, the weight of the car exceeds 17 tons. The battery consists of 180 cells of a capacity of from 220 to 260 ampere-hours, and with this equipment the car is capable of making 10 journeys per day, the distance covered being 96 miles. During the month of December alone the performance of the car reached 2,883 miles, the average speed being at the rate of 9·3 miles an hour, although on level sections a maximum of 14·25 miles an hour has been attained. As the pressure of the batteries ranges from 320 to 360 volts, which is dangerous for the shunt winding, the battery has been divided into two halves, and the motor armatures arranged for half the voltage. The connections are so arranged that either one or two motors, and one or both batteries, can be brought into requisition. In the tests made by the author, the measurements were taken by means of the Weston laboratory apparatus, and the results are plotted in curves which accompany the article. It appears from these that the average consumption of energy, including the mounting of gradients and passing round of curves, amounted to only 18·91 watt-hours per ton-kilometre, or, say, 30·50 watt-hours per ton-mile. The car has accommodation for 42 passengers, but during the tests the total weight of car and load reached 20½ tons, the length of track traversed being four miles.

BUSINESS NOTICES, &c

Agency.—Messrs. John Turner & Sons, of Denton, near Manchester, have appointed Messrs. Geo. Piggott & Co., of 110, Cannon Street, E.C., as sole London agents for their electrical specialities, chiefly with regard to the "Turner" dynamos and motors.

Bankruptcy Proceedings.—At a sitting of the London Bankruptcy Court, held on Tuesday last, before Mr. Registrar Linklater, Sydney George Trehearne and Arthur Haywood Crump, trading as Trehearne, Son & Crump, electrical engineers, 155, Fenchurch Street, E.C., attended for public examination. The accounts filed under the proceedings show debts £1,102 9s. 1d., and assets £449 13s. 2d. Mr. Trehearne stated that he commenced business alone in June, 1895, and was joined in May, 1897, by Mr. Crump, who brought in a cash capital of £750. The business came to a stop last December when the office furniture and effects were sold off by the Sheriff. The failure was attributed to the heavy expenses of establishing the business, losses on trading and bad debts. Mr. Trehearne was examined at some length as to the circumstances under which he had sold off a reversion to which he was entitled, and ultimately the examination of both debtors was concluded.

Birmingham Electric Supply Company v. Barnes.—This was a claim, heard at the Birmingham Police Court, for £29 10s. 9d. for electric light supplied to club premises in Barwick Street. An order for payment was made.

Bootle's Baby.—At the close of this strange winter Bootle finds itself adopting electric light. The Chloride Electrical Storage Syndicate have taken the contract for accumulators.

Dinner.—The annual dinner of the officials of the Glasgow Corporation Gas and Electricity Departments was held on 31st ult.

Disclaimer.—Mr. F. M. Rogers, of 21, Finsbury Pavement, E.C., asks us to state that he is not the Mr. Rogers mentioned in the case of Crompton *v.* Liardet, reported in our issue of March 25th, p. 396.

Dissolution of Partnership.—In regard to last week's notice of Messrs. Harrison, Coles & Co.'s dissolution of partnership, Mr. Pringle asks us to state that though the partnership has been dissolved he is still carrying on the business as heretofore.

Fippard & Cooper.—This firm, of Albert Road, Bournemouth, has at present in hand electric light installations for St. John's Church, Bournemouth, Congregational Church, Westbourne, and Boswell's Circus.

Hodges and Todd v. Watson and Another.—This action was brought before Mr. Justice Wright, without a jury, in the Queen's Bench Court last week, by Messrs. Hodges and Todd, of Hampstead Road, London, to recover damages for breach of contract; the defendants, Mr. Arnold T. Watson, of Sheffield, and Mr. Robert Hodgson, of Hull, denied the breach. Mr. T. W. Chitty and Mr. J. H. Gray appeared for the plaintiffs; Mr. R. M. Bray, Q.C., and Mr. Marshall Hall for the defendants. Mr. Bray, in opening the case, said that the defendants agreed in January, 1897, to supply to the plaintiffs a Priestman oil engine of 24-brake H.P., suitable for working an electrical installation at the residence of a gentleman called Combe. The engine supplied was not sufficiently powerful, and worked in a noisy manner. Evidence was called in support; with reference to the noise one witness stated that the engine was generally known as "Mr. Combe's artillery," and another said that having lost his way while riding his bicycle he was guided back by the noise of the engine. Mr. Priestman was called for the defence and stated that his engine had been on the market for about 12 years. The engine in question, when tested, showed a power of 24·6 H.P. He thought it suitable for the purpose required if properly worked. Further evidence having been called for the defendants, Mr. Justice Wright delivered his judgment. According to the *Times* report, he said that the difficulties had arisen to a great extent from a miscalculation of the margin of power in these engines. The margin of power appeared to be small. He was satisfied that as this engine was adjusted in February, 1897, it was capable of working up to 24-brake H.P. according to the contract, but he was also satisfied that as it was fixed in July it would not work anywhere near up to 24-brake H.P. The main contention of the plaintiffs failed because it was an engine of 24-brake H.P., but they had a cause of action because the defendants had contracted to fix and start it as a 24-brake H.P. engine, but did not do so. It was an extremely difficult matter to assess the damages, but the defendants had minimised the loss by now agreeing to take back the engine and return the money, though they were not obliged to do so. In addition, there would be judgment for the plaintiffs for £50, but without costs, as the plaintiffs had failed in their main contention.

Lighthouse Illuminants.—In reply to a question put by Mr. H. Plunkett in the House of Commons last week, Mr. C. T. Ritchie said that the Elder Brethren of the Trinity House did not consider that the great additional expenditure necessary for installing and maintaining two separate electric light stations would be justified in the case of Lundy Island. The question whether electricity, gas or oil are to be adopted as illuminants in the future must depend to a great extent on the circumstances of the particular lighthouse.

Liquidation Notices.—A general meeting of Latimer Clark, Muirhead & Co., Limited, is to be held at the offices of Messrs. Trinder, Capron & Co., 47, Cornhill, E.C., on Monday, May 2nd, at 3 o'clock for the purpose of hearing an account of the winding up proceedings from the liquidator, Mr. J. Worley.

Lists.—Mr. William Patterson, of Walker Gate, has issued a list of copper wire gauze dynamo brushes.

The United Ordnance and Engineering Company, Limited (Messrs. Easton, Anderson and Goolden, Limited, of Erith), have issued a pamphlet well illustrated both by means of photographic and other views, in which they describe their multipolar continuous current dynamos and motors. In tabulated form there are given particulars, prices, weights and overall dimensions. Views are shown of the winding, erecting and brass finishing shops, and the test-bed at Erith.

Parabolic Reflectors.—A sole license has been granted to Messrs. Chance Bros. & Co., Limited, of Smethwick, for the manufacture of parabolic reflectors for search lights by the Cowper-Coles electrolytic process.

Partnership.—Mr. L. Alwyn, of Cowcross Street, E.C., informs us that he has taken the Hon. Rupert Craven into partnership, and the style of the firm will henceforth be "Alwyn & Craven," of the above address. All outstanding liabilities to date will be discharged by Mr. Alwyn.

Portable Galvanometer of the d'Arsonval Type.—The Weston Electrical Instrument Company, of America, have recently got out a new form of testing galvanometer, made up in exactly the same sort of form as their well-known ammeters and voltmeters. In this instrument the moving coil is exceptionally light, and is wound with about 300 ohms resistance. A light pointer is provided, and the sensibility of the instrument is such that one volt applied to the terminals through an external resistance of 250,000 ohms gives a deflection on the scale of about 1 millimetre. The instrument is in a very compact case, and is very handy for portable work in resistance, measurements and potentiometer work of all sorts. Messrs. Elliott Brothers, acting as agents for the Weston Company, are keeping these instruments in stock.

"Relugite" Resistances.—From the Electric Insulation Syndicate, Limited, of East Moors, Cardiff, we have received a catalogue of the "Relugite" resistances and other apparatus manufactured by them. "Relugite" is a new elastic and compressible resistance material, the resistance of which can be raised by pressure, and by means of this and of improvements in the means of applying it, a novel and useful series of resistance appliances is made. The following are among the specialities which are described and priced:—Dynamo and motor shunt resistances, arc lamp resistances, regulating ditto, special resistances in standard frames, motor starting resistances, "Standard" "Relugite" electric stoves or regulators, and lamp switches.

South African Electrical News.—We glean the following items of interest from the April issue of the *British and South African Export Gazette*:—The electrical installation at the Woodbine gold mine, De Kaap, comprises three 50-B.H.P. 200-volt three-phase motors, two to serve the mill and one the air compressor; two oil-transformer-type transformers, of 100 kw. and 50 kw. respectively, wound for a high tension of 10,000 volts and a low tension of 200 volts, and were supplied through Messrs. Reunert & Lens. Orders for 500 lamps, with their fittings and accessories, for the electric light service of the post and telegraph office now in course of erection at Johannesburg, are about to be placed by the Transvaal authorities. The electric lighting and tram plant which the East London (Cape Colony) Town Council are about laying down is estimated to cost £25,000. A scheme for electric lighting the public buildings, shops, and private houses of Kimberley is proposed. Among the latest towns in the Cape Colony meditating the introduction of electric lighting is Queenstown. Proposals for supplying the light have already been submitted to the Council by Mr. E. T. Monteath, E.E., which have been handed to the Lighting Committee for consideration and report. Woodstock, a municipality situated 1½ miles from Capetown, is considering the advisability of a similar installation. Repeated extensions mark the tramway system of Capetown, the latest being to Plumstead, a suburb situated about nine miles from the metropolis, and the project is even being entertained of forming a link with Muizenberg, a favourite seaside resort 15 miles from Capetown. The track connecting Wynberg with Capetown is expected to be shortly ready for opening. This will add another eight miles to the existing electric network, which, with the several extensions referred to, will make a total of 33 miles.

Telephone Contract.—Mr. James Pollock, of Glasgow, has received an order for the erection of a complete telephone plant throughout the Western Infirmary, Glasgow. We understand that Mr. Pollock has completed a number of telephone installations of this kind, besides having erected upwards of 600 private telephone lines on rental throughout the city.

ELECTRIC LIGHTING NOTES.

Bath.—Mr. R. Hammond, in his last monthly report to the Electric Light Committee, reported that 17 arc lamps had been erected in the city, and the total number cast was 53. He also stated that with respect to the switchboard extensions, specifications were sent out to different firms, and recommended the acceptance of Messrs. Madder's tender at £253.

Brewery Lighting.—Messrs. O. Edwards & Sons, brewers, have introduced the electric light into their brewery and other premises at Tenterden.

Brighton.—At the Council meeting on Thursday last week the Lighting Committee submitted a report, which contained an announcement that Mr. Arthur Wright, the electrical engineer, had accepted the post of consulting electrical manager of the British Thomson-Houston Company, Limited, the terms of his arrangement enabling him to give at least half his time to the Corporation. The committee submitted accounts of the past year's trading. The gross revenue was £32,722 17s. 10d., of which £18,512 4s. 6d. were expended on maintenance, and £14,210 13s. 4d. carried forward. Leaving £110 13s. 4d. of this as provision for bad debts, and adding £5,000, balance from 1896, the Corporation had in hand £19,100, of which £2,000 were applied in aid of the district rate, £3,000 transferred to reserve fund, £5,688 5s. 6d. paid as interest, £5,547 9s. 1d. to the sinking fund, and £2,864 5s. 5d. carried forward to 1898 account. Private consumers purchased 1,505,867 units last year, and the public lamps consumed 486,634 units; 116,693 units were used in the works, and 335,977 units represented the extra quantity generated, but not accounted. An elaborate report, recommending a reduction in the charge for electricity after the first hour's average daily use from 1½d. to 1d. per unit, had been submitted to the committee by Mr. Wright, who concluded as follows:—"I trust that the policy inaugurated by the Lighting Committee of the Brighton Corporation in vigorously encouraging the use of electricity among the vast body of small ratepayers, who, either in their business or private residences, are in the habit of using artificial light for many hours per day throughout the year will be continued, and thus keep Brighton in the enviable position which it now holds, of being the first to enable the smaller ratepayers and householders to benefit by the many advantages of electricity." The committee resolved: "That from and after June 30th next, the charge for electricity after the first hour's consumption be reduced from 1½d. to 1d. per unit."

Bristol.—The report of the electricity department of the Corporation for the year ending March 25th, 1898, shows a very great advance upon the working of former years. At the date of the last return, *i.e.*, March, 1897, the department had connected to their mains 614 customers with 38,502 lamps. At the present date there are connected 814 customers with 49,917 lamps, showing an increase of 200 customers and over 10,000 lamps. The extension of the public lighting has not yet been carried out, but is in progress, and before the summer is over it is expected that the number of public arc lamps will be increased three fold. Extensions of the mains for private lighting have been, or will be made within the next two months, in various roads. The number of sub-stations has been increased from 31 to 39. The extensions at the generating station in Temple Back have been almost completed. Of the buildings, the new chimney and the coal bunkers are practically the only portions incomplete. Five new boilers have been put in, together with a new elevator, conveyor, and mechanical stokers and electric motors for driving these, and the sundry pumps are now being placed in position. One new steam alternator has been fixed and brought into use, and two others will be put in during the summer (these three machines alone are capable of keeping over 40,000 lamps alight at one moment). In addition to the alternators other steam dynamos have been and are being put in for public lighting and the supply of power. Various important buildings have been fitted with electric light during the year. The following table shows at a glance the financial progress of the electricity department. For the purpose of making the annual accounts agree as to date with the other accounts of the Corporation, these are now made up to March 25th, whereas formerly the financial year ended at December 31st, as required by the Board of Trade; thus it will be noticed in the following table that between the third and fourth year there are included in the figures the working for a period of three months only. It is interesting to note the relation in the profits arising from such three months, they being during the winter season, as compared with the whole year's working. The net profits during those three months far exceeded the whole of the profits for the previous year, and were only a few hundred pounds less than the profits for the succeeding year. The trading profits for the past year exceed 8 per cent. of the capital expended at the end of the term, although a considerable amount of this capital has been expended on buildings and plant which have not yet come into operation, and thus have not tended to swell the revenue.

City Electrical Engineer's Department Progress Table.

Year of working.	Customers connected.	Lamps connected.	Net profits.	Trading profits. Amount.	% of capital expended per annum.
			£	£	
1st ending Dec., '94	240	14,530	Loss	456	½ %
2nd " '95	439	24,046	Loss.	4,020	4 %
3rd " '96	593	30,299	2,487	7,590	7 %
*3 months Mar., '97	617	38,826	2,738	3,722	13 %
4th ending Mar., '98	749	49,719	3,290	11,307	8 %

* The results given in this line are for three months only, and the per cent. capital given as 13 per cent. is unusually high, as it is for a winter quarter only, and represents the rate per annum.

The Bristol Sanitary Authority has refused permission to Messrs. Spillers & Baker *re* laying wires under the roadway on Redcliff Backs for electrically lighting their premises.

Dublin.—The chairman of the Alliance and Dublin Consumers' Gas Company, addressing the shareholders last week, said that whatever apparent loss might have taken place by the use of the electric light, it was more than made up by the extended use of gas for cooking, heating, and gas engines. They would be interested to hear that large establishments were beginning to discover that to produce electric light at a very low cost they must have their own installations, and hence within the last 12 months a number of large gas engines had been erected in the city for electric lighting.

Durham.—The Cathedral authorities want to light up the Cathedral with electricity, and they have approached the Town Council to see if that body would permit the local gas company to apply to the Local Government Board for an electric lighting provisional order. The Council is considering the matter.

Eccles.—The laying of the electric light cables is to commence early this month. Rapid progress is being made with the station plant. The Electric Light Committee has fixed the rental for 5-ampere meters at 2s. 6d. per quarter, with a scale up to 100 amperes at 6s. per quarter. The electrical engineer says that the cable included in the private lighting estimate will be totally inadequate for the demand. It will supply 2,400 lights, but he suggests one that will be equal to 4,000 lights from Cawdor Street generating station to the Polygon. This proposal the committee has adopted at an increased cost of £119.

Edinburgh.—The Electric Lighting Committee has resolved to recommend, on a report from Prof. Kennedy, that the charges for current be reduced in June to 3½d. per unit with the ordinary discount; for each public lamp £14 per annum, and for motive power 1½d. per unit. It is suggested that the salary of the resident electrical engineer should be increased from £500 to £600 per annum.

Festiniog.—A proposal to light the district electrically was recently before the Gas and Water Committee from an electrical engineering firm. The Council has resolved to prepare an estimate of the cost and to inquire the experience of other towns.

Folkestone.—It is stated that the capital of the Folkestone Electricity Supply Company has been subscribed twice over. The amount offered to the public was £27,500, and application was received for shares to the amount of £75,000.

Hampstead.—Sixteen tenders were sent in for additional electric lighting plant at the central station, and they have been referred to the Lighting Committee. Messrs. Massey & Allpress are preparing specifications for the Guardians for electrically lighting the workhouse.

Kilmallock, Co. Limerick.—Mr. J. J. O'Sullivan, J.P., has made arrangements with the Markets Committee for the public lighting of this town, and is also putting down a plant for private consumers. The mains extend in four circuits of about quarter mile each, and the current will be delivered to the customers at 200 volts. Hitherto the town has depended upon oil as its illuminant, but nearly all the residents are now wired for electric lighting, the greater number not having more than three lamps and at a fixed contract price per annum for current, which has given satisfaction to the consumer and should prove remunerative to Mr. O'Sullivan. We wish the enterprise every success, as the lighting of small towns by electricity is opening a large field for the electrical industry. It has certainly given the lead to the neighbouring city of Limerick, whose provisional order dates several years back. The engine is being supplied by Messrs. J. and R. Lees, of Glasgow, and the dynamo, switchboard, wires, and general fittings are by the Edison & Swan United Electric Light Company, Limited.

Leeds.—On 31st ult. a Local Government Board inquiry was held at the Town Hall regarding the City Council's application for a provisional order (1) to empower the Corporation to create irredeemable stock bearing a dividend at a rate not exceeding 5 per cent. per annum, in order to issue or transfer the same to the undertakers, as provided in Clause 59 of the Leeds Electric Supply Order, 1891; and (2) to confer on the Corporation such borrowing powers, and powers to create and issue redeemable stock, as may be necessary in connection with the purchase of the undertaking of the Yorkshire House-to-House Electricity Company, Limited. The position of affairs was explained in detail by the Town Clerk.

The Great Northern Railway Company has asked the Corporation to extend the electric light farther along Wellington Street.

Lincoln.—At the Council meeting on Tuesday the Electricity Works Committee recommended that:—(1) The price of supply be 6d. per unit for first hour's average maximum demand, and 2½d. per unit afterwards. (2) That a contract be entered into with the National Electric Free Wiring Company to "free wire" any consumers who wish to take advantage of this method of providing themselves with wires and fittings. We understand that the works are in a very forward state, and supply will be given on October 1st next.

Peterborough.—A number of councillors are enraged at the stand which is being maintained by the Local Government Board in regard to the application for an electric lighting loan. It seems that the margin of borrowing power now remaining to the Council is not more than £26,160, and as £15,000 or £16,000 is to be spent for water supply, there would not then be sufficient to enable the Council to meet the city's requirements in this respect, if £15,000 is allowed for electric lighting. The Board, therefore, declines to comply with the application. The Town Council has had a very long discussion, and decided to send a deputation to wait upon the Board.

Ryde (Isle of Wight).—An inquiry was held last week into the application of the Ryde Electric Light and Power Company, Limited, for a provisional order. The Corporation opposed the application.

Sheffield.—A special meeting of the City Council has been fixed for Wednesday, April 13th, regarding the proposed application for an Act "To confirm an agreement for the purchase of the undertaking of the Sheffield Electric Light and Power Company, Limited, by the Corporation of Sheffield, and to confer borrowing powers and other powers on the said Corporation."

Shipley.—The Special Committee cannot recommend the purchase of the Baildon Bridge Mills for electricity works site, as the price is far too high.

Southend.—A special meeting of the Ratepayers' Association was held some days ago, when Mr. Kershaw, chairman of the Shoreditch Electric Lighting Committee, gave an address on the merits of electric lighting. He referred to tramways and dust destructors.

Spain.—A central station for the supply of electrical energy for lighting and power purposes to several small towns in the neighbourhood has lately been completed and put in operation at Tarancon. The water-power of the River Tajo is utilised, the plant comprising three 120-H.P. turbines, and a large 250-kilowatt multiphase alternator, the latter having been supplied by Messrs. Brown, Boveri & Co., of Baden, Switzerland.

Swansea.—A special meeting of the Corporation is to be held to consider Mr. Manville's report on electric lighting.

Weston-super-Mare.—Negotiations are in progress with the Great Western Railway for land for electricity works site.

Willenhall.—The District Council has affixed its seal to the agreement of the Midland Electric Corporation for Power Distribution, Limited.

Withington and Moss Side.—The Manchester Electricity Committee held a special meeting last week to consider a proposed extension of the city electric lighting system to Withington and Moss Side, under agreements with the Withington and Moss Side authorities. The estimated cost of extending the system to these suburbs, and of completing certain works, is £138,000. It was decided to apply for sanction to borrow £150,000.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Belfast.—It is stated in a Dublin paper that a special committee, recently appointed by the Belfast Corporation, is at present making active inquiries as to the cheapest and most efficient means of providing electric tram traction in those districts through which the horse car service of the Belfast Street Tramways does not at present pass.

The Secretary of the Tramway Company wrote to the Electric Committee on March 7th to the effect that the directors are not prepared to establish electric traction upon the Belfast tramways for the short remainder of their term, nor do they believe that any possible terms can now be suggested which would justify them in so doing. The Corporation had a long discussion on the matter last week.

Bristol.—The report of the Bristol Sanitary Committee upon electric traction and their negotiations with the Tramway Company (of which the pith was given last week in the Electrical Review) was discussed for two hours by the Town Council, and the members appeared to agree with a concluding remark that the debate had "cleared the air." The motion of the Chairman of the Sanitary Committee was, in effect, to oppose the Tramway Company's Bills, but the scope of the discussion was largely influenced by an amendment moved by Alderman Inskip in the following terms: "That this Council is of opinion that, subject to the settlement of all proper clauses for the protection of the public interests, it is desirable to conclude arrangements with the company for the withdrawal of the Corporation's petition against the Bristol Tramways (Electrical Power, &c.) Bill, upon the condition that the purchase periods of all the existing lines, together with all new lines to be hereafter constructed within the City and County of Bristol, shall fall in at the expiration of 18 years from the passing of the Bill; and the Sanitary Committee are hereby instructed accordingly." The purport of that amendment seemed to meet with almost general approval, but the wisdom of fixing a term in the resolution was criticised by many as fettering the Committee needlessly. The horse cars forming the main part of the Bristol Tramways are purchasable in about 14 years, or lines at longer periods, so that Mr. Inskip stated that the average period including the present extensions was 17¾ years. He intimated he was in a position to say the tramway company would accept 18 years. Mr. George Pearson, Chairman of the Electrical Committee, criticised the tramway company's action in offering to Alderman Inskip terms not offered to the Committee which had been negotiating, and pointed out there were one or two other matters for consideration. The company refused to think of anything but the overhead system, although an alternative underground system in a few streets where the overhead wires would be objectionable, could be easily worked in conjunction with the trolley system generally applied. His view was that the company should be bought out at once, and he believed it could be done with financial success by the city. Eventually Alderman Inskip withdrew his amendment, and accepted another, which asked the Committee to continue negotiations with a view to settle a fixed period for purchase of all undertakings, and to make terms and arrangements with regard to overhead wires and other matters, and report at the earliest opportunity. This was agreed to.

Coatbridge and Airdrie.—The Light Railway Commissioners held an inquiry at Coatbridge on 29th ult., regarding this light electric railway scheme promoted by the British Electric Traction Company. Mr. Morse explained the proposal, which was to run a railway from Blair Street, in Coatbridge, to Forsyth Street, Airdrie, a distance of three miles. The gauge would be 3 feet 6 inches. The Councils of Airdrie and Coatbridge wished this extension to be the same as the tramways of Glasgow. This the Traction Company is prepared to accede if the Commissioners think it desirable. The chief objection of Airdrie and Coatbridge Town Councils is the using of the proposed railway for the conveyance of minerals without their consent. The Council of Coatbridge also desire that the railway be extended westward to Woodside Street, and a branch line from the Cross to Sunnyside Station. While the Airdrie Council request it extended eastward to Carlisle Road, the Traction Company was also prepared to allow the Corporation to purchase the railway at the end of 21 years, instead of 35 years, as mentioned in the order. The N. B. Railway and Caledonian Railway opposed the scheme.

Crowborough.—A meeting was held on Wednesday evening at Nutley in support of the proposal to construct a light railway from Nutley through Crowborough to Groombridge. It was considered desirable to have the railway facilities improved, and a committee was appointed.

Derby.—Messrs. Kincaid, Waller & Manville are proceeding with the valuation of the tramways for the Corporation.

Dublin.—The Court of Referees of the House of Commons had before it last Thursday applications from the Gas Company and the Dublin and Wexford Railway Company for *locus standi* as petitioners against the Dublin Southern District Tramways Company Bill, under which power to run at increased speed is sought. The Gas Company was disallowed, but the Railway Company has been allowed a *locus* on the ground that the proposed change would create a new form of opposition.

Electric Tramways v. Kew Observatory.—The instruments used at Greenwich to register the variations in the earth's magnetism, and so on, are so delicate that they are appreciably affected by the establishment of the electric railway to Stockwell. Experiments made elsewhere show that the sending of a strong electric current through a district can affect these instruments at 12 miles distance. On these grounds, says the *Financial News*, the London United Tramway Company's Bill is going to be opposed on behalf of the Royal Society's Observatory at Kew. The scheme of the company embodies eight lines between Hammersmith, Ealing, and Hounslow, with electric traction substituted for horse-power. The Richmond Corporation will also oppose, being desirous of working the Richmond-Kew line for its own benefit.

Hanover.—In 1897, according to the annual report of the Hanover Tramway Company, electric traction has been introduced on all the tramways within the municipal boundry of Hanover. The conversion has been carried out one year sooner than time limit fixed by the authorities. Along with the report a map is published showing in different colours the sections of the lines worked by accumulators, and the sections worked by overhead conductors; and also the positions of the power stations. The cost of maintenance and renewal of the accumulators amounts to 46·18 marks per car per month; 1·22 pfennig per kilometre of the mixed system; 2·06 pfennige per kilometre of the accumulator system. Although it was not possible in 1897 to finish all the projected lines, or to start the working of those which were finished soon enough to show a financial success, nevertheless the profits have increased by about £13,800. The following lines are in course of construction:—1. Laatsen to Hildesheim. 2. Rethen to Pattensen. 3. Sieben Trappen to Gehrden. 4. Various small sections. The lines one to three are to carry goods as well as passengers. Some of these lines, for example, that to Hildesheim, run a distance of 20 miles from Hanover. Both power and light are supplied to the neighbouring parishes from the power stations. The expenses amounted to 63·8 per cent. of the total income, as compared with 68·2 per cent. last year. The power stations are at Glocksee, Vahrenwald, Kirchrode, Buchholz, Rethen, and Schude. At Glocksee there are four tubular boilers, each having a surface of 180 m^2, and two combined Cornish boilers, each with a heating surface of 200 m^2. Recently erected, there is one tubular boiler with a heating surface of 272 m^2. As to steam engines, there are four horizontal engines, each of 200—250 H.P., and one vertical engine of 350—460 H.P. The direct coupled dynamos have a normal output of 760 kilowatts, and a maximum of 960 kw. The report also specifies the plant in the other power stations. Buffer batteries are used to equalise the output from the dynamos. The central station at Glocksee is to be connected with the outer stations, and the depôts by telephone. The rolling stock at the end of the year consisted of 23 motor cars of the old type for overhead lines; nine motor cars of the old type for both overhead and accumulator working; 110 motor cars of the new type (one motor) for combined accumulator and overhead working; 17 motor cars, new type (with two motors), accumulator and overhead working; one snow plough (one motor) for overhead lines; one snow plough (with two motors) for overhead lines, used in summer as a water cart; one water cart for overhead lines. The number of horses at the beginning of 1897 was 253; this number has now been reduced to 50. A dividend of 5 per cent. has been paid, after making ample allowance for depreciation, &c.

Kidderminster and Stourport.—According to the *Birmingham Post* for April 1st, this tramway is now fast approaching completion, and we understand that in about a fortnight's time the contractors will have finished the works in hand. The only remaining piece of the permanent way to be done is that which has to be constructed over the level railway crossing at Stourport. The Great Western Railway have the construction of this to do, and it is to receive early attention. All the poles used for the purpose of suspending the trolley wire along the route are fixed, and the greater part of the trolley wire has already been attached. The whole of the underground cables have been laid. Some important road and bridge widenings were included in the scheme, and these have all been completed, and long lines of iron fencing have been erected where the road to Stourport has been widened.

London.—The London United Tramways Company's Bill for providing electric trams for West London passed the Standing Orders last week, and has been introduced into Parliament. The company proposes to run electric cars from the Broadway, Hammersmith, direct to Hounslow, passing through Chiswick, Turnham Green, Brentford, and Isleworth, whilst another and almost parallel line will run from Uxbridge Road, Shepherd's Bush, to Hanwell, through Acton and Ealing. The company promises to permit the local authorities of the districts through which the cars run, to use the standards for electric lighting, so that the whole of the West London suburbs may be lighted with electricity.

Northampton.—The Northampton Street Tramways Company is desirous of reorganising and improving the tramway service of Nottingham, but, as the Corporation has power to purchase the lines in 1901, the company has written suggesting that the Corporation should at once purchase, on terms to be arranged, the whole of the tramways, or should agree not to exercise the option of purchase until 1919, or thereabouts. Early consideration of the matter is requested.

Norwich.—It is expected that the construction of the electric tramway lines will be commenced shortly after Easter; 500 tons of rails from Belgian contractors are on the way. Continuous rails, with welded joints, are to be used. The trolley poles will come from America. The routes to be first taken in hand will be the Thorpe Road, Newmarket Road and Dereham Road.

Nottingham.—There has been a good deal of local discussion regarding the tramway question, and the special committee which was appointed a few months ago by the City Council to inquire into the matter has issued a lengthy report, the recommendations made therein being:—1. That the permanent way of the whole of existing system shall be reconstructed. 2. That certain important extensions to this system, given in full detail later in this report and shown on the sketch plan, shall be carried out as soon as Parliamentary powers can be obtained. 3. To equip the whole of the system on the principle of electric overhead traction. The report discusses overhead electric traction *versus* cable traction, the committee having inspected lines equipped by both methods. The merits of the electrical systems, *i.e.*, the conduit, accumulator, and trolley, are considered. The total estimated cost of the reconstruction of the existing tramways and the proposed extensions, including the overhead electrical equipment, cars, and car sheds, power station and plant, &c., is £425,000. The Council is advised to obtain the necessary Parliamentary powers, and to empower the Finance Committee to raise the capital required.

Paris.—The Compagnie Générale des Omnibus has applied for official permission to convert three more of its horse tramways in Paris into electric lines.

Whitley.—On 31st ult. a public inquiry was held at North Shields by the Light Railway Commissioners regarding the proposed extension of the tramway system, and the introduction of the overhead trolley by the British Electric Traction Company. Mr. Sydney Morse explained the scheme. He said the new line would be partly in the borough of Tynemouth, and partly in the Whitley and Monkseaton Urban District. The gauge of the proposed line would be 3 feet, and the engineer's estimate for the undertaking was £11,356. There were to be two new lines or extensions, the first being within the borough of Tynemouth and 2 furlongs in length. It would run from the present terminus in Saville Street, West, down the Borough Road to the penny ferry leading on the New Quay. The second one would be 1 mile 5½ furlongs, and would run through Cullercoats and end at the Ship Inn, Whitley. Of the latter distances 1 mile 1 furlong were in the borough of Tynemouth, and the rest in the Urban district of Whitley. There would be no difficulty in construction, the only heavy gradient being 1 in 11, and it was very short. It was said that some millions of passengers used the ferries in the year, and, therefore, with this very important traffic it was essential that the facilities suggested should be given. At present the tramways were run by a slow and unsatisfactory method, and the local authorities had long considered that there should be some change for the better. Mr. Morse then referred to the past negotiations which had failed between the Corporation and the late North Shields Tramway Company, and added that although there had been a great deal of correspondence on the subject of improving the trams there had been no practical results. The Corporation had an order for supplying electrical energy to the borough, and in February, 1897, they passed a resolution in favour of the trams being driven by electricity. Excepting three clauses in the order which the company sought to obtain under the Light Railways Act, everything had been agreed upon, but in these clauses the local authorities sought absolute veto upon matters vital to the undertaking. There were three objections by the Corporation. The first referred to the future purchase of the undertaking by the Corporation, the second to the paving and subsequent repairing of the roads by the company, and, thirdly, that in the event of a dispute arising the questions at issue should be referred to the Board of Trade. The latter clause was important to the company, as they considered it only reasonable and desirable that an independent authority should be called in to bring about a settlement. The company could not accept terms which might prove disastrous to them, and if some amicable arrangement could not be come to, the company would seek to carry out their business elsewhere. Mr. Garcke gave evidence in support of the scheme.

TELEGRAPH AND TELEPHONE NOTES.

Fire at Zurich Telephone Station.—A Reuter despatch says that:—"In consequence of a telephone wire falling upon the overhead wires of the electric street tramways at Zurich, the central station of the telephonic service, which has 5,000 subscribers, caught fire and was completely destroyed. The damage to the building is estimated at over £40,000, while the losses caused indirectly amount to at least the same figure."

The Pacific Cable.—A Reuter despatch from Hobart says that at Monday's sitting the Inter-Colonial Conference agreed that in the absence of a satisfactory proposal from the Eastern Extension Telegraph Company, no fresh arrangement could be made with the company. A motion was passed in favour of the speedy construction of a Pacific cable.

The Telegraph System.—Few people, says the *Daily Chronicle*, have any adequate idea how large the annual balance on the wrong side really is. The capital amount of Consols created in respect of money raised for the purchase of telegraphs, &c., stands at, net, £10,868,664, on which interest at 2¾ per cent. amounts to £298,888. The expenditure on salaries, rent, maintenance, buildings, stationery, rates, &c., amounted to £3,111,810. The gross receipts were £3,287,611, and the net receipts, deducting the amount paid to cable companies and telegram moneys refunded, £2,922,449, but to this is added £44,905, being the value of services performed for other Government departments without remuneration, total £2,967,354. There has been a deficiency in every year since the purchase of the telegraphs by the State, and the aggregate from the beginning of 1871 to March 31st, 1897, amounted to a total deficiency of £6,629,890.

The Telephone Service.—In the House of Commons, sitting in committee, on Monday last, a resolution was moved authorising the payment out of the Consolidated Fund of a grant of £1,000,000 for the telegraphs. Dr. Clark: Has this anything to do with the telephones?—Mr. Hanbury: A sum of money has already been paid for the trunk lines of the telephones, and this is to complete it.—Mr. Lough objected to large sums of money being voted in this way.

CONTRACTS OPEN AND CLOSED.

OPEN.

Accrington. — April 19th. The Corporation wants tenders for the supply and erection of three sets of steam dynamos, each set consisting of a triple expansion condensing steam engine of the inverted vertical type, 90 I.H.P., and of a shunt wound dynamo. Also a feed water heater, storage battery having a capacity of 750 ampere-hours, switchboard instruments, apparatus cables, wires, street boxes, connections, &c. For further particulars see our "Official Notices" April 1st. Consulting engineer, Mr. J. N. Shoolbred, 47, Victoria Street, S.W.

Belfast.—April 18th. The Harbour Commissioners are inviting tenders for the supply and erection in the electric light station, Abercorn Basin, Belfast, of three compound, two-crank, self-lubricating, single-valve quick revolution vertical engines, each capable of developing 70 H.P., with a steam pressure of 130 lbs. per square inch. Also for three belt-driven, continuous current, series wound dynamos, capable of giving 15 amperes, 2,850 volts, at a speed not exceeding 800 revolutions per minute for 18 hours continuous running, without undue heating. Specification and further particulars from the harbour engineer, Mr. G. F. L. Giles. See our "Official Notices" this week for particulars of these two contracts.

Derby.—April 12th. The Corporation wants tenders for the electric wiring of its Ford Street yard and premises. See our "Official Notices" March 18th.

Derby.—April 11th. The School Board want tenders for the electric wiring of the Traffic Street Board School, Derby. Particulars from Mr. J. E. Stewart, Corporation electrical engineer. See our "Official Notices" March 25th.

Edinburgh.—April 23rd. The Midlothian and Peebles Lunacy Board is inviting tenders for the installation of electric light in the Asylum at Rosslynlee, near Edinburgh, including (1) generating plant, accumulators, switchboard, &c.; (2) wiring, fittings, &c. Particulars may be obtained on application to Prof. Bailey, Heriot-Watt College, Chambers Street, Edinburgh.

Shoreditch.—April 12th. The Vestry wants tenders for the supply and erection of arc lamps and accessories, also for electric light cable. Electrical engineer, Mr. C. N. Russell. See our "Official Notices" March 25th.

Switzerland.—April 15th. The Works Department of the Municipal Council of Berne is inviting tenders until the 15th inst. for the supply of between 60,000 and 70,000 metres of low tension cable (for 250 volts), and from 27,000 to 35,000 metres of high tension cable (for 3,000 volts) ranging from 15 to 150 sq. metres in section, as also the necessary junction pieces, distributing boxes, &c., for the new municipal alternating current system. Tenders to be sent to La Direction des Travaux de la Ville, Berne, Switzerland, from whom particulars may be obtained.

Switzerland.—April 30th. Plans and estimates are being invited, says the *Contract Recorder*, by the Government authorities of Fribourg, Switzerland, until April 30th next, for a projected electricity generating station to be established at Hauterine. Water-power is to be utilised, and the station will have a capacity of about 6,000 H.P. A premium of £120 will be awarded to the three schemes submitted which are considered to be the best. Plans and estimates are to be sent to the Department des Travaux Publics, Fribourg, Switzerland, from whence full particulars of the competition may be obtained.

The War Office.—April 27th. The Secretary of State for War is prepared to receive offers, competitive designs and specifications for the supply of portable electric search light apparatus. Particulars from the Director of Army Contracts, War Office, Pall Mall, S.W. See our "Official Notices" February 4th.

Victoria.—June 24th. The Council of the city of Hawthorne (Colony of Victoria, Australia) is inviting tenders for the supply and erection of buildings, boilers, engines, dynamos, transformers, mains, meters, arc lamps, poles; also running the plant for three years. See our "Official Notices" March 11th.

CLOSED.

Hammersmith.—The Vestry has accepted the tender of Mr. T. W. Thomas (£3,504) for the extension of the electricity works. Messrs. W. T. Glover & Co.'s tender for switches for 50 new arc lamps at £5 each has been accepted.

Middlesex.—The Asylum Committee of the Middlesex County Council has accepted the tender of Messrs. Veritys, Limited, for lighting the recreation hall and the stage therein by electricity, at the sum of £289.

NOTES.

Mr. Crompton's Smashes.—It is thought that our report last week of Mr. Crompton's remarks on the subject of Mr. Hammond's Institution paper may suggest that when the speaker was referring to a good many smashes he had Brighton in his mind. This matter is made clear by Mr. Crompton's letter in our "Correspondence" columns, and since that part of this issue went to press we have received a letter from Mr. Arthur Wright on the subject. This will appear next week.

Magnetism and Diamagnetism.—In the fifth and last lecture of his course on "Recent Researches in Magnetism and Diamagnetism," delivered at the Royal Institution on Thursday last week, Prof. J. A. Fleming dealt with the subject of magnetic theories. After briefly pointing out the nature of older views on the causes of magnetic action, he said, according to the *Times* report, that all modern physical theories were based on the denial of action at a distance, and on the conviction that in the ultimate analysis all invisible as well as visible physical actions could be reduced to simple mechanics. The origin and explanation of physical effects were sought for in the interactions of matter, ether, and energy, governed by the fundamental principles of dynamics. From this point of view electric and magnetic phenomena were regarded as events happening in the ether, modified by the presence of matter. The nature of these events could only be determined in terms of some hypothesis as to the structure of the ether, and the suppositions made must be justified by their power to predict new facts. The lecturer passed on to discuss the probable molecular structure of the ferro-magnetic metals, iron, nickel, and cobalt. After some experiments indicating that each small particle of magnetised iron was itself a magnet, a model magnet made up of a large number of small compass needles pivoted on a board at equal distances was shown to exhibit all the characteristics of a piece of iron subjected to magnetisation, and it was pointed out that these small magnets produced by their mutual action (as first shown by Ewing) all the phenomena of hysteresis, retentivity, and coercivity. Referring next to the probable ultimate causes of the magnetic properties of the iron molecule, Prof. Fleming discussed various hypotheses and gave arguments for and against the well-known theories of Ampère and Weber. Experiments and illustrations were brought forward in support of the view advocated by the lecturer that the causes of the magnetic properties of the iron molecule were most probably to be looked for in the magnetic field produced by the rotation of a molecule built up symmetrically of atoms carrying electric charges. This hypothesis led to a simple explanation of the disappearance of ferro-magnetic susceptibility beyond a certain critical temperature, characteristic of iron, nickel, and cobalt. All recent work strongly confirmed Maxwell's electro-magnetic theory of light, according to which light consisted of a rapid alternation of electric displacements and magnetic flux taking place in the ether at any point. The energy of sunlight (equalling 10,000 foot-pounds per cubic mile) was half magnetic and half electric, the *maximum* value of the electric force in a ray of sunlight being equal to 200 volts per foot, and of the magnetic to about one-tenth of the earth's horizontal magnetic force. No proper account, however, the lecturer observed, could be given of the nature of electricity or magnetism until it was known what was the nature of the physical change in the ether that produced what was called an electric displacement or a magnetic flux.

Acknowledgment.—The three notes on pp. 448, 449, and 450 of our last issue, headed "In Honour of M. Gramme," "Large Continuous Current Dynamos," and "French Import Duties on Lead and Accumulators," were translations from our esteemed contemporary, *L'Industrie Electrique*, of Paris. We regret that references to our contemporary were inadvertently omitted.

Paris Academy of Sciences Awards.—The Academie des Sciences, of Paris, recently awarded prizes to M. Ph. Lenard and M. André Blondel. That awarded to M. Lenard was the La Caze prize for physics, and that awarded to M. Blondel is known as the Gaston-Planté prize. Lenard's work in connection with the cathode rays is well known. He was the first to prove that these rays, after coming outside the tube, can be made to excite phosphorescent bodies, light gases, discharge electrified bodies, and among other functions can traverse to various different degrees bodies opaque to light. The Paris correspondent of a New York contemporary (*Electrical World*) says that M. Blondel received his prize for his work in electricity. He has given a great deal of attention to alternate current work. In 1891 he determined automatically, and by a continuous process of tracing, the curves of tension and currents, and indicated for the first time the method of tracing them by photography, and in this way permitted at the same time the analysis of the phenomena, of which the alternating current arc is the seat, particularly in directly demonstrating the fact that a currrent of particles is directed from the positive toward the negative carbon; it appeared even to measure the velocity of their passage. But the most important result was the realisation of a new type of apparatus, the oscillograph, capable of transmitting to a mechanical system the exact law of variation of currents with time. He also investigated such matters as the methods of coupling alternators, a theory of synchronous motors, the use of polyphase current, the discussion of methods for measuring the power and efficiency of machines, &c. He has likewise made a special study of the electric arc. The absence of difference of phase between the current and the E.M.F. at the terminals of an alternating arc led him to think differently from the opinion widely held since the time of Edlund, that there does not exist in the arc any inverse E.M.F. analogous to that of polarisation. An ingenious method recently applied to the continuous current arc seems to confirm this conclusion, and demonstrate that the arc is equivalent simply to a resistance. M. Blondel, in his position of engineer attached to the lighthouse service, studied the photometric properties of the arc, and has undertaken a long series of experiments, which have already led to useful improvements in the apparatus of French electric lighthouses.

Coherers.—M. Branly has recently (C.R. 125, p. 939) repeated and extended some of his original experiments with discontinuous conductors described in *La Lumière Electrique*, May and June, 1891. He had found that the most sensitive substances were those which showed on the galvanometer a very feeble conductivity. This condition was produced, in many cases, by applying a pressure of 50 to 100 grammes to a layer of filings 1 to 2 mm. in thickness, contained in an ebonite cup between two metallic electrodes. Using mixtures of metallic powders and insulating substances, he found that the sensitive condition could only be obtained by the application of enormous pressures. In practice the sensitive condition is obtained by pressing the metallic layer in a small ebonite chamber between two electrodes, one of which is actuated by a screw, till a small deflection is shown on the galvanometer. It is sometimes difficult to limit the deflection to a few degrees of the scale, but in case the deflection is too great, it can always be brought back to zero by gentle tapping. As formerly, Branly sorts his powders by sifting; the higher the conductivity of the metals, the smaller the filings are made. Many metals and alloys have been found to give good results. In giving a list of metals suitable for coherers, it should also be stated what thickness of layer is best, and even the age of the layer should be stated. A great variety of mixtures of insulators and filings have been found to answer, viz., resins and filings, gumlac and filings, balsams and filings, &c. These mixtures are sometimes made up in the form of pastilles 1 mm. thick, and 2 to 3 mm. in diameter; sometimes it is convenient to form films with filings and collodion, gelatine or celluloid. These pastilles or films are placed between two metallic electrodes and pressure applied by screw till the galvanometer begins to deflect as already described. The intensity of the tapping back blow ought to be regulated. The best E.M.Fs. to employ have been found in some cases to be from $\frac{1}{20}$th to $\frac{1}{10}$th volt. Mixtures have been discovered which recover without tapping back.

The Kinetic Motor.—One is so accustomed to hear of electricity duplicating all other power agencies on American tramways, that the Dodge motor, albeit only a modified form of steam motor, comes as something of a surprise. Nevertheless, we do not doubt that there are occasions where its use may be advantageous. This new motor is on general principles much the same as the Lamm-Francq system. The kinetic system, according to the *Railway World*, to whom we are indebted for the account, is made an addition to the car, and consists of a small locomotive type double cylinder engine and a hot water storage boiler. There is on the roof a tubular air condenser similar to those used in this country. At the central station water is heated to about 380° F., which corresponds with a pressure of 200 lbs. Each car is filled up with 275 gallons, and this represents 50 horse-power (50 horse-power-*hours* we presume). To balance radiation losses, a fire-box is provided and supplied at the central station with a pan of anthracite coal, which is sufficient to keep up pressure on the longest trip. In this system the driver has a power supply to call upon at once, and his duties are no more severe than those of an electric carman. Steam from the boiler is dried by the passing of the pipe through the flue and smoke box. The cylinders are 9″ × 10″, and are fitted with ordinary link motion. Pressure is reduced through a reducing valve to suit the load requirements; speed is regulated by the link motion, and the car can be handled from each end alike. The wheels are 30 inches diameter. The driver controls the engine by means of two concentric hand wheels on a vertical post and rapid reversal of the motor can be made. A safety valve discharges any possible excess of pressure into the condenser, and in winter the exhaust is used for car warming. Nothing is visible to differentiate the car from an electrically-driven car, and there is probably a fair opening for these cars in outlying districts. They have been tried on the West Chicago Railway, the Babylon, Long Island line, and a branch line of the New York and New Jersey Railroad, the grades on which latter line, are long and heavy, but a kinetic motor on this line hauled a 33 tons trailer for a consumption of water only 35 lbs. per car mile. Speeds of 12 to 30 miles an hour have been made, and runs of 20 miles with one charge of boiler and furnace. An ordinary single truck motor car weighs 28,000 lbs.

This Year's B.A. Meeting at Bristol.—The next meeting of the British Association for the Advancement of Science will be opened at Bristol, commencing on Wednesday, September 7th. The president elect is Sir William Crookes, F.R.S., V.P.C.S. The vice-presidents elect are:—the Earl of Ducie, the Lord Bishop of Bristol, Sir Edward Fry, Sir Fredk. Bramwell, the Mayor of Bristol, the Principal of the University College, Bristol, the Master of the Society of Merchant Venturers of Bristol, John Beddoe, Esq., M.D., F.R.S., Prof. T. G. Bonney. Prof. A. W. Rücker is the general treasurer; Prof. Schäfer and W. C. Roberts-Austen are general secretaries, and Mr. G. Griffith is the assistant general secretary. The local secretaries for the Bristol meeting are Mr. Arthur Lee, J.P., and Mr. Bertram Rogers, the local treasurer being Mr. J. W. Arrowsmith, J.P. The presidential address will be delivered on the Wednesday evening, and the concluding meeting will be held on September 14th. Prof. W. J. Sollas, M.A., F.R.S., and Mr. Herbert Jackson will deliver the two evening discourses. The presidents of the various sections are: Section A, Prof. Ayrton; B, Prof. Japp; G, Sir John Wolfe-Barry. There is to be an international conference on terrestrial magnetism and atmospheric electricity associated with Section A, under the presidency of Prof. Rücker. An interesting feature of the Bristol gathering will be the formal opening of a Cabot memorial tower on September 6th by the Marquis of Dufferin and Ava. It was from Bristol that, in the year 1497, Cabot sailed to discover the mainland of the American continent.

Proposed Technical Institute for Hammersmith.—The *London Technical Education Gazette* says a movement is on foot in Hammersmith for providing a technical institute adequate for the needs of the district. The Vestry has offered a site next the Vestry Hall, and subscriptions will probably be obtained.

Electric Locomotives at Terminal Stations.—Although the day when the electric will supplant the steam locomotive on trunk lines may be quite remote, it is, says the *Scientific American*, steadily encroaching upon its domain in certain branches of locomotive work. The latest evidence of this comes in the shape of an announcement that the handsome Union Depôt at Boston is to make use of electric locomotives, and that no steam traction will be used within a mile of the station. The steam locomotives will bring their trains up to the electric yard, where they will be picked up and brought in by the electric locomotives. Outgoing trains will be similarly handled, being picked up by the steam locomotives at the limits of the electric yard. The proposed scheme is an excellent one, and could be adopted by the existing terminal stations to great advantage. Though it might involve a slight delay and greater cost of operation, the gain to the travelling public and the locality surrounding the great terminals would be valuable in many ways. The handsome terminal structures themselves would be healthier and more cleanly. Any traveller with an eye to the artistic, must have noticed how speedily the fresh painted ironwork of such a terminal as the Grand Central Station in New York, or the Pennsylvania Railroad Station in Philadelphia, is begrimed by the gases from the locomotives. With the substitution of electricity, the handsome train shed roofs would preserve their proper colouring, and the light graceful effect of their ironwork indefinitely. In the yards, moreover, the noisy exhaust of the switching engines would give way to the quiet hum of the motor—a change devoutly to be wished by the residents of the adjoining districts, who would, at the same time, be rid of the smoke and ashes that add their quota to the general inconvenience. When the approach to the terminal is in tunnel, as in many of the European cities, and here on Manhattan Island, the purifying of the atmosphere, due to such a change, is too obvious for comment. Before leaving this subject, says our contemporary, it should be noted that an electric switching locomotive has just made a successful trial on the Hoboken Shore Road, New Jersey. It has been built for hauling heavily loaded freight trains between the railroad terminals and the wharves of the trans-Atlantic liners at Hoboken. The locomotive, which is eight-wheeled, develops a total horse-power of 540, on four axles, each motor being of 135 horse-power. The substitution of electric for steam traction will prove a great boon in the populous district affected by it.

Electric Welding.—The Manchester Association of Engineers, on 12th ult., discussed various topical engineering questions. One of the questions, as given in the *Practical Engineer*, was:—"Can defects in iron castings be electrically welded?" Mr. Kelsall said if the attempt he witnessed at a large foundry in Bolton was any criterion, he should answer "No." Everything was arranged in splendid order. A piece had been broken off the edge of a segment of a large pulley, and an attempt was made to fill this up. The soft metal used, which was fused with the cast-iron, was found, immediately it was cold, to be so hard that it could not be dressed. During the melting of the two irons—the cast-iron of the pulley and the added iron—the latter became charged with combined carbon from the graphitic carbon of the cast-iron, so that it could not be dressed owing to the intense heat, the graphitic carbon, which was only mechanically mixed in the cast-iron, becoming converted into combined carbon, and making a steel harder than any steel could touch. Mr. Rae mentioned a case of the successful electric welding of a large broken fly-wheel. The president (Mr. Henry Webb) said he knew of cases of steam cylinders, calender bowls, &c., which were effectually welded, but which would have been rejected had not this operation been performed. Electric welding had saved many expensive castings from being thrown into the scrap heat. Another question was, "What is your experience of steel castings after electric welding?" Mr. Daniels said his experience was that the parts in which the castings had been electrically welded were very hard. These hard places were very difficult to overcome. Mr. Kelsall observed that he saw no reason why steel castings and forgings should not be very successfully electrically welded. The theory he had given as the cast-iron did not effect the present question. In welding steel they used metals of almost an exact equality—say steel carbon, ·50 per cent.—whereas in cast-iron they might have as much as 3 to 4 per cent. graphitic carbon to act upon. There was, however, still one rather objectionable point, and that was, they could not always get the appearance of the surface alike after tooling, different shades being shown. Otherwise, he had seen very good results, and at some works electric welding was generally adopted for castings and forgings without any detriment. Mr. Butterworth related an experience he had had, which went to show that the electric welding on some steel pistons was very superficial, and that it caused warping. Mr. Hodson mentioned cases in which he had sent back steel castings to the maker, but which had been electrically welded, and then passed inspection. There had been no difficulty in machining after the welding. The electric welding of steel by people who were experienced in the operation was a perfectly satisfactory process. The president said steel castings and forgings, and iron, too, could be electrically welded most successfully. A good firm, who had proper appliances, would do it well, and those who had made a study of cast-iron thought it could be electrically welded, but not quite as well as steel forgings or castings.

"Made in America."—The New York *Electrical Engineer* says:—"In a letter addressed to the *Iron Trade Review*, Mr. Andrew Carnegie, in a brief but convincing manner, shows that a shipyard built in or near New York Harbour, and properly equipped and managed, ought to be able to compete with any similar establishment in any part of the world. As Mr. Carnegie points out, we can produce steel more than 25 per cent. cheaper than at Glasgow, for example, while as to cost of labour, the most modern appliances, even at higher rates of labour existing here, would reduce this item below that prevailing abroad. Mr. Carnegie is anything but a dreamer, and if confirmation of his proposition be desired, the electrical arts will furnish an excellent example. As to American electric railway apparatus in Europe, that has taken so firm a position that it will be difficult to dislodge our products permanently, if at all, in the future. It may be urged that our experience in electric railway work gave us an advantage of which we have reaped the benefit. Granted for the sake of argument. But how does this explain the continued and increasing shipment of dynamos and motors, circuit breakers, &c., to Europe from our shores? Only recently we were permitted to glance at a list of foreign orders in the works of one of our well-known manufacturers—a list covering page after page of various types of machines and apparatus. But what struck us most was the fact that the machines ordered were not merely for fan motors and the smaller sizes, but ranged all the way up to 60 H.P.! We must confess that the showing surprised us. The meaning of it appears plain when one considers, first, the cheapness of our raw material, iron and copper; and, secondly, the perfection of methods of manufacture, of which machine work is the dominant factor. That this is probably the true solution of the question finds further confirmation in the fact that an able American electrical engineer will shortly leave for Germany to design a line of dynamo-electric machinery for a firm in that country, on the American system of manufacture. Reduced to a plain proposition, Europe is still building dynamos, while we have long since manufactured them. We believe that the lead taken by America in this respect will be maintained for a long time to come, while, on the other hand, our cheaper raw materials will always give us an advantage which ought to be of a lasting nature."

Lectures.—Before the Royal Scottish Society of Arts at Edinburgh on 28th ult., Mr. G. K. Grieve read a paper on "The Comparative Cost of Gas and Electricity as Sources of Light, Heat, and Power."

Prof. Barrett delivered a lecture on "Electric Tramcars: Their Propulsion and Lighting," at the Royal College of Science, Dublin, on Monday.

Before the Chesterfield and Midland Counties Institution of Engineers at Derby a paper was read last Friday by Mr. W. Maurice on "Electric Blasting," this being Part III. of a series of five papers on the practical application of electric blasting in mines. A discussion followed. A paper was then read by Mr. L. W. de Grave on "Photographs of Electric Detonators."

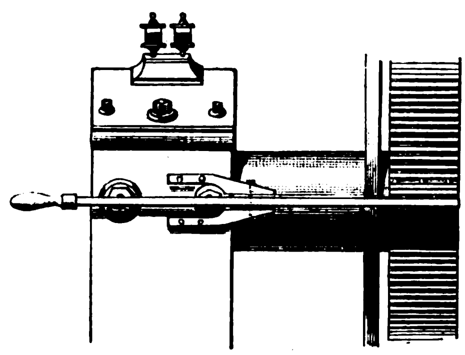
Induction Coils.—A writer in the *English Mechanic* recently asserted that the working of induction coils, when used for generating Röntgen rays, may be very much improved by increasing the capacity of the condenser. To illustrate his point, he describes the following experiment made with a coil by a French maker:—"The coil was a *perfect* one, by an excellent French maker, that is to say, *needed* no amelioration, *primâ facie*. Though of rather small size, it gave not only the 6-inch spark it should theoretically give, but very nearly 6¾ inches, and several interesting chirurgical cases were radiographed by the instrument. Wishing to try the extreme output of the small coil before buying a stronger one, my friend *doubled* the already voluminous condenser by a roughly made independent one of 100 tinfoil, not even placed in a basement, but left open next the existing one. He pressed the conduction wires upon the foil poles *by an ordinary iron weight*, and connected the improvised condenser in parallel with the constructor's one, by winding the two conductors round the spring pillar and the contact pillar respectively, so that during the experiment the wire could be connected or loosened *ad libitum*. I *saw* the experiment made, and stated, to my great astonishment, that the same Crookes tube gave nearly twice as much light upon the screen with the two condensers as with one. A bad tube giving a bad and much too intermittent image of the bones, gave immediately a sharp and permanent one. The effect of the additional condenser had been to reduce considerably the sparking at contact break, and to utilise better the extra current therefore. Time of exposure for a very strong radiograph of the hand-link is now *10 seconds* with the small 6-inch, and a mercury or some other costly or complicated contact breaker is useless." It does not follow from this that the working of every coil will be improved by increasing the capacity of the condenser. The condenser of this coil, even though made by "an excellent French maker," may have been too small. The best capacity for a condenser should be determined by experiment, and should be different for different kinds of breaks. The effect of making the condenser larger than the normal will be to reduce the sparking at the break (as the experimenter found), but also to decrease the E.M.F. and current in the secondary. The frequency of the intermittent discharges from the secondary will also be reduced. It is possible, however, that the best size of condenser may be different when different work is performed; so it might be worth while to try varying the condenser, and comparing the effect on the Röntgen rays emitted. The whole question of the working of coils and Röntgen tubes is still too indeterminate to permit of dogmatising on the subject.

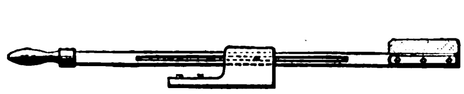
Crystal Palace Company's School of Practical Engineering.—The certificates awarded by the examiners for the Easter Term were presented to the students on Wednesday last (6th). Sir Henry C. Mance presided on the occasion, and in the course of a very appropriate and interesting address referred to the great facilities now afforded for technical education, as compared with the time when he himself commenced his career. Greater advantages, however, entailed more weighty responsibility, and led to increased emulation and competition. And this not only amongst ourselves as a nation, but we had to hold our own against foreign rivals. He mentioned the fact of the contract going to America for the machinery for the great Central London Electric Railway as a warning in this connection. If trade unionism had anything to do with it, he hoped that recent experiences might lead to the removal of that obstacle. He concluded with a few words of advice to the students, urging upon them to have a definite aim in life, and to endeavour to get early into a groove affording work of a kind that will prove a pleasure and not a drudgery. If there be such a thing as luck, and if, as it is said, it knocks at every man's door once in his lifetime, it is of the utmost importance to be in every way prepared to take advantage of the occasion when it offers.

United States Exports.—The *Electrical World* says that the value of the instruments and machinery exported from the United States for scientific purposes during 1897, was $3,054,453, which was an increase of half a million dollars as compared with the 1896 exports.

Electric Lighting Plant Required for Australia.—In our issues of 11th and 18th of March the Council of the City of Hawthorn, a rising suburb of Melbourne, Australia, invited tenders for electric lighting plant. We have received copies of the specifications, and shall be glad to show them to tenderers. The city appears to be in a sound financial condition, having a total debt of only £35,000, or £1 15s. per head of the population. Its revenue from a General Rate of 1s. 9d. in the £ on the property valuation is £15,200 a year. At the present the Council propose to provide for one or two of its main streets only at an estimated cost of £8,000, and if the scheme meets with general favour it will in all probability be extended over the whole of the municipality, comprising some 3 square miles, at a cost estimated at £40,000. The central station will be located within 1½ miles of the most distant light, and the plant now desired is to provide 50 arcs of 2,000-C.P., public, and an equivalent of 40,000 C.P. incandescent, private, with a complete unit in reserve. The Council are willing to consider any scheme that may be submitted, other than that comprised in the specification, provided it be complete in itself.

Method of Sand Papering Generator Commutators.—A novel appliance for sand papering the commutators of generators has been devised by J. D. Lynch, chief engineer of the power station of the Hestonville, Mantua, and Fairmount Passenger Railway Company, of Philadelphia, and is used in that station. It is designed, says the *Street Railway Journal*, to avoid the necessity of holding by hand a piece of sand paper against the commutator, a very tiresome operation. The device consists of a bracket of wrought-iron, ⅜-inch thick, held against the pillow block of the engine by





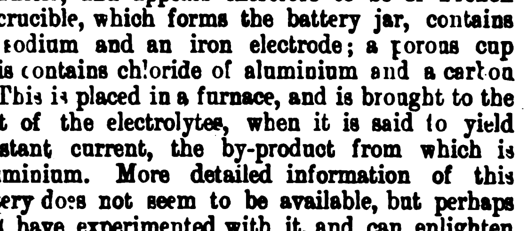
four lag screws. Inside this bracket a long iron bar with forged lever and slot running almost its entire length is held by means of a bolt. The sand paper is fastened to a wooden block at the end of this bar. The method of holding the bar in the bracket keeps the sand paper in a plane at right angles to the diameter of the commutator, so that the surface of the latter will always be flat. At the same time the pressure can easily be regulated by the handle. The commutators in this station run very smoothly and without sparking and evince great care on the part of the engineers.

The Action of the Electric Current upon some Alkaloids.—It seems that the use of the electric current provides a means for producing certain chemical substances, the production of which would otherwise involve complicated chemical reactions. As a short-cut to obtaining new decomposition products, the electrical method presents many advantages. Some examples of these are given by Herbert Pommerehne (*vide Arch. Pharm.*, 1897, No. 235, pages 364—368). He states that caffeine, when decomposed by the electric current, yields amalic acid, formic acid, ammonia, and methylamine, whilst morphine, when submitted to the same treatment, gives rise to oxydi-morphine and quinine to thalleio-quinine.

Electrical Features at the Alexandra Palace.—At the Alexandra Palace, which opens to-morrow, there are several electrical features of interest. The electric railway, to which we have already referred, is being laid down by the Imperial Electric Light and Power Company, in conjunction with Messrs. Wandruszka & Co., of Berlin. The cars are expected to be running on Friday. The power house, which faces the east entrance to the Palace, contains two sets of generating plant. The trolley system is employed, and the cars are built in the American pavilion style, for 60 passengers each. Their speed will be from 8 to 10 miles an hour. As this is the only instance of an electric trolley tramway either in or near London, it should have an educational influence both upon the public and the guardians of its interests, the members of the London County Council. The lighting arrangements are, of course, electrical. The main hall is lighted by arc lamps, and the lakes are electrically illuminated for firework displays. Electric motor cars will ply about the park. Messrs. Taylor & Field, of Westminster, are acting as consulting engineers for the whole of the electrical arrangements.

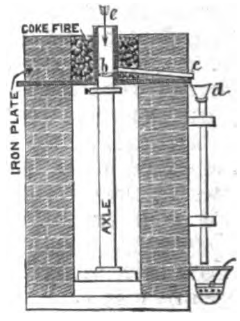
Aluminium as a By-Product of a Battery.—Judging from conversations with some experts on the subject of electro-chemistry, it appears, says the New York *Electrical World*, that it is not generally known that a battery was invented quite a number of years ago which yielded metallic aluminium as a by-product. The following meagre notes, which were made some 15 years ago, may, therefore, be of interest. The primary battery is known as that of Lacassagne and Thiers, and appears therefore to be of French origin. A crucible, which forms the battery jar, contains chloride of sodium and an iron electrode; a porous cup placed in this contains chloride of aluminium and a carbon electrode. This is placed in a furnace, and is brought to the fusing point of the electrolytes, when it is said to yield quite a constant current, the by-product from which is metallic aluminium. More detailed information of this curious battery does not seem to be available, but perhaps some readers have experimented with it, and can enlighten those interested in the subject. As it has been known a number of years it is not unlikely that practical difficulties are involved in its use.

An Ingenious Form of Armature Cradle.—The accompanying engraving, taken from the *Street Railway Journal*, shows a novel form of armature cradle or truck employed in the Glenwood shops of the United Traction Company, of Pittsburg. The special feature of this truck is that it is equipped with projecting forks or rests, so that it will pick up armatures when the latter are resting on the floor, saving in this way the labour of raising the armature by hand or tackle. The armature can then be drawn to any point desired in the repair shop. The truck is simple in



construction, and can be made by any blacksmith. The handle is about 5 feet in length. The United Traction Company is also employing an efficient kind of sand-box hose. The usual hose, of course, is of rubber, and is satisfactory in warm weather, but in winter often becomes clogged by frozen mud. In place of rubber hose, the United Traction Company is using a tube of coiled steel wire, which, naturally, is just as flexible as rubber, and has the additional advantage that when it becomes clogged, it can be stretched three or four times by the hands, which breaks up any lumps of frozen mud which it may contain. The tube is japanned, to prevent rusting.

Casting a New End on an Axle.—A writer in the *Street Railway Journal* recently gave the following illustration, showing a method of casting a new end on a car axle. The object of casting the end in this form was for experimental purposes. A brick wall was built up and around the axle as shown in the sectional view. The lower end of the axle rested upon a firm base also of brick. A collar was set-screwed to the axle as shown and a plate iron disc set in the brickwork just above. The hole in the disc was the same size as the outside diameter of the axle, and the axle was held in position by this means. The plate formed the



bottom support of the mould, *e*, also the bottom of the fire chamber. Previously to adjusting this mould, a coke fire was made in the chamber and the end of the axle, *b*, was brought to a high heat. Then the fire was drawn, all foreign matter removed from the end of the axle, the mould put in place, a new coke fire made around the mould and the hot metal poured in as the arrow indicates. There was a drain at *c*, leading from the bottom of the mould, through which the hot metal escaped to a ladle through the funnel, *d*. This was kept up until the hot metal softened the end of the axle, *b*, when the outlet was plugged and the mould filled. After cooling, and removing the axle, the point of union of the two metals was turned down and tests proved the axle to be as strong at that point as elsewhere.

Appointment.—We hear that Mr. T. B. Goodyear, who has been in the service of the Birmingham Tramways Company, Limited, for the past 10½ years in the capacity of assistant traffic manager and traffic manager, has been appointed general traffic superintendent to the British Electric Traction Company, Limited.

NEW COMPANIES REGISTERED.

Electric Supply Company of Western Australia, Limited (56,551).—Registered March 18th with capital £100,000 in £1 shares, to acquire the business of the Westralian Electric Lighting and Supply Company, Limited, to adopt a certain agreement, and to carry on the business of electricians, electrical and mechanical engineers, mortar and artificial stone manufacturers, coal, coke, and fuel merchants, &c. The subscribers (with one share each) are:—E. K. Muspratt, Seaforth Hall, Seaforth, near Liverpool, gentleman; J. B. Atherton, Manhattan, Gateacre, near Liverpool, manufacturer; J. E. Pearson, 63, Catherine Street, Liverpool, gentleman; W. H. Edwards, 4, Olive Street, Wavertree, Liverpool, merchant; D. L. Chalmers, 5, Fenwich Street, Liverpool, chartered accountant; F. J. Leslie, 15, Union Court, Liverpool, solicitor; A. E. Haptie, 5, Durham Road, Seaforth, cashier. The number of directors is not to be less than three nor more than seven. The first are B. Fitch, E. K. Muspratt, J. E. Pearson, W. H. Edwards, and T. Evans; qualification, £200; remuneration £150 each per annum and £200 for the chairman. Registered by F. J. Leslie & Co., 15, Union Court, Liverpool.

F. W. Smith & Co., Limited (56,604).—Registered March 22nd with capital £5,000 in £5 shares, to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity, and electrical apparatus manufacturers. The subscribers (with one share each) are:—F. W. Smith, 126, Sussex Road, Southport, electrical engineer; G. F. Travis, 49, Ash Street, Southport, gentleman; S. R. Park, 32, Scarsbrick Street, Southport, iron merchant; J. Richmond, 16, Derby Road, Southport, manager; J. White, 20, Chambres Road, Southport, manufacturer; W. W. Hall, 32, Chambres Road, Southport, merchant; R. F. Stephenson, 10, Chambres Road, Southport, manager. Registered without articles of association, by the Solicitors' Law Stationery Society, Limited, 12, New Court, W.C.

Mutual Telephone Company, Limited (56,627).—Registered March 23rd with capital £250,000 in £5 shares, to adopt an agreement with the Mutual Telephone Syndicate, Limited, and to establish, work, manage, control and regulate telephonic exchanges and works for the supply of electric light, heat, and motive power. The subscribers (with one share each) are:—N. Bradley, Mosley Street, Manchester, merchant; B. Robinson, Pendleton, Manchester, manufacturing chemist; W. Lees, Fairfield, Davenport, Stockport, hat manufacturer; G. Evans, Rochdale, merchant; A. Macnair, 20, Dutton Street, Manchester, drysalter; W Thomson. Royal Institution Laboratory, Manchester, chemist; F. Scott, 33, Brasennose Street, Manchester, chartered accountant. The number of directors is not to less than five nor more than 15; the subscribers are to appoint the first; qualification, £250; remuneration as fixed by the company. Registered office, 75, Princess Street, Manchester.

Globe Electrical Advertising Syndicate, Limited (56,673).—Registered March 26th with capital £1,000 in £1 shares (50 deferred), to adopt an agreement with W. T. Bell, of one place, and to carry on the business of advertisers by means of electric light, or otherwise advertisement canvassers, and agents, electrical and mechanical engineers, &c. The subscribers (with one share each) are:—W.T. Bell, 69, Henry Road. West Bridport, lace manufacturer; W. W. Hopewell, Broad Street, Nottingham, lace manufacturer; F. B. Whitty, Pilcher Gate, Nottingham, lace manufacturer; G. Middleton, 5, Baker Street, Nottingham, secretary; L. Mosley, 230, Askwright Street, Nottingham, clerk; N. Soans, Riverley House, Hoveringham, Nottingham, clerk; H. B. Hopewell, Eldon Chambers, Wheeler Gate, Nottingham, mortgage broker. The number of directors is not to be less than two, nor more than six; the first are, F. B Whitty, W. W. Hopewell, H. B Hopewell, and W. T. Bell; qualification, £100; remuneration as fixed by the company. Registered office, Eldon Chambers, Nottingham.

Simplex Steel Conduit Company, Limited (56,684).—Registered March 26th with capital £10,000 in £1 shares to carry on the business of manufacturer of all kinds of fittings for electric wiring, metal tube manufacturers and dealers, wire drawers, electrical, mechanical, and hydraulic engineers, tool makers, &c. The subscribers (with one share each) are:—F. Wain, 252, Moseley Road, Birmingham, clerk; J. H. Rice, Clifton Road, Sutton Coldfield, cashier; H. L. V. Pryse. Surrey House, Leamington, solicitor; H. R. Hodgkinson, Norwood House, Erdington, Birmingham, solicitor; H. C. Silk, Alcester Road, King's Heath, Birmingham, clerk; H. G. Chambers, Frederick Road, Aston, Birmingham, clerk; B. Smallwood, 84, Popular Road, Edgbaston, clerk. The number of directors is not to be less than two nor more than five. The first are H. Huggins, F. Huggins, and C. Middleton; qualification, £200; remuneration as fixed by the company. Registered by Waterlow Bros. & Layton Limited, Birchin Lane, E.C.

Improved Telephone Patents, Limited (56,698).—Registered March 28th with capital £300,000 in £1 shares, to adopt an undescribed agreement, and to acquire, manufacture, adapt, prepare, alter, improve, repair, use and deal with any materials, machinery, tools, or things connected with telephones, telegraphs, or other means of communication. The subscribers (with one share each) are:—J. H. Cuthbert, 58, Beversbrook Road, Tufnell Park, N., accountant; W. E. Elmslie, 20, Abchurch Lane, E.C., solicitor; A. E. Seamer, 7, Park Place Villas, W., clerk; J. L. Cooper, 6, Union Road, Tufnell Park. N., accountant; J. Perry, 175, Essex Road, Islington, N., clerk; H. Adams, 111, Mayall Road, Herne Hill, S.E., clerk; H. I. Bethell, 128, Beresford Road, Hornsey, N., clerk. The number of directors is not to be less than three nor more than seven. The subscribers are to appoint the first. Qualification, £100; remuneration, 5 per cent. of the net profits divisible. Registered by E. A. Foster, 6, Great St. Helen's, E.C.

Motor Omnibus Syndicate, Limited (56,718).—Registered March 29th with capital £6,000 in £1 shares, to acquire Patent No. 21,302, of 1896, to carry on the business of electricians, engineers, machinists, fitters, founders, millwrights, &c., and to construct, purchase, equip, maintain and work omnibuses, vans, steamboats, tugs, &c. The subscribers (with one share each) are:—E. H. J. C. Gillett, Hunworth Road, Hounslow, engineer; W. R. Manning, St. Maur, Henderson Road, Wandsworth Common, surveyor; C. Hayles, Perivale Lodge, Hounslow, coal merchant; A. V. England, Bank House, High Street, Hounslow, bank manager; W. B. Hurt, 78, Cicada Road, Wandsworth, S.W., clerk; R. A. Burrows, 17, Unwin Mansions, West Kensington, gentleman; H. G. Rivington, Coniston, Epping, Essex, gentleman. The number of directors is not to be less than two nor more than five; the first are A. V. England, C. Hayles, and W. R. Manning. Qualification of the first directors £50, of others £100; remuneration as fixed by the company. Registered office, 27, Chancery Lane, W.C.

Ernest G. Denner & Co., Limited (56,777).—Registered March 31st with capital £5,000 in £1 shares, to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity, and manufacturers of electrical apparatus. The subscribers (with one share each) are:—E. Denner, 5, Binfield Road, Sheffield, electrical engineer; M. Nicholson, 156, Steade Road, Sheffield; W. Haslam, 29, Spencer Street, Chesterfield, clerk; G. Smith, 1, Attercliffe Road, Sheffield, licensed victualler; W. Crake, 397, Staniforth Road, Sheffield, chemist; B. Nicholson, 156, Steade Road, Sheffield, steel melter; H. H. Ewing, 2, Plumpton Street, Sheffield, clerk. The number of directors is not to be less than two nor more than four; the subscribers are to appoint the first; qualification, 50 shares. Registered by Waterlow & Sons, Limited, London Wall, E.C.

Tyer & Co., Limited (56,760).—Registered March 31st with capital £25,000 in £1 shares, to acquire and carry on the business of an electric, telegraph, and railway train signalling engineer and contractor, carried on by E. Tyer at Ashwin Street, Dalston, N.E., as "Tyer & Co.," and to adopt a certain agreement. The subscribers (with one share each) are:—E. Tyer, Thurlow, Godalming, civil engineer; G. H. Jelfe, 35, Fairlawn Avenue, Chiswick, manager; R. W. E. Davey, 17, Walpole Road, Twickenham, clerk; H. J. Barrow, 19, Ironmonger Lane, E.C., chartered accountant; A. Barrow, 29, Heathland Road, Stoke Newington, solicitor; W. E. Tyer, 88, St. George's Square, S.W., solicitor; H. Field, St. Jude's, Maida Hill, clerk. The number of directors is not to be less than three nor more than seven; the first are to be nominated by E. Tyer; qualification, £500; remuneration as fixed by the company. Registered by Needham & Co., 10, New Inn, Strand.

Mechanical Improvement Syndicate, Limited (56,778).—Registered March 31st with capital £1,000 in £1 shares, to acquire, own, and work Provisional Patent No. 26,367 of 1897, for an improved appliance in connection with electrical illumination, and to adopt an agreement with H. Cooney. The subscribers (with one share each) are:—A. E. Box, 49, Amesbury Avenue, S.W., engineer; H. H. Farrell, 13, Silverdale Avenue, Tuebrook, Liverpool, cashier; J. H. Cheshire, 22, Johnson Street, Liverpool, agent; T. P. Martin, 16, Redcross Street, Liverpool, engineer; A. E. Boothroyd, Lord Street, Southport, cabinet maker; H. Cooney, 71, Lord Street, Liverpool, auctioneer; W. R. Carmichael, 71, Upper Stanhope Street, Liverpool, accountant. Registered without articles of association. Registered office, 71, Lord Street, Liverpool.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Direct United States Cable Company, Limited (11,597).—This company's annual return was filed on February 16th, when 60,710 shares were taken up out of a capital of £1,300,000 in £20 shares, and all considered as paid.

Yorkshire House-to-House Electricity Company, Limited (29,235).—This company's annual return was filed on February 19th. The capital is £200,000 in £5 shares (100 founders). 37,474 ordinary and 100 founders' shares have been taken up, and the founders' are considered as paid. £5 per share has been called on 18,848 and £2 per share on 18,626 ordinary shares, and £131,988 has been paid.

London Electric Wire Company, Limited (36,544).—This company's annual return, made up to February 9th, was filed on March 26th. The capital is £50,000 in £5 shares (5,000 preference); 4,188 preference and 4,597 ordinary have been taken up, and 3,860 of each description are considered as paid; £5 per share has been called on the others, and £5,325 has been received.

Madeira Electric Lighting Company, Limited (46,371).—This company's annual return was filed on February 9th. The capital is £15,000 in £1 shares, of which 10,537 have been taken up; £1 per share has been called, and £10,537 paid, and £25 has been received on 100 forfeited shares.

Malaga Electricity Company, Limited (48,076).—This company's annual return was filed on January 12th. The capital is £57,000 in 10,000 £5 ordinary and 7,000 £1 deferred shares. 9,981 ordinary and 7,000 deferred shares have been taken up, and the latter are considered as paid. £5 per share has been called on the ordinary, and £44,280 has been paid, leaving £5,625 in arrears.

Madras Electric Tramways Company, Limited (36,158).—This company's return was filed on February 26th. The capital is £100,000 in £1 (or Rs.15) shares. 64,704 shares have been taken up, and the full amount has been called and paid. £2,713 15s. 1d. has also been received on forfeited shares.

Morley Fletcher Wave Power System, Limited (48,648).—This company's return was filed on February 26th, when 694 shares were taken up out of a capital of £20,000 in £10 shares; 342 are considered as paid, and £10 per share has been called on the others. £3,375 has been paid, £150 is in arrears, and £5 has been paid on 11 forfeited shares.

National Electric Supply Company, Limited (29,992).—This company's return was filed on March 3rd. The capital is £84,943 15s. divided into 9,050 ordinary shares of £5 each, 10,850 ordinary shares of £3 12s. 6d. each, and 100 founders' shares of £3 12s. 6d. each. 10,850 ordinary and the founders' shares have been taken up, and £39,693 15s. has been called and paid thereon; £20 has been received on four forfeited shares.

Milver Portable Electric Battery Syndicate, Limited (44,003).—This company's return was filed on January 22nd, when 4,381 shares were taken up out of a capital of £22,000 in £5 shares. The full amount has been called, and £21,869 paid, leaving £36 in arrears.

International Telescriptor Syndicate, Limited (49,860).—This company's annual return was filed on March 3rd, when the whole capital of £10,000 in £1 shares was taken up; 9,993 of these are considered as paid, and £7 is in arrears.

Improved Electric Glow Lamp Company, Limited (47,636).—This company's annual return was filed on January 5th. The capital is £100,000 in £1 shares, of which 73,390 are taken up. 33,390 are considered as paid, and £39,975 has been paid on the others, leaving £25 in arrears.

Lamp Manufacturing Company, Limited (43,920).—This company's annual return was filed on January 14th, when 6,377 5/6th shares were taken up out of a capital of £20,000 in £1 shares. £1 per share has been called, and £6,377 16s. 8d. paid.

Julius Sax & Co., Limited (37,435).—This company's annual return was filed on January 17th, when the whole capital of £20,000 in £10 shares was taken up. 1,993 shares are considered as paid, and no calls have been made on the others.

Okonite Company, Limited (31,782).—This company's annual return was filed on January 24th, when 16,000 ordinary and 15,995 preference shares were taken up out of a capital of £320,000 in £10 shares; 9,332 are considered as paid, and £10 per share has been called on the rest; £225,665 has been paid, £1,015 is in arrears, and £5 has been received on five forfeited preference shares.

Newmarket Electric Light Company, Limited (44,450).—This company's annual return was filed on February 28th, when 36 shares were taken up out of a capital of £36,000 in £10 shares, and paid for in full.

Newcastle-upon-Tyne Electric Supply Company, Limited (27,997).—This company's return was filed on February 28th, when 9,259 shares were taken up out of a capital of £100,000 in £5 shares; 301 shares are considered as paid, and £5 per share has been called, and £44,790 paid on the others.

Newcastle and District Electric Lighting Company, Limited (28,022).—This company's return was filed on March 11th, when 9,918 shares were taken up out of a capital of £100,000 in £10 shares. £8 per share has been called on 5,000 and £4 per share on the others. £59,672 has been paid, and £829 has been received in advance of calls.

Northampton Electric Light and Power Company, Limited (28,640).—This company's return was filed on March 10th. The capital is £50,000 in 10 "A" and 49,990 "B" shares of £1 each. 10 "A" and 22,000 "B" shares have been taken up, and £1 per share has been called on the "A," and 17,710 "B" shares, while 10s. per share has been called on the rest. £18,594 has been paid, and £1,271 is in arrears.

CITY NOTES.

Eastbourne Electric Light Company.

In their report the directors state that the gross profit realised on the working for the year 1897 was £3,619 7s. 11d., and that the net amount available for reserve and dividend, after allowing for the interim dividend paid to June, 1897, and £400 carried to the depreciation fund, is £1,838 9s. 9d. They propose that £412 be placed to reserve, and that out of the balance left of £1,426 9s. 9d. a dividend at the rate of £10 per cent. for the half-year, making with the interim dividend paid in June, £7 10s. per cent. for the year, free of income-tax, be paid upon all the share capital of the company. This, after allowing for the interim dividend, will absorb £974 15s. and leave £451 14s. 9d. to be carried forward to next year's account. The depreciation fund now stands at £3,025; and if the proposal of carrying £412 to the reserve fund is adopted the reserve will then stand at £3,250, making a total reserve of £6,275.

The capital account shows a considerable outlay in the past year for main extensions and for additional machinery and plant, bringing up the deficit on this account to £5,553 1s. 1d.; and the directors have to provide for a prospective outlay for the next two years of at least £4,400, making a total further capital required of £9,953 1s. 1d.

The directors have had under consideration the desirability of placing the depreciation and reserve funds upon a more solid basis. The aggregate of the funds, as stated above, is £6,275, but the money is actually in use in the company's business and is not represented by separate cash.

The lamps in circuit, reckoned upon an average of 8 candle-power per lamp, number 19,288, against 16,690 at the close of 1896, an increase of 2,598 lamps for the year. The net increase of customers for 1897 was 56.

Rand Central Electric Works.

The directors state in their report that steady progress has been made in completing various installations and connecting them with the main line, and it is expected that the revenue from the constantly increasing power supply will show a satisfactory return for the current year. It must be borne in mind that up to December 31st last the central station had only been in partial operation, supplying but a comparatively small proportion of the power contracted for, and therefore the revenue derived from power supply during the past year is no criterion of future earnings. The earnings of the past year do not, however, affect the dividend payable to shareholders, because Messrs. Siemens & Halske guaranteed that the net profits available for dividend in the financial year under consideration would be at least 6 per cent. The necessary arrangements having been made with the contractors, the directors have decided to recommend that a dividend at the rate of 6 per cent. be declared for the year 1897. In accordance with the articles of association, Sir C. Rivers Wilson, G.C.M.G., C.B., the chairman of the company, and Mr. Carl von Siemens retire by rotation from office as directors, and being eligible, offer themselves for re-election. Messrs. Price, Waterhouse & Co., the auditors, also retire, and offer themselves for re-election.

Electrical Street Car Manufacturing Syndicate, Limited.

A statutory meeting of the shareholders in the Electrical Street Car Manufacturing Syndicate, Limited, was held on Friday at the works of the syndicate, Wednesfield Road, Wolverhampton. The syndicate, it may be remembered, was incorporated in December last, and the present meeting—at which there was no business for consideration—was held in order to comply with the provisions of the Companies Acts. The chair was occupied by Major Flood Page, of London, chairman of the syndicate.

The Chairman made a short statement respecting the company's prospects. He thought that the speed and success with which the new works and offices had been erected and equipped, indicated great energy and skill on the part of those of his colleagues who had directed the work. They had got excellent premises. The amount of money subscribed in cash was a little over £7,000, and there was only one very small sum in arrear. That was an element of satisfaction in starting the enterprise. They were probably witnessing the commencement of a very great advance in electrical matters, and he was sure that electric traction in the streets would in a few years cause a great diminution in the number of horses so engaged. They only required a good accumulator and good business management. The fact that Mr. Parker was engaged in the undertaking gave it an element of certainty, for chance was, he was sure, placed out of the question by that gentleman's association with the company. All over the world Mr. Parker was known in connection with electrical engineering, and they could congratulate themselves that so far as electrical engineering was concerned, the undertaking would be a success. So far as the business department was concerned, he could say—speaking on behalf of his colleagues and himself—that they would do their very best. He thought that their prospects were excellent. In four or five years' time there would hardly be a horse-drawn omnibus in the country. The London omnibus companies had incomes amounting to over a million, and they represented the business which the syndicate was waiting for. He thought that the younger shareholders present would live to see the day when that business would attain vast proportions, comparable even to that of the London & North-Western Railway Company.

A special general meeting was subsequently held on the requisition of eight shareholders, when a resolution was passed amending No. 86 of the articles of association, so as to enable the shareholders to remove any director before the normal expiration of his term of office if necessary.

The Indo-European Telegraph Company, Limited.—The directors after adding £15,000 to the reserve fund, have determined subject to audit, to recommend the payment of a dividend for the six months ended December 31st, 1897, of 17s. 6d. per share, making with the interim dividend already paid, 6 per cent., and a bonus of 20s. per share, both free of income-tax, making in all 10 per cent. for the year. The dividend and bonus will be payable on and after May 1st next.

Anglo-American Telegraph Company, Limited.—The directors have resolved, after placing £6,000 to the credit of the renewal fund, to declare an interim dividend for the quarter ending March 31st, 1898, of 15s. per cent. on the ordinary stock, and £1 10s. per cent. on the preferred stock, less income-tax, payable on April 30th, to the shareholders registered on the books of the company on March 31st, 1898.

Stock Exchange Notices.—The Stock Exchange Committee has ordered the undermentioned to be quoted in the Official List:—Milwaukee Electric Railway and Light Company—$603,000 additional 5 per cent. 30-year consolidated mortgage gold coupon bonds of 1926, Nos 7,001 to 7,603.

TRAFFIC RECEIPTS.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending April 1st, 1898, were £2,339 11s. 6d.; corresponding period, 1897, £2,025 7s. 10d.; increase, £314 3s. 8d.

The City and South London Railway Company.—The receipts for the week ending April 3rd, 1898, were £1,050; week ending April 4th, 1897, £1,026; increase, £24; total receipts for half-year, 1898, £14,942; corresponding period, 1897, £14,818; increase, £124.

The Dublin Southern District (Electric) Tramways Company.—The receipts for week ending Friday, April 1st, 1898, were £358 12s. 3d.; corresponding week last year, £367 11s. 1d.; decrease, £8 18s. 5d.; passengers carried, 62,971; corresponding week last year, 60,701; aggregate to date, £5,152 1s. 8d.; aggregate to date last year, £5,514 4s. 9d.; decrease to date, £362 3s. 1d.; mileage open, 8 miles.

The Liverpool Overhead Railway Company.—The receipts for the week ending April 3rd, 1898, amounted to £1,313; corresponding week last year, £1,323; decrease, £10.

The Western and Brazilian Telegraph Company, Limited.—The receipts for the week ending April 1st, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company Limited, were £2,895.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, March 30th.	Closing Quotation, April 5th	Business done during week ended April 5th, 1898. Highest.	Lowest
137,400l	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	...	...	100 104	100 —104	...	...
25,800	Amazon Telegraph, Limited, shares...	10	...	...	...	7 — 8	7 — 8	...	...
125,000	Do. do. 5% Debs. Red.	100	...	...	...	93 — 96	93 — 96	...	...
923,960l	Anglo-American Teleg., Ltd.	Stock	£2 9s.	£2 13s.	3 %	59 — 62	61 — 64	63½	62
3,038,020l	Do. do. 6 % Pref.	Stock	£4 18s.	£5 6s.	6 %	110 - 111	111½ - 112½	113	110⅝
3,038,020l	Do. do. Defd.	Stock	...	...	...	12½ - 13	12¾ — 13½	13 5/16	12⅞
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	...	...	16½ - 17	16½ - 17 xd	16⅜	16 3/16
75,000l	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	...	...	112 —116	112 —116	...	...
44,000	Chili Teleph., Ltd., Nos. 1 to 44,000	5	4 %	4 %	...	3 — 3½	3 — 3½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	...	185 — 190	185 —190 xd	...	...
918,297l	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	104 —106	104 —106 xd	105½	105
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	2 %	...	1/16 — 3/16	1/16 — 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	...	6½ — 7½	6½ — 7½	7	...
6,000	Do. 10 % Pref.	10	10 %	10 %	...	14½ - 15½	14½ — 15½	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 11	10 — 11	...	...
30,000l	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	4½%	103 - 106%	103 —106%	...	...
60,710	Direct United States Cable, Ltd.	20	2½%	2½%	...	10¾ — 11¼	10¾ — 11¼	11⅛	10 13/16
120,000	Direct West India Cable 4½% Reg. Deb	100	...	...	...	99 —102	99 —102	100⅛	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	...	17¾ — 18¼	17¾ - 18¼	18⅜	17¾
70,000	Do. 6 % Cum. Pref.	10	6	6%	...	18½ 19½	18½ — 19½	...	...
89,900l	Do. 5 % Debs., repay. August, 1899	100	5 %	5%	...	100 - 103	100 —103	...	..
1,302,615l	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4%	...	128 —131	128 - 131	130	128
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7%	...	18¾ — 19¼	18¾ - 19¼	18 15/16	18 13/16
25,200l	{ Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	}100	5 %	5%	...	99 — 103	99 - 103	...	...
100,500l	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5%	...	100 —103	100 —103	...	...
320,000l	Do. 4 % Deb. Stock	Stock	4 %	4%	...	128 —131	128 —131	...	...
35,100l	{ Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	}100	5 %	5%	...	99 - 103	99 —103	...	...
46,500l	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5%	...	100 —103	100 —103	...	...
300,000l	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4%	...	102 —105	102 —105	102	...
200,000l	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4%	...	107 —110 %	107 —110%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	...	11¾ — 12¼	11¾ — 12¼	12	11 13/16
180,042	Do. do. 6 % Pref.	10	6 %	6%	...	17½ — 18	17½ — 18	17¾	17 9/16
150,000	Great Northern Teleg. Company of Copenhagen	10	10 %	10%	...	29½ — 30½	29½ — 30½	29¾	...
160,000l	Do. do. do. 5 % Debs.	100	5 %	5%	...	100 —103	100 —103	...	...
97,000	{ Halifax and Bermuda Cable Co., Ltd., 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	95 —100	95 —100	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10%	...	52 — 55	52 — 55	...	...
100,000l	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6%	...	106 —109	106 - 109	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	...	...	2 — 2½	2 — 2½	..	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5½%	5½%	6 %	6 — 6½	5½ — 6	6⅜	5 7/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 18	16 — 18	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5½ - 6	5½ - 6	5 13/16	5½
1,329,471l	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	102 —107	100 —105	104	101
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	⅝ ¾	⅝ ¾	...	...
100,000l	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	...	105 —108	105 —108	...	.
11,889	Reuter's Ltd.	8	5 %	5 %	...	8 — 9	8 — 9	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	140 - 145	140 —145	143	141
58,000	United River Plate Teleph., Ltd.	5	4 %	...	...	4 — 4½	4 — 4½	...	...
146,733l	Do. do. 5 % Debs.	Stock	5 %	...	...	105 - 108	105 —108	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	nil	...	3½ - 4½	3½ - 4½	...	...
213,400l	Do. do. do. 5 % Debs.	100	5 %	5 %	...	99 —102	99 - 102	...	...
64,269	Western and Brazilian Teleg., Ltd.	15	3 %	2 %	...	12 — 12½	12 — 12½	12⅛	...
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	...	7¾ — 8¼	7¾ — 8¼	7⅞	...
33,129	Do. do. do. Def. Ord.	7½	1 %	...	...	4½ — 5	4½ — 5	4⅞	4 11/16
389,521	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	106 —109	106 —109	106½	...
88,321	West India and Panama Teleg., Ltd.	10	⅞%	1 %	...	½ — ¾	½ — ¾	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	7½ — 8	7½ — 8	7⅞	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	5 — 7	5 — 7	...	...
80,000l	Do. do. 5 % Debs. No. 1 to 1,500 ...	100	5 %	5 %	...	105 —108	105 —108	...	...
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7%	...	105 —110	105 —110	...	...
160,100l	Do. do. 6 % Ster. Bonds.	100	6 %	6%	...	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share.	1895.	1896.	1897.	Closing Quotation, March 30th.	Closing Quotation, April 5th	Highest.	Lowest
30,000	Charing Cross and Strand Electy. Supply	5	5 %	6 %	7 %	13½ — 14½	13½ — 14½	...	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	...	...
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	...	10½ — 10¾xd	10½ — 10¾	10⅝	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	4½%	4½%	...	115 —117	115 —117	...	...
50,600	City of London Elec.Lightg. Co., Ltd., Ord. 40,001—90,000	10	5 %	7 %	10 %	25½ — 26½	26 — 27	27½	26½
10,000	{ Do. do. Prov. Certs. Nos. 90,001 to 100,000 £5.	}10	...	...	...	12½ — 13½	19 — 20	...	...
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17½ — 18½	17½ — 18½	...	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	129 —134	129 —134	130	...
30,000	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—30,000	10	nil	nil	nil	14¾ — 15¼	14¾ — 15¼	15½	14⅞
20,000	Do. do. do. 6% Pref., 40,001—60,000 ...	10	6 %	6 %	6 %	15½ — 16	15½ — 16	15⅝	...
17,400	Edmundsons Elec. Corp., Ltd., ord. shares 1—17,400 ...	3	...	...	...	3¼ — 3¾	3¼ — 3¾	...	...
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5	.	...	...	10½ — 11½	10½ — 11½	11	...
10,000	Do. do. 7 % Cum. Pref. ...	5	...	...	...	11½ — 12	11½ — 12½	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	4 %	5 %	6 %	20 — 21	20 — 21 xd	20⅞	20½
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem. ...	10	...	...	3 %	20 — 21	20½ — 21½	20½	...
220,000l	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½%	117 —121	117 — 121	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	2½%	4 %	6 %	19½ — 20½	20 — 21	...	...
31,960	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord.	5	7½%	10½%	14½%	18 — 19	18 — 19	18 15/16	18½
20,000	Do. do. 7 % Pref., 20,001 to 40,000	5	7 %	7 %	7 %	10 — 11	10 — 11	...	...
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	4 %	107 —110	107 —110	107	...
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2½ — 2¾	2½ — 2¾	2 11/16	2⅝
79,900	Westminster Electric Supply Corp., Ord., 101 to 80,000 ...	5	7 %	9 %	12 %	17 — 18	17 — 18	...	...

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation March 30th.	Closing Quotation. April 5th.	Business done during week ended April 5th, 1898. Highest.	Lowest.
30,000	British Electric Traction	10	...	...	...	16 — 16½	16 — 16½	16½	16⅛
90,000	Brush Elect. Enging. Co., Ord., 1 to 90,000...	3		...	...	1⅝ 2	1¾ — 2	1⅝	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	...	...	2¼— 2½	2¼— 2½	2⅜	2¼
125,000*l*	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	...	...	...	110 - 114	110 —114	...	...
50,000	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	102 —105	102 —105	...	...
19,894	Central London Railway, Ord. Shares	10	...	...	...	10½— 11	10¼— 10⅝	10 11/16	10½
129,179	Do. do. do. £6 paid	10	...	...	...	6½— 6⅝	6¼— 6⅝	6⅝	6⅝
59,254	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1½— 2	1½— 2	...	...
67,680	Do. do. Def. do. £5 pd. ...	...	...	...	...	4⅝— 4⅞	4⅝— 4⅞	...	...
630,000*l*	City and South London Railway	Stock	1 3/16 %	1 9/16 %	1⅞ §	66 — 68	67 — 69	69	68⅝
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	...	...	1⅝ - 2¼	1¾ — 2½	...	...
99,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 99,261	5	5 %	5½%	...	2¼ - 2¾	2¼— 2¾	2 11/16	2⅝
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5½%	...	4 — 5	4 — 5	...	...
194,023	Do. do. do. 4% Deb. stock Red. ...	100	...	...	...	103 —105	103 —105	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	5 %	6 %	...	2⅝— 2⅞	2⅝— 2⅞	2¾	2 11/16
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 ...	2	7 %	7 %	...	3⅛— 3⅜	3⅛— 3⅜	...	...
111,100	Do. do. 4% Perpetual 1st Mort. Deb. Stock	Stock	...	...	...	106 —108	106 —108	...	...
91,196	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,989	2	...	...	...	½— ¾	½— ¾	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	...	...	...	⅜— ⅝	⅜— ⅝	...	...
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	10½%	...	...	9 — 11	9 — 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	8 %	10 %	12 %	22 — 23	22 — 23	23	22¾
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½— 19½	18½— 19½	19⅝	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½%	110 —115	110 —115	112	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	21½— 22½	21 — 22	21⅞	21½
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	102 —106	102 —106	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	2⅞%	2⅞%	3¼%	10⅝ — 10¾	10⅝ — 10¾	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15¾— 16¼	15¾ — 16¼	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	15 %	15 %	35 — 38	35 — 38	36¾	35
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...		...	135 —138	135 —138	137	136½

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0°/₀; 1891—7°/₀; 1890—8°/

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

* Birmingham Electric Supply Company, Ordinary £5 (fully paid) 10½.

House-to-House Company, 4½% Debentures of £100, 108—110.

Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 16¾—17¼; 1st Preference Cumulative 6 %, £5 (fully paid), 8¼—8¾. Dividend, 1896, on Ordinary Shares 7 %.

London Electric Supply Corporation, £5 Ordinary, 4—4½.

* T. Parker, Ltd., £10 (fully paid), 14—15.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8—8½. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount 3 per cent. (October 14th, 1897.)

MECHANICAL STOKERS.

The inventor of an American stoker, Mr. Roney, has given a brief history of mechanical stokers in *Cassier's Magazine*, in which, naturally, the hopeful side of stoking by machinery is looked upon. It is over 100 years since machine stoking was first employed, and it appears that in Great Britain the mechanical stoker has seen its largest employment, over 25,000 being stated as at work, chiefly upon the long, narrow grates of internally fired boilers. James Watt patented the first stoker in 1785, which consisted of two sets of horizontal grate bars, worked intermittently by hand levers. It is said to have been a success as a smoke preventor. It is a little amusing to see the Hopcraft Furnace of 1889 seriously described among a host of others, and its complicated construction set down as an evident obstacle to success. There never was any necessity to put forward the question of complicated construction to account for the failure of this furnace. It never was known to be a success anywhere. It never even acted in any way as it was claimed; it was hopelessly impossible from the first, and was condemned by experts from the beginning, and only one of the company's engineers had the pluck to say so, for which —but we will draw a veil; the inner history of this furnace has to be written, but the time is not yet. It forms a unique specimen of the art of company-mongering, an art which drew £180,000 from the eager public for a patent that no practical man would have passed as worth 2½d.

German stokers are rated by the author as merely modified British stokers without their advantages. Novelty in design seems, however, to have been sometimes sought in America. The Murphy is one such. It was the first distinctively American stoker, and was patented in 1879. It is applicable only to under-fired boilers, and consists of a V grate under a brick arch, fed by lateral plungers from coal hopper passages in the side walls about 6 or 7 feet long. The bars of the V grate run parallel with the slopes, which are at an angle of about 35°. At the apex is a revolving toothed bar to grind out clinker. All the sloping bars are hinged at their upper ends, and are moved by cams about an inch at their apex ends. This brings down the fire as it burns away. It is said that this machine has a good record. We can believe it, for, apart from the serious inconvenience of the lateral coal hoppers it seems well designed, but it appears only specially applicable to single boiler installations.

The general trend of American stokers, constructed as they are for use with externally fired boilers, is to the use of steeply inclined grates sloping down from the firing plates, and with the separate bars moving more or less, so as to induce the fuel to move forward and downward. The advantage of these sloping grates, is that the fire need never burn into holes, for the grate movement can be arranged to be quick enough to cause the fuel to gather and fill up the voids as formed.

Mr. Roney is in error when he states that the English Jukes grate was made with bars crosswise to the furnace. We have seen some scores of these furnaces in Yorkshire, and never saw one which had not the link belt grate exactly as illustrated in Mr. Roney's illustration of this furnace, as copied by the Babcock & Wilcox Company, of New York. As in England, underfeeding has been attempted. American underfeed stokers follow closely on the design of Holroyd Smith. As we have before stated, the patent of Mr. Roney himself includes the sloping grate idea, but with transversely placed bars which rock and form a rocking-step grate. There is a dumping grate at the lower end for cleaning purposes.

For externally fired boilers, possessing ample space and height for liberal mechanical arrangements, we cannot see how anything much better than the Roney idea can be evolved. The ability to use gravity gives the power of overcoming that worst fault of other coking stokers, the thinning out of the fires at the back ends of the bars. By gravity and grate shaking the fuel can be travelled down the slope at a speed sufficient to keep the bars covered, the dumping grate serves to clear off clinker, and, generally, the machine looks like a success on paper, and, we believe, is one *de facto*, as, indeed, is borne out by the tendency towards this type. Externally fired boilers are not so common in England, and we are, therefore, confronted in our internally fired boilers with a far more difficult problem mechanically. Our coals are chiefly bituminous, and must be burned on the coking system for perfect smokelessness, and unless there be a bridge against which to travel the fuel on the bars, so as to feed up the hollow places burned in the fire, there is always apt to be an excess of air, and corresponding reduction of efficiency. With Mr. Roney, however, we agree that the stoking of the future will be more and more by mechanical means.

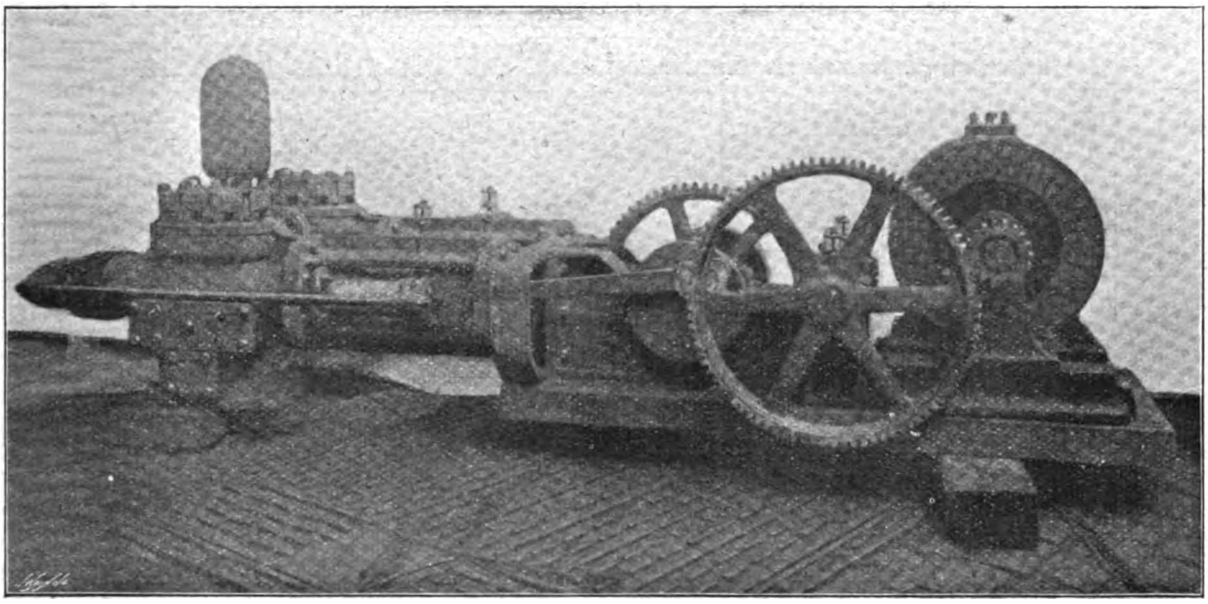


Fig. 5.

THE NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

The Practical Operation of Multiphase Currents. By T. Hawkins, Member. March 14th, 1898.

(*Concluded from page* 457.)

The electromotive force at the generators is 960 volts at 50 cycles, the length of the line being 835 yards. The power is transmitted through bare overhead conductors, supported on porcelain insulators. The station and line are fitted with Wurts's lightning arresters.

Figs. 5 and 5a show one of three horizontal 5 inches by 9 duplex pumps, made for the Consolidated Goldfields of South Africa. Each pump is capable of raising 200 gallons 60 feet per minute, and is coupled to a 9 H.P. three-phase motor through double reduction gearing. The speed of the motor is 1,150 revolutions per minute, with 60 cycles and 110 volts between two phases.

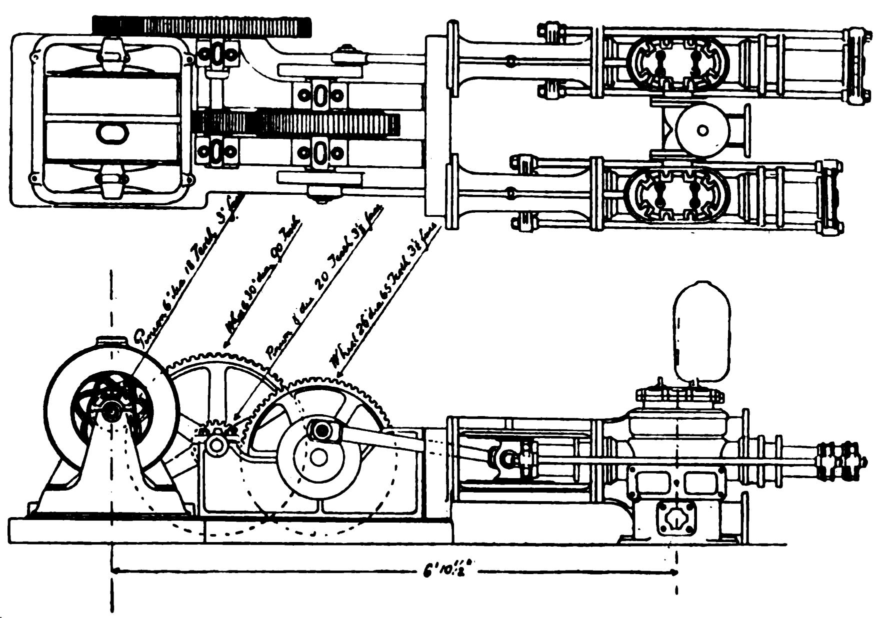


Fig. 5a.

Fig. 6 is a photograph of an electrically driven coal cutter, fitted with two 10-H.P. three-phase motors. The motors are wound for 500 volts, and are switched into circuit without any starting device. Their speed is 960 revolutions per minute, this being reduced to 9 revolutions per minute at the cutter through treble reduction gearing. The diameter of cutter wheel is 5 feet 8 inches.

This machine has been constructed for Messrs. Pope & Pearson, Limited, for use in their colliery at Normanton. The distance between the generators and coal cutters is about a mile.

The plants described in this paper have all been supplied within the last two years, and although, I am sorry to say, it is a very small amount when compared with what is being done in the United States, Germany, or Switzerland, it is some satisfaction to know that a little progress has been made in this country in the manufacture of this class of work.

Even those who do not admit of any or sufficient superiority of the three-phase over the continuous current system to induce them to take up the manufacture of the former for use in England, must acknowledge that many large and valuable orders for our colonies and elsewhere are given to foreign firms, which ought to be executed in this country, but unfortunately so little has been done here that so far we are not in a position to compete.

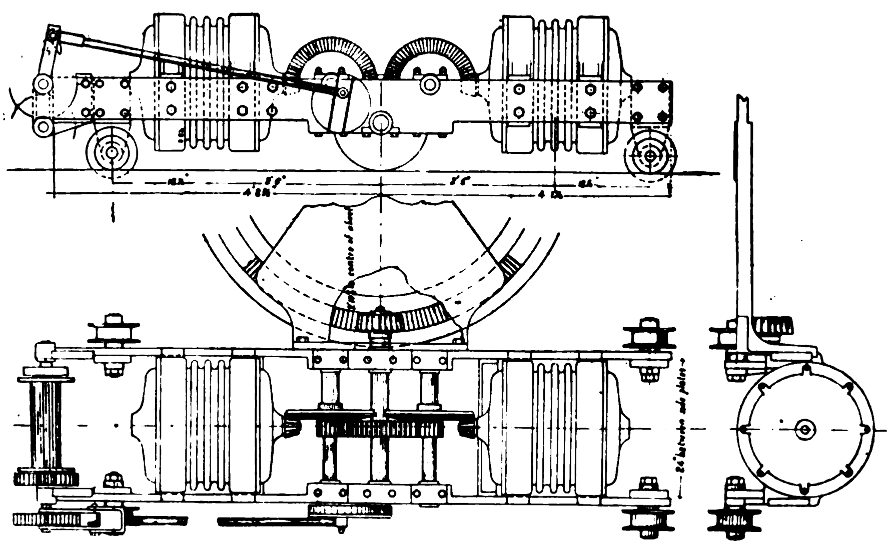
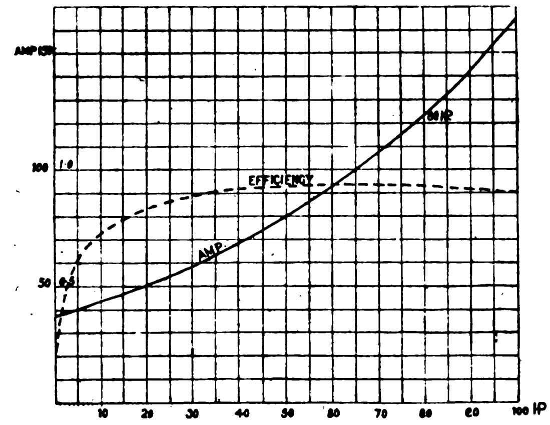


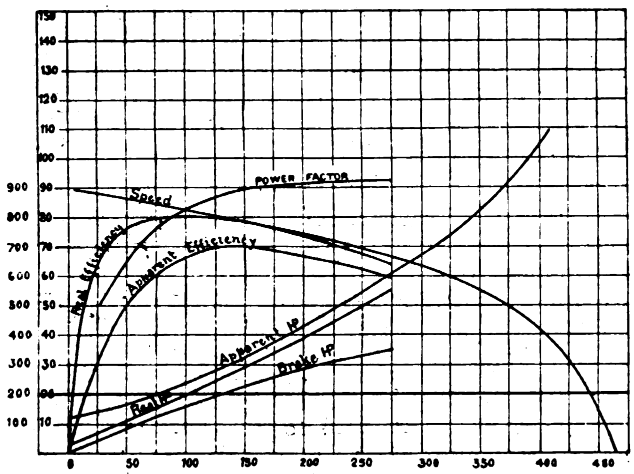
Fig. 6.



Efficiency Curve.

80-H.P. Motor, 220 volts, 123 amperes.

No. 4 Polyphase Crane Motor, two-phase, 7,200 alts. 8-pole, 200 volts.

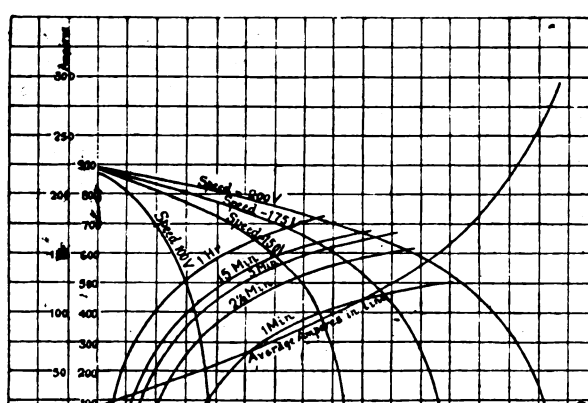


Pounds torque at 1 foot radius.

Rise in temperature for 8 hours' run at 20 H.P. Output, 200 volts; primary, 20° C.; secondary, 20° C.

No. 4 Polyphase Crane Motor, two-phase, 7,200 alts., 8-pole, 200 volts.

Speed, torque, time, and temperature curves.



Lbs. torque at 1 foot radius.

The Northern Society of Electrical Engineers.

SOME RECENT IMPROVEMENTS IN ACCUMULATORS AND THEIR APPLICATION TO TRACTION ON COMMON ROADS.*

By J. T. NIBLETT.

Means of vehicular locomotion by the aid of some power other than that of horses is a subject that is now receiving a vast amount of attention. Not only is it of interest to electrical and mechanical engineers and carriage builders, but it has been taken into serious consideration by all those responsible for the regulation of traffic in our large towns. The subject is of such huge importance, that it not only affects those whose business or pleasure calls for some rapid and safe means of transport from place to place, but it affects the safety and comfort of the ordinary pedestrian as well. Our present system of horse traffic is open to many objections, not only from a humanitarian point of view, but from its sanitarian and economic aspect as well. The streets in our large towns would present a vastly different aspect if, instead of horses, some other means of drawing our vehicles were used.

Much attention has been given to the application of steam, petroleum, and spirits to produce the necessary motive power; but there is but little doubt that electricity will eventually supersede them all, not only on the score of economy, but owing to its freedom from heat, steam, disagreeable odour, and to the ease with which it can be manipulated.

In this communication we do not propose touching upon the numerous applications of electricity for the propulsion of tramway cars and light railways, but we shall devote our attention more especially to the subject of the electrical propulsion of vehicles on common roads by means of batteries. We shall point out some of the recent improvements that have been made in batteries suitable for this purpose, and shall then indicate in a few words how they are best employed, and the most approved methods of dealing with them. An endeavour will be made to deal with the subject in a popular manner, and all technicalities will be avoided as far as possible.

Secondary batteries may be divided into two classes, viz., those in which the active material is formed from the substance of the element itself, either by direct chemical or electro-chemical action, and those in which the chemical formation is accelerated by the application of some easily reducible salt of lead. Elements of the former type are usually termed "Planté," and those of the latter "Faure" or pasted, Messrs. Planté and Faure being the respective inventors.

The active materials in all the best known types of secondary cells, whether of the Planté or Faure pattern, is peroxide of lead in the positive element, and spongy lead in the negative. The medium through which the necessary chemical changes occur during either a charge or discharge is a solution of sulphuric acid and water. There is still much doubt as to the precise nature of the chemical changes involved in a lead sulphuric acid cell, due to the action of an electric current, and therefore this matter will not be discussed here. Enough, however, is known to enable those concerned in their commercial manufacture to construct cells of almost any electrical capacity, and capable of taking up and giving out any rate of charge or discharge. It is now usual to speak of any given type of secondary cell as being of so many ampere-hours capacity per pound of plate, or per pound of complete cell. In the latter case the precise nature of the containing vessel, whether it be of glass, earthenware, metal, or vulcanite, must, of course, be specified.

One of the earliest to introduce into this country a commercial cell of the Planté type was Mr. Epstein, and a cell bearing his name has been long on the market. Mr. Epstein has given much attention to the production of accumulators of this type, and in a recent communication to the Institution of Electrical Engineers he promised to shortly introduce an improved form of his plate, which he stated was particularly suitable for traction purposes. Such a promise, coming from one so well versed in the subject, leads us to expect a real improvement. The original Epstein plate was made by deeply grooving both sides of a lead plate. The plate, when grooved in this way, was boiled in a solution of nitric acid and water, or some similar solution. This process is said to so corrode the metal that it is easily acted upon electrolytically. Owing to the serrated nature of the plate, the active material appears to wedge itself in the narrow grooves, and does not fall out under ordinary working conditions.

The Crompton-Howell cell, which we do not hear much of now, was constructed of plates sawn from a cast mass of porous lead. We believe this material was prepared by a system of aerating the metal while in its molten condition. The resulting plate was of a highly porous and crystalline nature, and, owing to its porosity, the electrolyte easily permeated it, thus rendering the formation quite an easy matter.

A form of cell now on the market, known as the "D.P." accumulator, manufactured by the D.P. Battery Company, is also of the Planté type. The elements in this case consist of a large number of narrow strips of lead built up one above the other. By this method a large active area, enabling the cells to be charged and discharged at high rates, is obtained, while disintegration of the active material or buckling is said not to occur. As in the case of the Epstein cell, the plates are chemically treated to accelerate the formation.

The traction cell made by this company is not designed with a view

* Abstract of paper read before the Self-Propelled Traffic Association, Liverpool Centre, on March 29th.

to extreme lightness, but rather with the idea of combining durability with as little weight as possible. The containing case of this particular form of cell is of ebonite, and it contains three plates—one positive and two negative. The weight of the complete cell is about 33 lbs., and three cells are put in a crate for convenience of handling, the weight of the three thus fitted being about 100 lbs.

The capacity of each cell is 100 ampere-hours, at a normal discharge rate of 15 amperes. They can, however, the makers state, be discharged at any rate within reason that may be desired without damage to them, the only consequence being a loss in capacity as the discharged rate is increased. The makers assert that with this form of cell a current capacity of four ampere-hours per pound of plate, and three ampere-hours per pound of complete cell, is obtained.

The "Lamina" accumulator elements, as manufactured by the Lamina Accumulator Company, are made up of a series of perforated and corrugated lead strips. The method of making these plates is somewhat as follows:—Lead is received in the form of rolls of 8 to 10 inches wide, and of varying thickness of from $\frac{1}{64}$th to $\frac{1}{32}$nd of an inch. The lead is first perforated, and is afterwards corrugated by a suitable machine. After being treated in this way the lead is cut up into strips of the desired size. These strips, when built up, are encased by a sheet of perforated lead, held in position by leaden rivets, and lead-burnt at the top and bottom.

The forming process is said to take only 36 hours. As the mechanical construction of the plates is simple and strong, they are said to withstand quite well the severe work imposed upon them when used for traction purposes. The makers state that a cell of this form of construction can safely be charged or discharged in one hour. The following data of the company's "A 5" traction cell may be of interest. The containing case is of ebonite, and is of the following dimensions:—10½ inches long, 4½ inches wide, and 12 inches deep. The complete weight of the cell, with elements and electrolyte, is given as 40 lbs. The dimensions of the positive plates are as follows:—8½ inches long, 7¾ inches wide, and ⅜ths of an inch thick. The size of the negative plates are:—8½ inches long, 8¼ inches wide, and ⅜ths of an inch thick. The discharging rate of this form of cell is 20 amperes, but it may be run up to 100 amperes. The normal charging rate is 25 amperes, but this can also be run up to 100 amperes.

Faure, or Pasted Cells.

Messrs. Sellon, King, Volkmar, Philippart, Parker, Swan, and others, have each devised methods of holding active material on grids, frames, or plates. These methods, combined with Faure's original discovery, constitute that group of inventions owned by the Electrical Power and Storage Company, and are well known shortly as the E.P.S. patents. In all cases the actual forming is done by the purchasers.

Of late years improvements have been made in the original E.P.S. plates. The King-Faure plate, now much used, has a series of ledges cast upon it on both sides, and these ledges are filled in with the active material. Plates made on this principle are much thicker than those originally made, and are said to give a greater capacity per pound of plate. The accumulators made by the E.P.S. Company, and so extensively used for electric light purposes, are so well known that they scarcely need further description here. We shall, however, have occasion to again refer to this company's traction cells later on.

Since the year 1880, considerably over 1,000 applications for British letters patent have been made for improvements in secondary batteries, chiefly of the Faure pattern, and of these some hundreds have developed into fully published patents. The great majority of the suggested improvements are of a mechanical nature, and refer more especially to:—(1) Methods of accelerating formation; (2) devices for preventing disintegration of the active material; (3) attempts to construct a mechanically solid cell; and (4) means to prevent that great bugbear of all lead accumulators—the warping and buckling of the plates or grids.

It is not within the scope of this communication to investigate all the attempts made to overcome the above-mentioned difficulties, and only a few of those batteries now on the market will be considered. In addition to the improvements noticed here, much has been done in this country by such workers as Sir Edward Frankland, Messrs. Reckenzaun, Drake, Gorham, Barber-Starkey, Pitkin, Bristol, and others. On the Continent, Messrs. Reynier, Tommasi, Gadot, Hagen, Jacquet, Payen, Laurent-Cely, Pollak, and Blot are each credited with improvements; while Messrs. Brush, Eickmeyer, Ernst, Carpenter, Knowles, Hering, Gibson, Currie and Winkler, in America, have modified, with some amount of success, either Planté's or Faure's original inventions.

A form of accumulator which has been received with much favour on the Continent is known as the "Tudor." Of late years this form of cell has been introduced into this country, and is now manufactured by the Tudor Accumulator Company. The elements are not of the grid form, but consist of lead plates deeply grooved, made by being passed between a pair of suitably made rollers. The grooves in the negative plate are narrower than those on the positive. When prepared in this way, the plates are coated by electrolysis with a thin layer of peroxide, and the interstices are then filled in with the usual paste of lead oxide. The reason for treating the plates in this way is to prevent the formation of sulphate of lead at the junction of the metal holder and the active material. After the above treatment the plates are allowed to dry, and are passed through smooth rollers. This last process closes up the grooves, and tends to key the active material in.

According to Prof. Kohlrausch, who made some tests of the original Tudor cell, he found that a capacity of 1·6 ampere-hours per pound of plate was obtained by a cell of the following dimensions:—The weight of the elements was 29·3 lbs., the total active surface of the positive plate was 1·29 square feet, the amount of electrolyte was six pints. Such a cell was stated to have an integral resistance of 0·015 ohm when charged, and 0·02 ohm when discharged. The best charging rate was found to be 5 amperes, and the discharging rate 6·5 amperes. As a mean of six ordinary charges and discharges a current efficiency of over 90 per cent. was said to be obtained. We believe that since the above test, and owing to improvements made, far better results have recently been obtained.

(To be continued.)

AN ELECTRICAL HYPOTHESIS FOR THE SOLAR AND PLANETARY SYSTEMS, AND SOME OF THEIR ASSOCIATED PHENOMENA.

By DELTA.

(Concluded from page 462.)

The Cometary Bodies.

The application of the electrical hypothesis to an explanation of this erratic body* is necessarily highly speculative, but not more so than that of any other hypothesis yet propounded.

It is suggested that the rotation of the solid element of the comet is effected electrically. The rapid movement of the body in a state of erratic movement drags along with it an atmosphere which streams behind like the tail of a kite, or the steam from a locomotive; this straggling atmosphere is illuminated by the passage through it of electric energy of high intensity and frequency.

The Nebulæ.

It is assumed—in the absence of more specific data—that the nebulæ are clusters of small electrical conductors, or stars, enclosed in a common luminous atmosphere.

The same theoretic assumption applies to the spiral nebulæ, the stellar character of whose nuclei is admitted.

The electric solar high pressure energy illuminates the nebular atmosphere, enters the stellar bodies, which are assumed to be spherical polarised electric conductors and transformers, to be admitted to the interstellar and low intensity electrical ocean at low intensity.

It is suggested that the coalescence of the stellar portions of the nebulæ is the result of inter-electrical action acting in the same way that electrified particles of aqueous vapour unite to from clouds.

Shooting Stars.

It is admitted that the luminous streaks, known as shooting stars, travel constantly in the same pathway around the solar centre, their orbits of passage being very similar to those of cometary bodies.

No doubt somewhat analogous to the currents that flow in specific lines in the aqueous oceans of the earth, there will, in the great interplanetary and interstellar electrical ocean, be distinctive electrical currents of voltage, differing specifically from that of the normal, and carrying with them bodies that are outside the influences of attraction of planetary and stellar bodies, but are exposed to the luminous influences of the electrical currents emanating from the sun.

Stars.

The repulsive force of electricity varies inversely as the ratio of molecular weight, the lightest particles being driven from the great solar electrical conductor.

Each star will be, it is suggested, a small conductor, and must either have its own luminous atmosphere, or be so constituted, as to offer a resistance to solar electrical emanations, such as to set up in a portion of its sphere a temperature of bright incandescence; such a form of inferior conductor can be easily imagined, and if thought of in combination with the effect of rotation, it should produce the intermittently luminous character associated with movable stars.

The fixed stars are probably amenable to the same law, and it is likely that this incandescence effect that induces

* It has already been admitted by one astronomer that the luminous emissions from cometary bodies are largely of an electric origin.

disintegration resulting in the formation of aerolites, meteorites.

The fixed stars may have atmospheres of varying chemical character and density, and thus we should have luminous effects of varying colours coincident with the density of the stellar envelope which is illuminated by the resistance offered to the flow of solar electrical energy.

THE INFLUENCE OF STARS IN THE EXTENSION OF HIGH VOLTAGE SOLAR DISCHARGES.

A high pressure electrical discharge can be extended indefinitely—by the introduction of simple conductor spheres, in the line of electrical discharge—and it is here suggested that the myriad upon myriads of stars that photography has disclosed to us may really constitute a means by which high pressure solar electrical currents are distributed over the vast area we know as the stellar and planetary space.

The starry elements we already know have varying degrees of luminosity; the greater number do not actually emit luminous rays of sufficient intensity to be seen by the human eye, although faithfully recorded by the sensitive photographic plate.

A CORRELATIVE THEORY.

Since the date of the publication of the first and second of these articles, the journal *Electricity*, of New York, in its issue of February 16th, publishes a new theory propounded by Dr. William M. Gross, which has a certain resemblance to the theory formulated in these articles.

The Gross theory briefly defined, and in his phraseology, slightly modified, is as follows :—

He believes that electrical force is induced and not static.

Dr. Gross asserts that the earth and its atmosphere go to make up an immense armature, with that portion of space between the earth and the sun as the electro-magnet.

He suggests that the earth in revolving generates a powerful current.

He says the solar rays are vertical on some parts of the earth all the time, and that *the space between the earth and the sun is heavily charged with electricity*.

Currents of this electricity are induced out of space by the revolution of the earth from west to east. In accordance with the law of Lenz, governing electrical currents, they, the electrical currents, pass in opposite direction, that is to say, induced currents of electricity always move in opposite directions to the electro-magnetic force producing the current.

These currents are brought down to, and through the earth by the latter's centrifugal force. This force tends from the centre and towards the east; the electrical currents tend from the east and to the centre of the earth.

When the centre becomes surcharged, the current flows off at about the 70th parallel, producing the north and south winds.

His experiments with ground telephonic wires has satisfied him that the earth is full of electricity. Dr. Gross is making elaborate investigations, more of which we shall doubtless hear anon.

THE INFLUENCE OF ELECTRICAL CONDITIONS UPON ORGANIC BODIES.

The importance of the investigation into the electrical characteristics of organic bodies has already been emphasised, and W. Branly's recent contribution in December, 1897, to the Academie Française, is most opportune, and establishes a striking analogy between the effect of continuous electrical currents upon the nervous system, and upon the coherer; Branly, although not prepared to say that the coherer and the nervous actions are altogether similar, nevertheless considers that the resemblance is sufficient to form a valuable guide to the electrotherapeutist.*

The author suggests that there is some analogy between the cause and effect of Hertzian rays and the strong impulses that are occasionally transmitted between human subjects, in strong sympathy with each other, but separated by many miles.

* It is only fair to W. S. Hedley, M.D., to say that he suggested in the *Lancet* a similar physiological analogue as far back as May 4th, 1895.

The influence on organic plant life is not at all realised in the measure of its importance.*

In concluding these articles the author asks for the unprejudiced consideration of the hypothesis he has so imperfectly formulated.

We are, even now, a century of years past the time when Volta first initiated his researches into the electrical condition of the atmosphere, but little in advance of his knowledge, either in the exact knowledge of the electrical characteristics of the atmosphere or of the earth itself.

The exact knowledge of the character and proper appreciation of the all powerful influence of high voltage rays that stream from the solar fountain of electrical energy (which is the master influence in developing and maintaining organic vegetable and animal life) may permit some of us to find means of control and diversion of such energy for the benefit of man, and especially in the removal of nervous stress. The tendency of modern *fin de siècle* civilisation is more and more in the direction of the suppression of the animal in favour of the mental energy. In the train of this tendency, and constituting one of the baneful effects of modern life, is the increase of diseases of an almost entirely nervous character; and the individual, who is compelled to follow in the mad rush, is becoming more and more susceptible to the varying conditions of his electrical environment, and, therefore, the demand for more light, is not merely the product of a desire for scientific research, but it is based upon motives having a far more serious *raison d'être*.

Given this enlightenment, then the necessity to grope in the gloom of uncertain knowledge, prompting hypotheses of more or less speculative character, however logical they may be, will disappear.

If the author has not sufficiently curbed his imagination in building up the electrical theory applied to a field of immeasurable dimensions, and one that must necessarily be of a more or less highly speculative character, he trusts that the contribution may lead at least to a proper recognition of the importance of correlating the day by day changes in the electrical condition, and the other physical changes of the atmosphere with that of the substrata of the earth, and in geographically well-distributed centres.

If ardent investigators would devote their serious attention to the exploration of this comparatively unknown field of scientific research, they would confer inestimable advantages on their fellow men.

Compared to this field of research, the importance of the exploration of Arctic and unknown territorial regions becomes puerile. There is no reason why practical science should not be able to provide means for testing the electrical condition of both the atmosphere and the earth at a distance of even five miles below or inside, and 10 miles above or outside the surface of the earth.

The competent and adequate exploration of the electrical mystery land offers far more prizes than can be easily imagined, and the fruit of such research may not only eventually command the ready and artificial discharge of clouds and the fall of rain, but it may permit the establishment of conditions that may prevent the influence of effects injurious to human life and happiness.

A society formed from the ranks of physicists, electricians, chemists, and from the medical fraternity, along with experts in astronomy and meteorology, would find ample scope for work in the field of research outlined. That this society will be formed, is the ardent hope of "Delta," and he trusts is also that of your readers.

* "I have been applying now for nearly a year electrical radiation for the purpose of improving our native wheats. I pass them through the terminals of a Tesla apparatus and find that the instantaneous exposure has a marked effect upon the germination and upon certain important functional features of the grain. There is a violet radiation round the wires, but *nothing visible* when the *grain passes* them. The defects which this treatment go farthest towards remedying exist in Scotch wheat and do not exist to the same extent in wheat which are grown *with more sunshine*, and it is an interesting question whether these differences are caused, not so much by the variations in the amount of sunshine as by the variations in the *quantity of violet rays reaching the growing wheat*. However that may be, I think it points in the direction indicated by your paper, that the electrical radiations from the sun play a most important part in the vegetable world."

Letter bearing date March 3rd, 1898, received by the author.

THE TELEGRAPH TROUBLES.

THE CLERKS' POINT OF VIEW.

BY CHAS. H. GARLAND.

(*Concluded from page* 386.)

DURING the progress of these papers it has been sought, by the free use of quotations, to show how far the ideals of State employment, as formulated by politicians, economists, and even barristers, of all shades of political bias, differed from the actual conditions which exist to-day. Whilst the whole country seems to be fast progressing towards a more real democracy, whilst the pressure of public opinion is forcing Ministers to proclaim themselves in favour of the most advanced and generous principles of State employment, the permanent Civil Service of the Crown remains the stronghold of a labour policy that, viewed in the light of present-day economics, is absolutely reactionary. The rights enjoyed by ordinary citizens are, in many instances, taken away from State servants, and this deprivation is thought to be justified by reference to certain illusory benefits, which, in many instances, exist only on paper. Thus the statement of Mr. Arnold Morley as to the "right to combine" among postal servants may be regarded as a sop to the Cerberus of public opinion. Any postal servant knows that the picture there painted of the privileges enjoyed by the various unions bears not the slightest resemblance to the actual state of affairs. What did Mr. Morley say? In a letter addressed to Mr. Murray Macdonald, M.P., on April 1st (an ominous date), 1895, the following words occur: "The officers of this Department are at liberty to combine in any way they may think proper. All the privileges which trade unions enjoy, and, in my opinion, rightly enjoy, are thus accorded to the unions of postal officials." The uninitiate would gather from this that the most complete liberty of combination, as at present understood, was enjoyed by Post Office servants. Yet this is far from being the case. The publicly-proclaimed rights are cut down to mere nothingness by restrictive regulations, which are defended on the ground of discipline—a defence which would not protect a private employer from censure. During the recent debate in the House of Commons on this subject, the point at issue was obscured by references to dismissed officials, and the real principle was lost sight of in a profitless discussion of a disciplinary measure of Sir James Fergusson. Although the principle of the right of combination may be said to be involved in the defence of this measure, such is the nature of Parliamentary debates, that the House generally "cannot see the wood for the trees." The truth is, that although unions are perforce tolerated in the Post Office, they are not officially recognised by the Department.

The officials of the various organisations are not recognised as such by the Department, their communications are not recognised as representative of their membership unless backed by the signatures of their members, their representations are only received at all on condition that they themselves are suffering from the grievances complained of, and they are never consulted by the Department when changes are contemplated or disputes are to be settled. Again, the union officials are regarded as rebels, and it only requires a brief survey of the recent agitation history to show that danger, difficulties and disfavour accompany the tenure of office in the unions of postal officials. Men have even been discharged for the ventilation of grievances which have afterwards been remedied, and the complaint thus justified. These things are hard to believe, but are nevertheless true, Mr. Morley notwithstanding. Official returns have been issued recently, tending to show that the Department has improved the condition of its employés, and that the ratio of the wages bill to the receipts has increased. It has not been contended that these improvements were not necessary. In many cases, as I have pointed out, they are illusory; but they have never, in one single instance, been initiated by the Department. They have all been won by the men themselves in the teeth of opposition, indifference, discouragement, and personal danger.

Instances innumerable could be adduced in support of these assertions. It is difficult to say where the blame lies, unless one attributes it to so impersonal an entity as the system. This administrative system, "iron-bound with red tape," forms an impregnable rock against which successive Postmasters-General beat themselves in vain; but it is high time that heroic measures were taken to change it. There is a tendency for the State to take charge of much more of the business of the country than at present, and if as each great industry is successively taken under its wing, the workers are to be deprived of the benefit of the common laws by restrictive regulations, we shall soon find ourselves sliding down a steep gradient towards a bureaucratic tyranny which is terrible to contemplate. In France the climax of this condition of affairs is fast approaching. By the same specious reasoning the State justifies the denial to its servants of the rights of combination assured to all other workers by the law of March 21st, 1884, and as the various industries of tobacco preparation, match-making, railways, education, telegraphs, telephones, letter-carrying, and the multifarious duties undertaken by the French Post Office come into the hands of the State, the employés are deprived of this important part of their civil rights. *L'Eclair* of August 29th, 1896, commenting on the matter, makes some remarks which have a peculiar appropriateness to the present position in England. "Why are State servants thus denied the common rights?" it asks. "Because they are civil servants, which amounts to saying that instead of being paid by some sort of commercial employer, a simple citizen like themselves, they are paid by His August Majesty the State. And the State doesn't like to be disturbed in the peaceful possession of its omnipotence. . . . . A fine reason, certainly! But this situation from which the State wishes to protect itself is the common right. Railway servants and miners are combined, and do you think the companies are too well pleased with the spirit that these innovations delelop in their staffs? Haven't they often complained? Wouldn't they like to get rid of the unions? But they have to put up with them because it's the law. When the law was made it was well known that its effect would be to lighten the serfdom of the wage-earner, to diminish the power of the master, that in protecting the one it exposed the other, and that these effects would be accompanied by others; the shifting of power, the weakening of authority. But the law was passed nevertheless, because it contained a principle of social justice before which all considerations of a contingent order must bow. Why should the State, then, seek to protect itself from obligations which its own judges impose upon all other persons? It sets a bad example by trying to disembarrass itself of a law when it does not suit it."

These words apply with equal force to the condition of English State employés. The State must either set itself the task of initiating reforms and keeping its employés abreast of the changing conditions of life, or it must give to those employés the full right of combination to enable them to fulfil this necessary and useful function themselves. At present, it does not do the first of these two things, and places difficulties and dangers in the way of the second; and the reason that a greater outcry has not resulted is, that only among the lower grades of postal employés, who are so meagrely paid as to feel the pinch of the changes around them, whose salaries leave no margin for adjustment, and who are brought directly into contact with the labour needs and problems of the day, have unions grown up and the restrictive regulations been enforced. But the sphere of those affected is growing, the public conscience is slowly awaking, and ere long the model employer, it is to be hoped, will be a useful, if tardy, model in this respect also.

Any summary, however brief, of the telegraph clerks' case, would lack an essential to completeness, did it not contain some references to the vexed question of overtime. Probably no portion of the trouble has been more subject to misrepresentation than this. When telegraph clerks have complained about compulsory overtime, it has been assumed that they took exception to the performance of any extra work that the exigencies of the service under abnormal conditions demanded. This is far from being the case. Telegraph clerks, despite the discouragements to zeal, are as much interested in the efficiency of their service, are animated by as much public spirit as many more generously paid bodies. They have never objected to giving extra attendance under extraordinary conditions; what they take exception to is quite another matter. They object to the chronic overtime exacted from them by the ordinary constant pressure, which they contend should be met by an increase of staff, and bring to them the concomitant benefits of promotion which are incident on service development. And when this continual overtime to meet ordinary and calculable pressure is made compulsory, and failure to readily undertake it is attributed to lack of zeal for the service, what wonder if not only their rights appear to them to be invaded, but their pride is wounded. A recently issued official statement of the London clerks puts the complaint forcibly and briefly. "It must be remembered," it says, "that the hours of duty vary throughout the whole of the day and night, so that any increase adds considerably to the discomforts of a telegraphist's life. The papers given to a clerk upon entry into the service state nothing regarding extra attendance, excepting occasional Sunday duty. The present Postmaster-General issued a circular stating overtime to be compulsory, and threatened the staff with severe punishment should any refusal take place. Sir A. Rollit, at the conference with Mr. Hanbury and the Duke of Norfolk, declared the Post Office had no legal right to enforce the demand, but the State could compel obedience under pain of dismissal. The subject is one that eminently calls for settlement, otherwise the eight hours' duty is extended indefinitely, and telegraphists are in the position of having no privileges and no rights. No difficulty has ever been experienced by the Department in obtaining volunteers for the ordinary fluctuations incident to the telegraph service, but, owing to the persistent undermanning of the staff, overtime is chronic throughout the summer months. The secretary of the Post Office indicated before the Tweedmouth Committee his willingness to sacrifice efficiency for economy, and it being cheaper to compel the present clerks to perform overtime during the busy season than to increase the staff, the Postmaster-General's recent decision is regarded as bearing in the same direction."

We have now traversed the principal points in dispute between the telegraph clerks and the postal administration, and although the whole matter is far from exhausted, enough has been related to show the roots of the difficulties and bring out the necessity for a change of policy in treating the discontent existing in the minor establishment. The policy of forcible repression has failed as utterly as it deserved to fail, and discontent is greater and more articulate than before that policy was initiated. Such a policy is deeply ingrained in the fibre of permanent officialdom, is consistent with its traditions, and will doubtless exhaust the energies of many well-intentioned Postmasters-General ere it is finally eradicated. A recent letter from the Secretary of the Post Office is a glaring example of the uncompromising and unconciliatory attitude assumed.

Throughout the sittings of the Tweedmouth Committee, as, indeed, always, telegraph clerks had been reminded of the many advantages they enjoy over and above those vouchsafed to the ordinary human worker, and not least among these trumpeted advantages was the permanence of their employment. They worked for an employer who never died, who never failed, and was, in many other ways, a model. They had heard it so often that, against their reason, they had begun to believe it. It may be that the soreness caused by the failure to get sympathetic, or even just consideration, of their grievances, had, to some extent, been healed by contemplation of these advantages. But while the wound was still smarting the balm was rudely torn away. In a letter to a correspondent, dated August 31st, 1897, Sir S. Walpole said:—"Telegraphists are not employed in the service of the Post Office under any kind of contract. The Civil Service certificate, which they obtain as a necessary condition of their employment, contains no contract, and gives no right to the holder; it merely certifies that he is qualified for a particular situation, such as that of telegraphist. The position is, therefore, simply this:—The telegraphist is employed during the pleasure of the Postmaster-General, and if he does not do what is required of him the pleasure may cease, and with it the employment."

Of course, we all know that the Postmaster-General, as steward of Her Majesty, exercises the right of dismissal at pleasure, that no formal signed contract is entered into by the Post Office to provide or maintain employment for a telegraphist. But we also know that the power theoretically possessed cannot be arbitrarily exercised in the way more than hinted at in the passage quoted, and that there is an implied contract which is not, and cannot be, altogether disregarded. It is impossible to dissociate telegraphists from the rest of the Civil Service in this matter of fixity of tenure. So the deliverance did not cause a panic of terror. It has been introduced here merely as an illustration of the useless irritation and possible exasperation likely to be caused by the unsympathetic policy of the Department.

The time has arrived when the Postal Department should depart from the time-worn traditions of an effete economic era, and approach the question of the discontent of its employés in the spirit of the best employers of the day, to whom it professes the *rôle* of model. The spirit should be a conciliatory one, and the end not the useless endeavour to stifle discontent, but a sincere desire to do justice, and remove the causes of disaffection. If telegraph clerks are listened to in this spirit, their demands will be found not to be exorbitant, nor will their attitude be found unreasonable, and the way will be short to the realisation of a contented, willing, efficient service.

THE USE OF ELECTRIC MOTORS IN PAPER MAKING.

It is extremely interesting to notice that nearly every special industry presents to the electrical engineer a series of problems new to him, and peculiar to itself. For this reason, possibly, it comes about that electrical engineers are continually engaged in what is real research work of a very high order. The application of electrical power to industries hitherto depending upon steam, is not merely a simple change from one system to another, but involves the most ingenious adaptations. Electric power has to stand upon its own merits, and be accepted or rejected according as it is or is not well fitted for the purpose in view.

Speaking broadly, the fewer intermediaries between the point at which power is generated and that at which it is utilised, the better for economy so far as power is concerned. And, therefore, if an electric motor is thrust between the prime mover and its work, it must show good cause for its presence. The energy necessarily lost in it must be compensated by a greater saving of energy somewhere else, or by some economy in time or labour sufficient to be worth the while.

Whenever electric motors have proved important adjuncts in any manufacturing process, it has usually been for one or more of the three following reasons, each of them definite and sufficient:—First, they may have enabled a cheap prime mover to be substituted for a costly one. Second, they may have materially reduced the energy lost between the prime mover and the point at which its power must be applied. Third, through their characteristic facility of application they may have been able to replace manual labour at some point in the process of manufacture. Beyond this, electricity may have an intrinsic value as the source of new processes, but electric power, as such, takes in these no part.

In the paper making industry, manufacturers have been, on the whole, somewhat slow to adopt electrical power instead of steam, doubtless feeling a little nervous as to the result, being only too well aware of the disturbance which so radical a change would make in their capital, yet a little reflection will show that paper making is one of the most suitable industries in which this motive power should be employed. This industry is invariably situated within free access to water power, and though until comparatively recently one would have hesitated to advise driving from water power either directly or indirectly, any machinery requiring uniform speed at varying load. It is possible to use water wheel governors which are able to help the speed with an exactness quite comparable to the governing of a good engine.

At a meeting of the American Paper Pulp Association, held in New York on February 17th last, Dr Louis Bell made a strong plea for electricity in paper making, and gave some extremely interesting and cogent arguments drawn from his knowledge of particular cases in order to show that if electric motors were introduced, they would be attended not only with great convenience, but would effect a very tempting reduction in the cost of working a factory. Of course, cheap motive power from water-falls is an essential; this once gained, the electric power can generally be developed at a lower cost than the local cost of steam power. A great point in favour of using electric motors in paper making is the fact that power is often used continuously throughout the whole 24 hours, and this is a condition which is very favourable for electric working. Dr. Bell realises that each case has to be considered upon its merit, but he says that the few instances in which transmitted power is actually at use in paper mills, all the reports received seemed to indicate the success that was to be anticipated.

At the same meeting at New York a very interesting description of an electrical plant, yielding good results, was given by Mr. Charles F. Scott. We think the following extract from this paper may prove suggestive to those of our readers who may be in touch with paper manufacturers.

The factory is a large one, and is located at Cumberland Mills, about 4 miles from Portland, M.E. Some 5 miles below the mill on the Presumpscot River is a water-power, having some 10 feet fall with about 1,500 available horse-power. At this point machinery is placed for the transmission of power back to the mill.

At the station are two 300-H.P. two-phase Westinghouse generators, each driven by two 48-inch Victor vertical wheels. The generators are operated in multiple and supply a current at 1,100 volts to four 200-H.P. step-up transformers, which deliver the current at 8,000 volts to a three-phase line of bare copper wire by which the power is carried 4 miles to the mill, where the pressure is reduced by four 133-H.P. step-down transformers to 400 volts for supplying two-phase motors, and an additional transformer of the same size supplies current for lighting. There are seven two-phase Westinghouse induction motors; four 50-H.P. motors and a 75 H.P. motor are used to drive pumps and other machinery, and each of two 100-H.P. motors is direct coupled to a 100 H.P. direct current generator which furnishes current at 110 volts for electrolytic purposes. (Rotaries could now be used for this work, but were not available when the plant was installed.)

This plant drives machinery in the pulp mill and is also used for an electrolytic process, and arrangements have been made so that the entire mill lighting can be taken from this system if desired, but ordinarily this lighting work is done by a separate plant.

In addition to the transmission plant just described, there is also a direct current transmission of about 250 horse-power from Mather generators, at 500 volts, from a station aobut a mile up the stream from the mill. This plant was installed prior to the polyphase plant, and drives various machinery in the sorting house, and has been used for operating the calenders. All the motors in both systems are belted to short lines of shafting or directly to their work. The standard speeds of belted motors has been found satisfactory. In certain parts of the mill the motors are necessarily exposed to chlorine gas, so that the least possible exposure of brass work or other metal subject to corrosion by these fumes is desirable. The polyphase motors installed about two years ago have not suffered interruption or damage from this source, and seem to be entirely satisfactory for the work. It is a serious question whether direct current motors with their exposed commutators, brush-holders, &c., would stand this service satisfactorily. In some parts of the mill there is considerable dampness, but this has not been so excessive as to require waterproof or inclosed motors. The pulp pumps are sometimes jammed and absolutely stopped by pieces of wood which get into the pump cylinders. This necessarily stops the motor, and the characteristics of the alternating current motors are extremely valuable, as this sudden stoppage does no harm whatever. A direct current motor if placed in circuit and treated in the same way will be seriously injured, if not burnt out, by the very heavy current and the violent sparking which would occur.

Tests at this plant show an efficacy of 75 to 77 per cent., that, is for every 100 horse-power mechanical output of the turbines the motors deliver 76 or 77 horse-power to the machinery at the mill. The tests of the power consumed in the pulp mill, before its operation by steam was abandoned, and again after the electrical plant had been installed, show a marked and very gratifying saving in the amount of power used, resulting from the more direct application of the power to the machinery and the elimination of the dead load of long shafting bevelled gears and belts.

It has been found advantageous to divide the motors used into many small units, thereby securing independent control of the different classes of work as well as saving considerable power which would otherwise be lost in long shafting, cross belts, bevelled gears, &c. Induction motors appear to be better adapted for the work than synchronous motors, although the infrequent stoppage of such parts of the work as the electrolytic process, for example, would make the use of the latter permissible.

SCIENCE ABSTRACTS.

To ascertain what work has been done, and what papers have been published on any particular subject, has hitherto been, and is still, a matter of considerable difficulty and labour to investigators and inventors, and especially so to a scientific man who absolutely requires a knowledge of the previous work in preparation for his attack on some problem. The difficulty, moreover, is rapidly increasing with the number of investigators and authors. Papers are continually published discussing problems and modes of operation which are well known, and have been worked out many years before. Undoubtedly men will always be found ready to rush into print with accounts of their work, without examining closely whether it is new and interesting to other people. In some cases this may be due to vanity, in others to a desire for advertisement; some do not realise that a subject of absorbing interest to the author may be old and trite to others; but in an immense number of cases the cause is undoubtedly ignorance of work previously done. Councils of scientific societies, and editors of scientific periodicals, have continually to accept or reject contributions submitted to them, and often prefer printing matter, not strikingly original, to discouraging a new investigator. But all these papers, whether the work of students or skilled experimenters, crude speculations or exact calculations, have to be taken into account by subsequent writers. If it were possible to refer readily to an index for the published literature of any subject, many of these papers would never be published; or, if published, only in confirmation or criticism of previous writers. Some writers might then prefer the construction of analyses or reports of the previous work in their subjects, to attempts, sometimes ill-directed, at individual advance. So a reference to such an index might enable a teacher or editor to assist a writer to criticise his own work without discouragement. The economy effected in the time of advanced and original investigators in discovering and looking up previous work, and of the authors of monographs and text-books, would be invaluable to them.

The best method of dealing with the matter is not easy to decide; but a great number of experiments have been made, and some conclusions reached. The Royal Society publishes a catalogue of scientific papers, similar in general arrangement to the author's catalogue of a library. Each volume of this well-known work is a complete index of all scientific papers published during a certain period. It is edited with scrupulous care and exactness, and published in a style corresponding with the dignity of its source. But it has all the defects of its quality. It is always of necessity some years in arrear; its alphabetical arrangement makes it impossible to publish any part of the period before the rest, and there is no subject classification. In past years its pecuniary circumstances have caused great delay in the production of the several volumes, even after the close of their respective periods; but this point has been, and is being, greatly improved. But even if it could be kept up to date, the Royal Society's catalogue would not altogether meet people's requirements. While an author's index, or still better, a subject index, enables a writer to consult readily all the works bearing on his subject, a set of systematic abstracts saves the trouble of consulting many of them at all, by indicating their scope and mode of treatment. As an instance, the writer having occasion to look up some particular point, obtained from indexes and catalogues a list of about 40 papers whose titles indicated that they might bear on his subject. Of all these, only two dealt with the point at issue.

Abstracts might have saved consulting the other 38. It is, moreover, important that the references should be available very soon after publication of the paper. Where many men are at work simultaneously on the same subject, as is now the case with cathode rays, the Zeeman effect, and electro-magnetic oscillations, the abstracts of newly published work should be in the subscriber's hands immediately after publication.

These conditions, however, are not easily met. Promptness in abstraction and publication involves risk of misrepresentation, and it is impossible to read some of the abstracts of papers published without perceiving that the abstractors have their idiosyncracies. It certainly appears that abstracts should at first be provisional, and afterwards be submitted to revision by the original authors, if the collection is to be a permanent work of reference. The impersonal and colourless statements of the Royal Society's catalogue free its editors from the sort of anxiety which we think an editor of abstracts must occasionally share with him of a newspaper.

For a long time past the journals of several societies have regularly contained abstracts of papers bearing on their own branches. The Institution of Civil Engineers have edited theirs with great care and completeness, and the Electrical Engineers have followed them closely. Since January, 1895, the Physical Society has done the work for physics and the allied branches of chemistry, and we believe the latter society has strained its resources, both of men and money, in carrying out their admirable and useful plan. The technical press has done its share, we ourselves having regularly read a large number of papers, choosing for abstraction those that seem to offer most general interest.

In all this disorganised work, however, power is wasted, many papers being dealt with by several persons, while others are overlooked altogether, and we note with great pleasure the appearance of a regular publication devoted entirely to this kind of work, and organised apparently with care and completeness. The Institution of Electrical Engineers and the Physical Society have joined their resources to publish *Science Abstracts* under the editorship of Mr. James Swinburne and Mr. W. R. Cooper, and give brief but fairly complete *précis* of all the important articles on physics and electrical engineering appearing in a long list of 53 periodical publications, which, we are informed, is being enlarged daily. This list does not at present bear on its face its principles of construction. We find *Comptes Rendus* but not *Philosophical Transactions*, the *Journal of the Society of Arts*, but not of the corresponding French body, la Société d'Encouragement pour l'Industrie Nationale; but omissions are to be expected at this stage. The first number appeared in January, and the second in February of this year; and the two numbers contain notices of 230 papers and articles. The second number has been sent to us with an invitation to criticism, but for this we have no desire. We only wish to express our cordial goodwill for the new child as well as for its parents and its nurses, and we hope it may have a long and vigorous life. Its degree of success must depend on the number of subscribers it secures, since without outside support it must be a considerable tax on the resources of the parent societies. We venture to express a hope that many of our readers, who do not receive copies as being members of one of the two societies, may think fit to subscribe to it. It is not unlikely, we think, that the establishment of a University for London may ultimately greatly assist ventures of this sort by the informal, though very real, connection they acquire with a large organisation, and a united body of scientific men. With success might come a further development that would be of great value. The publication from time to time of monographs summarising the progress along different paths, somewhat on the lines of encyclopædic articles, or British Association Committee reports, would be of great value; and *Science Abstracts* may not only find the bricks, but actively assist to build the Temple of Science.

Lighting Licensed Buildings.—At the meeting of the Middlesex County Council on Thursday last week, it was resolved that in future all buildings licensed by the Council for stage plays, or music and dancing, and where lighted by electricity, should have an auxiliary system of lighting.

NEW PATENTS.—1898.

[*Compiled expressly for this journal by* W. P. THOMPSON & Co., *Electrical Patent Agents,* 322, *High Holborn, London, W.C., to whom all inquiries should be addressed.*]

6,773. "Improvements in and relating to street lanterns for the reception of incandescent electric lamps." J. E. STEWART. Dated March 21st.

6,831. "Improvements in electric miners' lamps." W. O. WOOD. Dated March 21st. (*Complete.*)

6,834. "Improvements in safety devices for use in connection with high tension electric conductors." C. H. WORDINGHAM. Dated March 21st.

6,865. "Improvements in electric conductors and in appliances for making connections with same." J. D. F. ANDREWS. Dated March 21st.

6,902. "Improved details of electric tramways and railways." W. ALDRED and G. CARR. Dated March 22nd.

6,903. "Improvements in electric plug connectors." A. E. TANNER and G. W. LOWCOCK. Dated March 22nd.

6,954. "Improved holders for electric lamps." J. C. VAUGHAN. Dated March 22nd.

6,989. "Improvements in electrical measuring instruments." E. WESTON. Dated March 22nd. (*Complete.*)

6,990. "Improvements in electrical measuring instruments." E. WESTON. Dated March 22nd. (*Complete.*)

6,991. "Improvements in electrical measuring instruments." E. WESTON. Dated March 22nd. (*Complete.*)

6,992. "Improvements in electrometers." E. WESTON. Dated March 22nd. (*Complete.*)

7,061. "Improvements in telephone transmitters." G. F. PAYNE. Dated March 22nd. (*Complete.*)

7,027. "Improvements in dynamo-electric generators and motors." S. G. BROWN. Dated March 23rd.

7,057. "Improvements relating to plug switches and plug connections for the control and distribution of electric currents." H. F. PROCTOR and J. R. BLAIKIE. Dated March 23rd.

7,058. "An improved method of preventing the corrosion of electric battery connections." W. R. UNDERHILL and P. W. NORTHEY. Dated March 23rd.

7,129. "An improved means for generating electrical energy." T. HOLMES, A. HOLMES, and G. S. HOLMES. Dated March 24th.

7,150. "An electric locomotive." H. L. TODD and E. HARKER. Dated March 24th.

7,164. "Improvement in apparatus for electric signalling and adjuncts thereto." F. B. HERZOG. Dated March 24th.

7,170. "Improvements in, or in the construction of, electrical storage batteries." F. F. YEATMAN and W. DONOVAN. Dated March 24th.

7,199. "Improved wall socket and plug for electrical fittings." L. G. TATE. Dated March 24th.

7,236. "An apparatus, or improved manner of means, for determining or ascertaining the velocity of air currents in coal mines and other situations by novel electrical and other means." J. THOMPSON. Dated March 25th.

7,283. "Improvements in miners' lamps and apparatus for electrically lighting the same." S. HARRISON. Dated March 25th.

7,296. "Differential electric transformation apparatus." H. H. LEIGH. (Paul Lemaire, France.) Dated March 25th.

7,305. "Improvements in, and relating to, electrical accumulators." J. TABRAR and W. WALLER. Dated March 25th.

7,306. "Improvements in electrical bull's eye lanterns." J. TABRAR and W. WALLER. Dated March 25th.

7,310. "A divided cylinder dynamo." W. DOHERTY. Dated March 26th.

7,333. "Improvements in the construction of plates for electrical accumulators or storage batteries." E. MERIAN. Dated March 26th.

7,367. "Improvements in, or relating to, electric indicators or annunciators." A. J. BOULT. (The Antwerp Telephone and Electrical Works, Belgium.) Dated March 26th. (*Complete.*)

7,384. "System of lever drawbridges with overhead conductors for electric railways." A. CLEMENTS. (Union Electricitats Gesellschaft, Germany.) Dated March 26th. (*Complete.*)

CORRECTION.

6,633. For "an electrical charge conductor" on p. 464, April 1st, read "electrical charge *indicator*."

THE

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CONTENTS:

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DEGREES IN ENGINEERING.

NEXT Tuesday is set down for the second reading of the London University Commission Bill. This is a matter to be looked to most earnestly by all who desire the welfare and progress of engineering education in London. Young men who are studying the scientific part of engineering in London, are, and have for many years been, at a serious disadvantage as compared with their fellows who may be studying in other centres of the British Islands, since by the antiquated red-tapism that has dominated the Burlington House establishment, they are cut off from the chance of taking a degree in engineering. Young engineers studying in Glasgow, Manchester, Liverpool, Belfast, Cork, Dublin, Leeds, Dundee, or even in Cambridge, find a University degree open to them as the culminating point of their theoretical studies. The student who goes to University College, London, to work in the Engineering Laboratory created by Prof. Kennedy, or to the Central College of the City Guilds' Institute, to say nothing of the engineering courses at King's College, or at any of the newer Technical Institutes, finds no such chance open to him. The institution some 10 years ago of the Engineering Tripos at Cambridge has in reality been a severe blow to the London schools of engineering, cut off as they are from all organic connection with the doctrinaire examining board which possesses the title of University of London.

The Senate of the University seems to think the holding of a schoolboy matriculation in Jamaica of more importance than the creation of an engineering tripos for London students in London. It is, in fact, a London University only in name, being, like the Civil Service Commission, only an examining body, debarred by its very charter from teaching, or from appointing professors, or organising laboratory instruction, and may not spend on this object one sixpence out of the thousands of pounds it receives as fees from candidates. *It simply pays those fees into the Treasury to relieve general taxation!*

Of its many defects, a most withering indictment was recently framed by Mr. H. G. Wells, the well-known *litterateur*, in the pages of the *Outlook*. He points out how the University library is practically inaccessible, owing to the room, intended as a reading room (where the books are locked up), being nearly always used for examinations—sometimes even for practical anatomy examinations, giving "a thin, permanent odour, of dogfish and rabbits about the place." Fancy dissection in a library! Mr. Wells's narrative is, however, too graphic to be dismissed quite so briefly:—

"Whiles this grey and grimy University is dusty, desolate, and empty; whiles great crowds of bearded young fellows, callow men, priests from Stoneyhurst and Dissenting ministers, medical students, Hindoos, Board School teachers, the cheap hacks of private schools, careless school girls, too careless to pass! and careful school-mistresses, too careful!

and a most variegated tag-rag and bob-tail of specially hired commissionaires and graduates in unaccustomed gowns, also (gowns and graduates) specially hired. . . . . Outside lurk the hirelings of such notorious crammers as Mr. Briggs and Mr. Kerin, and so forth, armed with handbills and such like bait to thrust into the candidate's hand."

The engineering candidate is, indeed, conspicuous by his absence, just as the crammer's candidate, who has been "prepared" by correspondence for the pass degree in Arts, is conspicuous by his superabundance. The only thing that the University can offer him—supposing he has passed marticulation and intermediate examinations—is a Bachelor of Science degree, to acquire which he must select to be examined in any three out of the following subjects:—pure mathematics, mixed mathematics, experimental physics, chemistry, botany, zoology, animal physiology, geology, and mental and moral philosophy. Engineering is simply ignored.

For some 15 years there has been on foot an agitation for reforming the University. Some have favoured the creation of a second separate teaching University in London. Others have worked to reform the existing University by trying to reconstruct it. The former plan has commended itself to some who bore little love for the old examining Board, and would have gladly seen it superseded by a modern rival. The latter plan has been advocated by those who had a real attachment to the University with all its defects, and did not wish to see it strangled by a younger rival. Two parties have grown up—those who desire to see the University reformed and reconstituted, and those who wish to see its examinations left severely alone, and the work of teaching and organising education in London given to a new University. It is 11 years since a charter for a second University was applied for and refused in Parliament. Since that epoch two Royal Commissions have sat upon the question, and both—one by a mere majority, the second unanimously—condemned the notion of two Universities, and recommended the reconstitution of the existing University.

The Bill now before Parliament is a Bill to create a statutory commission under Lord Davey, armed with Parliamentary powers to carry out in general the recommendations of the second Royal Commission, modified, however, by certain safeguards which have been introduced as a part of a compromise arranged by Sir John Lubbock and his friends to meet opposition. The scheme will create a new representative Senate, with boards of studies, an academic council, and a board to look after the interests of external students. It is supported not only by the present Senate and by the Convocation of Graduates, but by all the educational authorities in London affected by the Bill, the great Colleges, the Royal Colleges of Physicians and Surgeons, the Polytechnic Council, the Technical Education Board of the County Council, and by the Medical Schools. It is supported also by engineers generally, who desire to see the quality of instruction in engineering raised to a higher level. It is supported by the Royal Society, as tending to raise the value of degrees in science, and of science teaching in general; and it is supported by many old graduates because it will tend to rescue the University, and particularly the B.A. degree, from the lowered reputation into which it has fallen in consequence of the vast growth, during the past 20 years, of organised cramming. The rage for competitive examinations which overtook England a generation ago has left many deep traces in educational life. It has effectually crippled the University of London, and retarded the progress of higher education in London. Under its *régime*, the examination, which ought to have been a mere incident at the close of a well-directed course of studies, has become the end and aim of all. The natural course of training is perverted to the sole purpose of examination passing. Education is warped, and teachers hampered by the trammels of the system. Cram dominates all. The Bill now before Parliament, is but the first step toward the undoing of this disastrous state of things. Every engineer, civil, mechanical, or electrical, who desires to see the University of London reorganised on modern lines, should urge his Parliamentary representative to support the Bill.

Forms of Electrical Treatment.

THE memorable crusade against electrical quackery some five years ago was immediately followed by a distinct weakening of faith in electrical treatment. Unfortunately, the public memory is a short one, and we have for some time noticed a distinct revival at the hands of quacks of that blessed word, electricity. The claims of the Electrical Hospital of Notting Hill have not, until recently, met with the consideration which they merited; indeed, had it not been for the advertising medium of a coroner and his jury, there is a large probability that the institution would have long remained comparatively unknown. It is unnecessary to detail the whole of the circumstances that have brought the Electrical Hospital into prominence, but the main facts are that John Salter, an artist, aged 71 years, was found dead at 51, Peel Street, Kensington. The Coroner said "the deceased had received treatment at a so-called 'hospital,' by electricity, but the people being unqualified could not give a certificate, and an inquest was necessary. In some cases electricity was beneficial, but in others might aggravate a disease and accelerate death, which made it a serious matter. He could not understand why people did not go to a proper hospital for treatment." The evidence revealed the hospital to be an institution at Notting Hill, presided over by Prof. D'Odiardi, a name familiar to our readers, who claims to be a medical electrician. Certainly to our own knowledge this gentleman has been associated with medical electricity for a considerable period. It was admitted that the "Professor" had no medical qualifications, but that proved no obstacle to his treatment of consumption, throat affection, blindness, short sight, internal diseases, tumors, influenza, and special treatment of the voice for public speakers, &c. In the case of the poor aged artist he was treated at the Electrical Hospital for muscular paralysis and numbness of the legs, but according to medical testimony the cause of death was syncope. Apart from the very strong rider of the jury and the caution of the Coroner, the evidence given was remarkable, most striking developments in electro-medical treatment having apparently arisen at Notting Hill. Our readers are fairly well acquainted with the action of X rays, yet "Prof." D'Odiardi is actually using them in the treatment of disease. The Coroner, in his examination of one of the nurses, asked the following questions:—

Nurses are sent out with apparatus, including that for the X rays?—Yes, for diseases; they did not take photographs.

With what object?—We use them for the eyesight.

For people who are blind?—Yes.

The "Professor," in his testimony, said he "found X rays useful in many diseases which caused a weak circulation. It re-animated capillary circulation." The cutaneous troubles arising from the application of X rays have been commented upon in these columns, and it has been necessary to devise methods to obviate them, yet here is an unqualified man pretending to treat blindness and other complaints by X rays, with probably disastrous results. The warning of the Coroner came not a moment too soon, and in the interests of genuine electrical treatment it is to be hoped that Mr. D'Odiardi will bear it in mind.

THE COST OF GENERATION AND DISTRIBUTION OF ELECTRICAL ENERGY.

(*Concluded from page* 471.)

MR. HAMMOND next deals with the efficiency of the generating plant and refers to the great improvement which has taken place in the last ten years or so, and to the important place which must be assigned to this efficiency as a factor in the low cost problem. The conditions usually specified by him for steam consumption tests are quoted, and his method of fixing the amount of the penalty for any failure on the part of the contractor to obtain the guaranteed results is explained. We notice, however, that no mention is made of a bonus to the contractor if the latter succeeds in getting better results than those guaranteed, and we would suggest that the offer of a bonus, similar in amount to the penalty, would be a further inducement to manufacturers to strive after better results even than those which have already been obtained. A table of steam consumptions at full load for various plants tested under the conditions already specified is given, and reference is made to guarantees which have been given for plant now under construction; but we should have been glad to see figures quoted for the steam consumption at three-quarters and half load, as these latter are generally even more important for central station work than the full load figures.

In this connection, we would say a few words for governing by automatic expansion. We are well aware that Capt. Sankey and Mr. Morcom, in their valuable papers on the Willans and Belliss engines, have quoted tests showing that with these engines, although there may be some advantage in governing by expansion valve if the I.H.P. is taken as the basis of comparison, this apparent advantage disappears and the balance turns in favour of throttle valve governing when the more rational basis of consumption per B.H.P. or E.H.P. is taken. These results appear to be due to the considerably increased friction of the engine when governing by expansion, and this particular loss certainly has not the same relative importance in slow speed engines such as are used sometimes for large powers; whilst the facilities afforded by the expansion valve for arranging that the lowest consumption of steam shall occur at some other load than full load are much to its advantage, owing to the fact that the plant load factor during running hours can hardly be expected to average more than 75 per cent. We remember seeing a guarantee for a slow-speed compound-condensing engine, which seemed to us a good example of what is required for central station work. The normal full load output of this engine was 450 B.H.P., but it had to work up to 550 B.H.P. as an emergency load, and the guaranteed steam consumptions per brake horse-power and per hour were as follows:—20·9 lbs. at 150 B.H.P.; 18·2 lbs. at 250 B.H.P.; 17·6 lbs. at 350 B.H.P.; 18·1 lbs. at 450 B.H.P.; and 19·8 lbs. at 550 B.H.P. It will be seen that, making allowance for the dynamo efficiency, it is possible with such an engine to get an electrical horse-power at the dynamo terminals at any load between half and full load for a consumption which does not vary more than about 5 per cent.; that the best results are obtained at about three-quarter load, and that a 20 per cent. overload can be obtained with about 10 per cent. higher consumption.

In speaking of the efficiency of the generating plant, nothing is said about boiler efficiency, and yet there is no doubt that a great part of the difference between the coal consumption that can be obtained on a full load test, and that which is obtained in practice as the average of the year, must be debited to losses in the steam raising plant. We believe that it is the practice in many stations to measure the feed water by meter, and to enter up the amount registered every 24 hours, and we hope that in the discussion some information may be given as to the efficiency of the boiler plant under different conditions of working as regards output and load factor. Various schemes for thermal storage have also been brought forward in the last few years, and we should like to know if any hopeful results have been obtained from them in practice, and whether there are any prospects of a better all-the-year-round efficiency of the steam raising plant being obtained in the near future.

When speaking of efficiency of distribution, Mr. Hammond refers to the various views held by engineers as to the headings under which the difference between units generated and units sold should be entered, and states that in some cases the units used for magnetising or lost in the batteries are entered under the heading of units used on the works. That there should be any engineers who so misunderstand the meaning of the Board of Trade form is certainly surprising, as the magnetising units can no more be counted as units generated than those which are spent in overcoming the resistance of the armature or in iron and frictional losses in the machine; whilst the units lost in the battery should undoubtedly be debited against distribution. We agree with Mr. Hammond that the form used by the Westminster and St. James's Companies is an improvement on that prescribed by the Board of Trade, but we think that another column under the heading of units utilised might be added with advantage, so that the units used at the generating station for lighting might be separated from those used for power purposes, such as driving feed or circulating pumps, mechanical stoker gear, or elevators for raising coal. We suggest this addition because such electric motors take the place of engines that would otherwise be drawing steam from the boilers; and, since the units utilised in this manner are again used for generating purposes, they cannot strictly be included in the net units generated.

In the table given in the paper showing the ratio of the units used in distribution and unaccounted for to the total number generated, there will be found a striking difference between the losses in the low pressure and high pressure systems, and also between the maximum and minimum values of these ratios for the various undertakings working on the same system. For example, for the year 1896, we find that the average value of this ratio for low pressure systems is 8·3 per cent., the maximum 14·09 per cent. (at Southampton in the sixth year of working), and the minimum 2·32 per cent. (at Hull in the fourth year of working); whilst for high pressure systems the average value of this ratio is 26·2 per cent., the maximum 39·88 per cent. (Newcastle District Company in its sixth year), and the minimum 9·38 per cent. (Reading in the second year of working).

With regard to the question discussed in the paper, as to whether the coal bill can be considered in any way a reliable test of the all-round efficiency of an undertaking, it is evident, as is pointed out by Mr. Hammond, that neither the actual cost of fuel nor the weight of fuel consumed per unit sold can be taken as a satisfactory basis of comparison, owing to the great differences in the average price paid by the several undertakings, which ranges from less than 5s. to more than 20s. per ton, and to the difference of quality which naturally increases the weight consumed when cheap fuels are used. We must add that we do not think that a comparison of the thermal units in the fuel consumed per electrical unit will help us much, as with different qualities of fuel, the actual evaporation which can be obtained under the most favourable circumstances is not proportional to the calorific values of the fuels as determined in the laboratory; indeed, this difference may be very considerable, as the percentage of the total thermal units that can be utilised for evaporation may, with some fuels, be more than 50 per cent. greater than it is with others. To get a really fair basis of comparison, it would be necessary to make a series of tests of actual evaporation with the various qualities of fuel burnt in boilers of the several types used in central stations, so as to get for each fuel a figure which would represent the best possible evaporation that could be obtained with it.

It must, however, be remembered that the engineer in charge of a station often finds plant already in service, and that the task which is set before him is to get the best possible efficiency out of the existing plant, and that he has not the chance, perhaps, of replacing it by other plant which could give a better result. Under these conditions, the all-round efficiency which is interesting to him is expressed by the ratio of the average weight of fuel actually consumed per unit sold, to the weight of fuel necessary to produce a unit at the dynamo terminals under the best possible test conditions. We would, therefore, recommend that in all works tests should be made on full load with the usual quality of fuel, and that the engineer should always keep the results of this test before him as the ideal consumption to which he has to approach as nearly as possible; and that tests of 24 or 48 hours' duration should be made under working conditions at various seasons of the year, so that the relative importance of the several losses under different conditions may be ascertained.

In the course of his paper Mr. Hammond quotes the ideal costs given by Mr. Crompton in 1894, and also tabulates some ideal costs made up by taking the best results for each item obtained by any works and combining all these records in one undertaking, and then discusses the probabilities of any works obtaining equally good results. He also concludes his paper with a prophecy as to the cost per unit at Leeds when the output reaches 5,000,000 units, and we propose to conclude these notes by a few remarks on this subject. As regards fuel consumption, it is unfortunate that Mr. Hammond has not given us any information as to the weight of fuel now used per unit at Leeds, nor as to its calorific value, so that it is difficult to get a correct appreciation of what is really represented by his prophecy, that the cost of fuel will be $\frac{1}{5}$th of a penny per unit when the output has reached 5,000,000 units. He speaks, however, in another part of his paper of its being possible to compare the coal results of works drawing from the same coal fields, such as Bradford and Leeds; and if we are to assume that the price at Leeds is about the same as that given for Bradford, the prophetic figure means a consumption of under 5 lbs. of fuel per unit sold. This appears to us to be a figure which will be difficult of attainment, unless the increased output is accompanied by a considerable improvement in the load factor; as, if this latter remains at about its present value, at which the units sold are only 70 per cent. of those generated, the consumption of fuel per unit generated will be under $3\frac{1}{2}$ lbs.

An examination of the tables of fuel consumption shows us that we are still a long way off Mr. Crompton's ideal of $2\frac{1}{2}$ lbs. of Welsh coal, the best result quoted in them being the 5·8 lbs. at Oxford, followed by the St. James's, Westminster, and Kensington companies, with 6·4, 6·5 and 6·6 lbs. respectively. Improvements may be made by the use of larger and more efficient generating units; but so long as the load factor remains at its present low figure, we believe that the stand-by losses in the boilers and condensation in pipes will prove the great obstacle to a reduction even to 4 lbs. of Welsh coal, no matter how much the actual output may be increased. Wages will also be diminished by the use of larger units, and automatic machinery for handling coal, but so far the best result is that obtained at Edinburgh of ·20d., or double the ideal cost proposed by Mr. Crompton; and the same difficulty will be experienced in reducing this item if the maximum demand on the works increases in anything like proportion to the output.

With regard to repairs and maintenance, we have already pointed out that the figures for stations which have been running for several years do not show such a great reduction in this item; and, although there is every reason to believe that Mr. Crompton's figure of ·35d. per unit may be improved on, we think that Mr. Hammond underestimates this item when he puts it at only one-tenth of a penny in his prophetic costs. The last items, rent, rates, taxes and management are beyond the control of the engineer, and depend to a great extent on local circumstances. We have already shown that with some of the most important undertakings, the tendency is towards a very slight decrease, and in some cases even there is an increase in this item; and there is nothing in the statistics published by Mr. Hammond to lead us to expect very material reductions. On the contrary, we know that there is a tendency on the part of local rating authorities to increase the assessment on electric light stations far more rapidly than is pleasing to the proprietors; that rents are proportionately higher if a station has to extend beyond its original boundaries and acquire leases of neighbouring property; that engineers and managers all hope for a substantial increase of salary with the growing importance of the undertaking; that the expenses of reading meters and collecting payments increase and that directors' fees have to be provided as the undertaking becomes more successful. We are, therefore, of opinion that Mr. Hammond's prophecy is somewhat too optimistic, but at the same time, we sincerely hope that he may be able in a few years to show us that we are wrong, and we can assure him that we shall only be too glad when the time comes that we can congratulate him on the fulfilment of his prophecy.

SOME NOTES ON SINGLE-PHASE MOTORS.

By A. C. EBORALL.

(*Concluded from page* 438.)

It will be seen that these motors show high power factors and efficiencies even at low loads, while the drop of speed is very little. These good points are well brought out in fig. 17, which gives a test of a 2-H.P. Kolben motor designed to

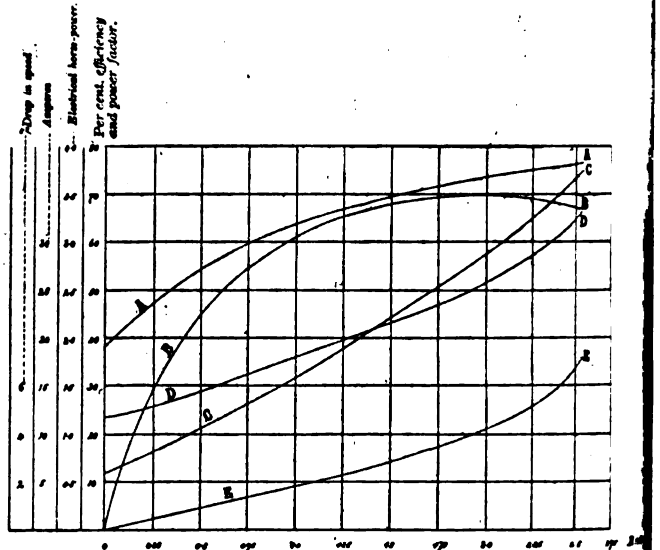


Fig. 17.

run at 1,500 revolutions per minute on a 50 ~ 110-volt circuit. The curve marked A A shows the percentage power-factor, B B the percentage efficiency, C C the electrical horse-power absorbed, D D the amperes at 110 volts, while curve E E gives the percentage drop in speed. The general

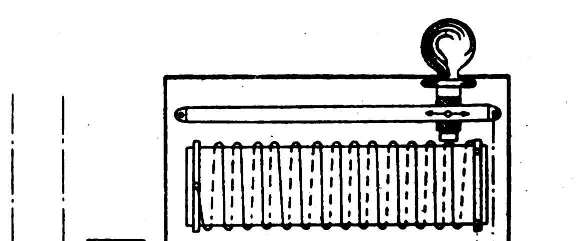


Fig. 18.

design of the Kolben motors is not very different to that of Messrs. Brown. The semi-rectangular stator holes used have already been noticed. Another point is that the stator core discs are magnetically separated from the case in which they are built in. This not only minimises leakage from the stator, thus tending to improve the power factor and the starting, but at the same time better ventilation is secured. The stator is drum wound with flat coils, as in fig. 8. The smaller motors up to 8 H.P. are all built with plain rotors, and are started up in a manner similar to that shown in fig. 12A, a non-inductive resistance being used instead of the condenser. The particular arrangement used is well shown in fig. 18, from which it will be noticed that the resistance is capable of being adjusted for different starting currents and torques. Motors above this size have a three-phase winding on the rotor, whose ends are connected to slip-rings as before described. They start up with the same device used in conjunction with a non-inductive rotor resistance. Fig. 19 gives the winding scheme of such a rotor for a 20-H.P. six-pole Kolben motor for a low tension circuit at 50 ~.

Mr. Kolben has recently been carrying out experiments with large motors, using mica condensers, which latter seem to promise the best results, not only for high pressure motors, but also for those working at low voltages. In this last case the pressure is transformed up by a small converter for the starting phase, as shown in fig. 20. A non-inductive resistance is, of course, used in the rotor. After the motor has run up, the transformer is switched off. In order to make

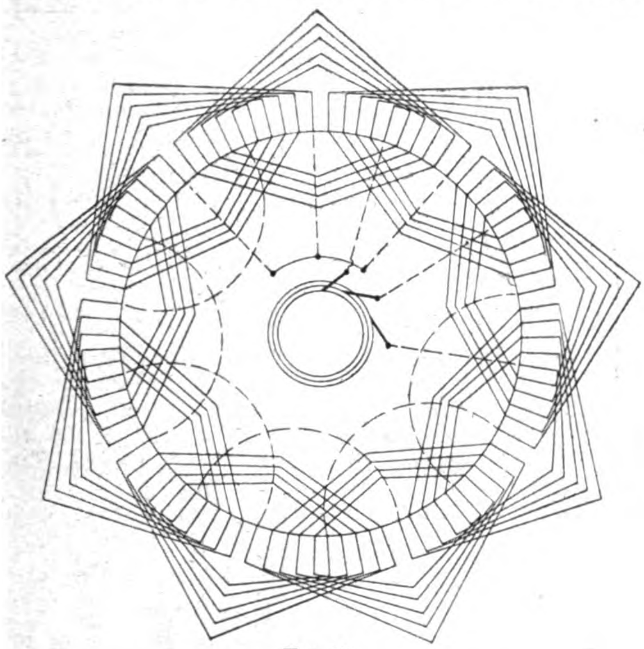


Fig. 19.

the motor perfectly safe under normal working conditions, the starting winding of the motor is made in two sections,

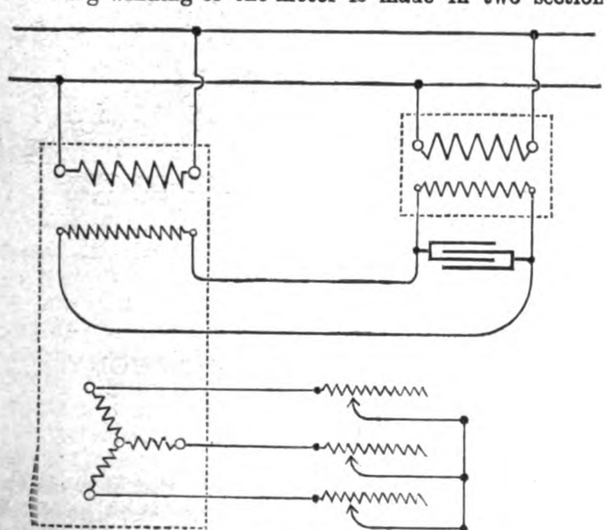


Fig. 20.

which are cross-connected after the motor has started and the transformer switched out, for otherwise the field of the working winding would produce a constant high pressure in the starting coils. A transformer would not be necessary in those

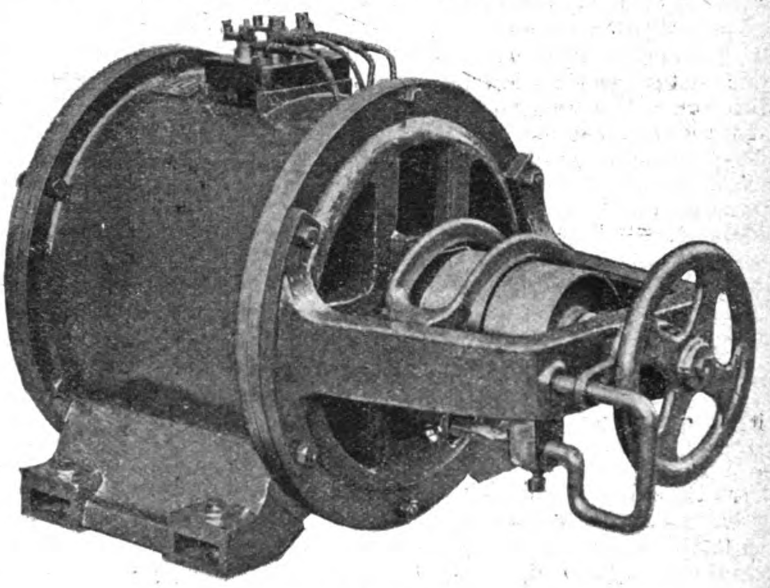


Fig. 21.

places where the high pressure circuit is directly available. This method of starting should prove very effective for high frequency motors.

It is worthy of note that in the case of high pressure Brown motors, the high pressure is reduced for the starting windings and condenser, while for the Kolben motors the high pressure is directly utilised; and if not available directly, is obtained by transforming up. This is, of course, because in the first case the condenser is of the liquid type, acting by electrolytic polarisation, and cannot stand a high voltage; whereas, in the second case, it is an ordinary condenser, and becomes smaller for the same effect as the voltage is raised.*

Fig. 21 shows one of Messrs. Kolben's 6-H.P. motors with fast and loose pulley.

(*D*) *The Allgemeine Elektricitäts Gesellschaft.*—This firm (the pioneers of multiphase working in Germany) have of late years been turning their attention to single-phase induction motors, and with very satisfactory results. Their design is on the same lines as those of the other firms mentioned above, but with a special starting winding used in conjunction with a non-inductive resistance. Mr. Stöttner, the manager of the company's London branch, recently showed the present writer two motors satisfactorily working at 100 ~ under trying conditions—one was comparatively small, the second, of nominal 6 H.P., driving a circular saw of large size. They were both working wonderfully smoothly, the latter hardly emitting any noise when fully loaded. This is rather a common characteristic of high frequency motors of any size, being most prominent at starting. The motor in question started up very quietly indeed, taking about 60 seconds to reach full speed on the loose pulley.

The single-phase motors noticed above are the only ones that have had a lengthy practical trial and been uniformly successful. Many others have been designed by various people, and with various schemes, to make them self-starting, but it remains to be seen whether they are capable of being successfully operated in any but toy sizes.

Single-phase motors of the induction type have undoubtedly solved the problem of power distribution from ordinary lighting circuits. It is true that all those in successful operation are of Continental make, but then the demand for power is much greater there than here, and must be satisfactorily met. And, as a rule, the alternate current generators on the Continent are much better able to take care of a combined light and power load than is the case in England, where the generators generally regulate extremely badly on any load containing self-induction. That this poor regulation on inductive loads is unnecessary, is shown by the case of Frank-

* Current through condenser = $2 \pi n \kappa \times$ the secondary E.M.F. of transformer. Hence if the condenser is to give a particular current, both a high frequency and high E.M.F. tend to reduce its size.

furt, where the lighting is quite as good as in any English town, despite the fact that motors of all sizes (including several of 70 H.P.) are running on the lighting circuits. The present writer was assured by the engineer of the Frankfurt station that the motor load gave him no trouble whatever; in the case of the large motors, he, of course, knew when they were coming on.

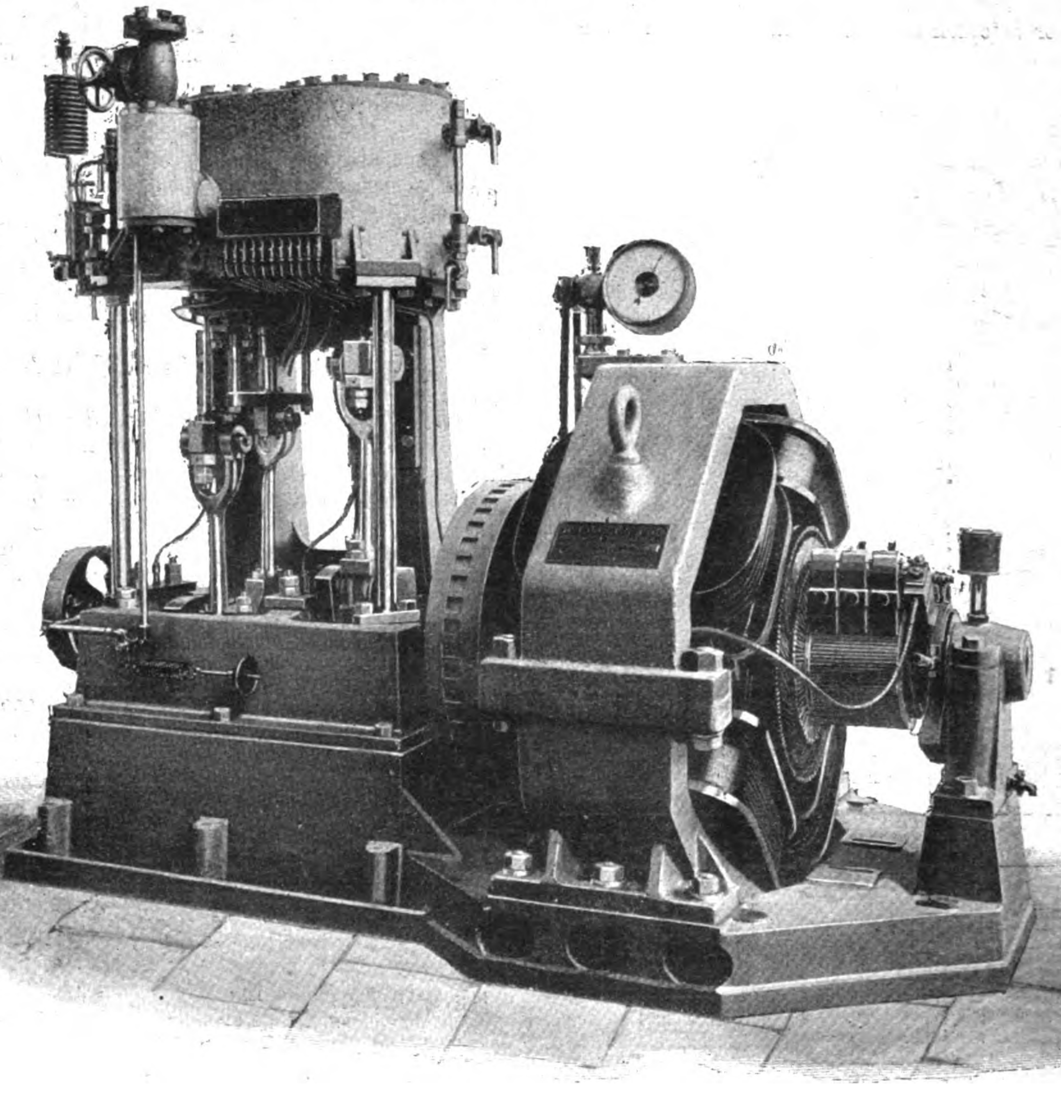
In conclusion, considering the excellent performance of motors such as those of Brown, Kolben, &c., it is rather difficult to understand why the common complaint heard so often here, that "alternate current motors cannot be run on lighting circuits" should exist. It is to be hoped that this complaint will disappear, as the present tendency to adopt reasonable frequencies becomes more general in this country.

THE LIGHTING OF WARSHIPS.

With the object of reducing the external magnetic leakage of dynamos, which was liable to affect the ship's compasses, the British Admiralty some years since made trial of a two-pole ironclad type of dynamo. This form of machine was, however, found heavy, and in order to reduce the weight, while at the same time keeping the magnetic leakage at a minimum, the Admiralty have now adopted a multi-polar machine. The illustration represents an 80-volt 600-ampere set running at a speed of 300 revolutions per minute, lately supplied by Messrs. W. H. Allen, Son & Co. for H.M.S. *Amphitrite*. The armature is of the series-wound drum type, the current being collected by two sets of brushes placed 90° apart. The core is secured to the shaft by means of a cast-iron spider, open at each end to allow free access of air, so as to ventilate the armature thoroughly. The commutator is built up of hard drawn copper sectors, and is insulated everywhere with mica. The magnets are of high permeability, cast-steel throughout, and consist of a yoke ring with four radiating poles projecting inwards bolted to it. The yoke ring is in two halves, the division being on the horizontal diameter, allowing of the easy removal of the armature without in any way disturbing the magnetic coils. The latter are wound on formers so that they may be readily removed or replaced.

The engine, which, with its dynamo, is mounted on a combination base plate, is of the compound vertical double-acting type, having cylinders $7\frac{1}{2}$ inches and 15 inches diameter × 9 inches stroke. The working parts are of steel, having a tensile strength of 30 tons with an elongation of 27 per cent. in 2 inches. The bearings have white metal linings. The engine is constructed for a working steam pressure of 300 lbs. per square inch. The steam consumption upon trial at the makers' works was 26 lbs. per electrical horse-power per hour, with a steam pressure of 200 lbs. per square inch, when exhausting into the atmosphere. The maximum temperature rise of the machine after a six hours' full load trial did not exceed 65° F. above the temperature of the surrounding atmosphere. The difference in weight between the four-pole set and an ironclad two-pole of the same output is over $2\frac{1}{2}$ tons.

Sets of a similar type, but for 400 amperes, have been supplied by this firm to H.M. ss. *Hermes*, *Highflyer*, and *Hyacinth*.



INDUCTANCE IN TELEPHONY.

By W. MOON.

The effects of inductance together with that of electrostatic capacity are more important in telephony than that of resistance. The effect of a distributed capacity, as it occurs in practical telephony, it is impossible to calculate. But if the inductance of the circuit be dealt with apart from capacity, the figures are not difficult, and I propose in the present paper to deal only with such inductance effects.

The inductance of a piece of apparatus can be readily measured by Maxwell's method, fig. 1.

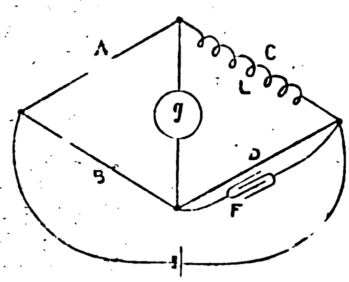


Fig. 1.

The bridge should first be balanced for steady currents, without any capacity in the condenser, and a deflection read "q_L" on closing or opening the battery circuit. The apparatus in arm "C" should then be replaced by an inductionless resistance which should be adjusted to obtain a fresh balance for steady currents, and a reading "q_r" taken on opening the battery circuit from the discharge of the condenser.

If then the arms "A" and "B" are equal

$$L = \frac{q_L}{q_r} F D^2.$$

There is no advantage to be gained by using unequal values in the arms "A" and "B" of the bridge.

The mutual induction of a piece of apparatus can be best measured by comparing the discharge "q_m" from the secondary circuit, when the primary circuit is closed, with the discharge from a condenser "q_r" through the galvanometer, as shown in fig. 2, where the secondary coil is first joined to the

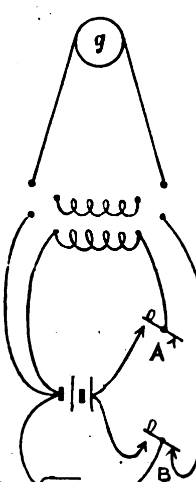


Fig. 2.

galvanometer, and the discharge taken with key "A," and a discharge afterwards taken from the condenser through the galvanometer with key "B."

$$\therefore q_m = M \frac{E}{R S} \text{ and } q_r = E F$$

$$\therefore M = \frac{q_m}{q_r} F R S,$$

where "M" is the mutual induction, "R" the resistance of the primary circuit, "S" that of the secondary circuit, and "F" the capacity of the condenser.

In double wound coils, the inductance of each coil and the mutual induction between them is the same. And as mutual induction can be more readily measured than self-induction, it is sometimes convenient to specially double wind particular coils in order to obtain their self-induction from the measured mutual induction.

When the battery is reversed between each measurement of mutual or self-induction, the deflection on closing the battery circuit is always greater than that of breaking it. This is due to the effects of the residual magnetism. The two deflections being proportional to "$c\,a$" and "$c\,b$," and the residual magnetism effect to "$b\,a$" on the magnetisation curve, fig. 3.

Thus the inductance for alternating currents should be measured by reversing the battery while the balance is

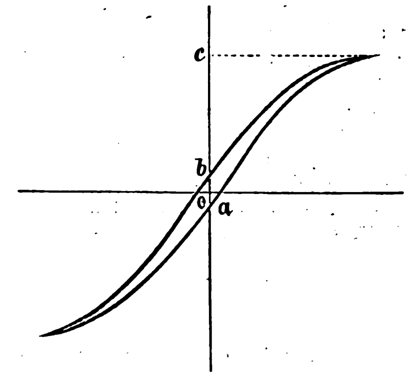
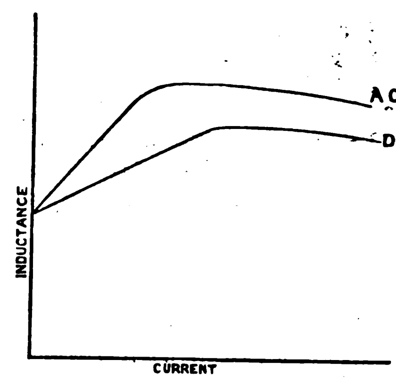


Fig. 3.

steady, or half the sum of the deflections, on opening the battery circuit, reversing the battery, and closing it again, may be taken. While for single current working the inductance should be measured by the deflections produced on opening the battery circuit only.

In all apparatus containing iron the inductance varies with the strength of the current used; and the inductance is greater with alternating currents than direct ones. But



A C, alternating current; D C, direct current.

Fig. 4.

with very small currents the difference between the inductance with alternating and direct currents is very small, as shown in fig. 4.

And the inductance for telephonic currents is not much less than that of the smallest currents by which the inductance can be measured.

The following list of inductances is for telephonic currents:—

	Henrys
Nonpolarised relay 1,000$^{\omega}$	4 9
Polarised indicator relay 1,000$^{\omega}$	8 6
Telephone galvanometer 4,000$^{\omega}$	52·
Magneto bell 1,000$^{\omega}$	15·
Switchboard telephone 75$^{\omega}$	·01
Bell telephone 150$^{\omega}$	·1
Self-restoring indicator local cicuit 250$^{\omega}$	·64
Self-restoring indicator line circuit 1,000$^{\omega}$	17 5
Telephone transformer 2[illegible]0$^{\omega}$ each coil	3 5
Triple wound transformer primary 150$^{\omega}$	5·
Triple wound transformer each secondary 1[illegible]0$^{\omega}$ ...	·73
Telephone induction coil 250$^{\omega}$	1 75
Telephone induction coil, mutual induction	·016

When the resistance and inductance of a circuit are known the impedance can be calculated from the formula

$$I_m = \sqrt{R^2 + p^2 L^2}$$

where $p^2 = (2 \pi n)^2$ and n is the number of pulsations per second.

In telephony "p" depends on the pitch of the voice, and hence there is a maximum and minimum impedance. For male voices n ranges between 90 and 140 pulsations per second. And for female voices between 280 and 560 per second. So that for male voices $p^2 = 320,000$ to $770,000$, and for female voices $p^2 = 3,095,000$ to $12,400,000$. And a maximum and minimum value of p^2 might be taken as 12×10^6 and 3×10^5 and a mean value as 2×10^6. Or for rough calculations p^2 may be taken as 10^6.

A number of telephonic apparatus are used as a shunt across others; the joint impedance of two such circuits is :—

$$I_m = \sqrt{\frac{(R^2 + p^2 L^2)(R_1^2 + p^2 L_1^2)}{(R + R_1)^2 + p^2 (L + L_1)^2}}$$

where "R" and "L" are the resistance and inductance of one circuit, and "R_1" and "L_1" that of the other.

The proportion of the whole current passing through "R_1"

$$= \frac{\sqrt{R^2 + p^2 L^2}}{\sqrt{R^2 + p^2 L^2} + \sqrt{R_1^2 + p^2 L_1^2}}.$$

Thus, an induction coil and Bell receiver in series having a resistance of 300^ω and an inductance of ·25 henrys would have an impedance on short-circuit of

$$\sqrt{300^2 + 3 \times 10^5 \times \cdot25^2} \text{ to } \sqrt{300^2 + 12 \times 10^6 \times \cdot25^2}$$
$$= 330 \text{ to } 916 \text{ ohms,}$$

and an indicator relay of $1,000^\omega$ and 10 henrys would give 5,560 to 34,700 ohms.

So that if the indicator relay is used as a shunt across the telephone and induction coil it would take

$$\frac{330}{330 + 5,560} \text{ to } \frac{916}{916 + 34,700}$$

$=$ ·056 to ·0257 of the whole current.

A magnetic bell of resistance $1,000^\omega$ and inductance 15 henrys, if used as a shunt across a circuit would give an impedance of 8,250 to 52,000 to speech, but only an impedance of $1,800^\omega$ to the current from a magneto generator when p^2 is taken as 10^4.

The principle of mutual induction enters largely into telephony as apart from the use of transformers for joining a single line on to a looped one, or their use in superimposed circuits; the telephonic induction coil acts as a transformer and may be regarded as such. Also the iron cores and iron sheathing of coils act as secondary circuits of small resistance and inductance.

The current "x" in the primary circuit and that "y" in the secondary circuit of a transformer are given by the formula

$$x = \frac{E_m}{\sqrt{(R + \nu S)^2 + p^2 (L - \nu N)^2}} \qquad (1)$$

$$y = \frac{E_m \sqrt{\lambda}}{\sqrt{(S + \lambda R)^2 + p^2 (N - \lambda L)^2}} \qquad (2)$$

where "R" and "L" are the resistance and inductance of the primary circuit, "S" and "N" that of the secondary circuit, "E_m" is the mean electromotive force apart from phase.

$$\lambda = \frac{p^2 M^2}{R^2 + p^2 L^2} \text{ and } \nu = \frac{p^2 M^2}{S^2 + p^2 N^2}$$

where "M" is the mutual induction.

The current, "I," without the transformer in circuit would be

$$I = \frac{E_m}{\sqrt{(R_1 + S_1)^2 + p^2 (L_1 + N_1)^2}} \qquad (3)$$

where the quantities in the denominator are reduced by the values of the resistances and inductances of the transformer.

To get the best effect from a transformer, obviously the primary and secondary coils should be so wound that its primary resistance and inductance should be in proportion to the resistance and inductance of the primary circuit, and its secondary resistance and inductance in proportion to the resistance and inductance of the secondary circuit.

(*To be continued.*)

THE WELSBACH INCANDESCENT ELECTRIC LAMP.

By A. M. Gibson.

So much has been written and spoken in a vague way about the latest invention of Dr. Auer von Welsbach, and such great expectations have been raised as to its ultimate commercial value, that all who are interested in the progress of electric lighting will welcome some definite information on the subject.

The following particulars are taken from the complete specification which has been "laid open for public inspection" by the Hungarian Patent Office at Buda-Pesth.

Two kinds of glow-bodies for use in incandescent electric lamps, with several different methods of producing the same, are described in this patent application. The first is a fine filament of osmium of a peculiar form. As is well known, osmium is one of the platinum group of metals. It usually occurs as a compound known as osmiridium, in flat, irregular grains, and sometimes in hexagonal prisms. In the separation of the iridium and osmium, the latter is generally found to contain ruthenium. It is easy to obtain the pure osmium from the ruthenium compound on account of the affinity osmium has for oxygen, the tetroxide, $Os\,O_4$, forming readily. The tetroxide is, however, extremely volatile, and the fumes given off in reducing by volatilisation to obtain the pure metal, are very poisonous. The vapour of tetroxide destroys sight if the eyes are exposed to it.

The second filament is one formed from thoria, the earth metal oxide so largely employed in the preparation of incandescent gas mantles.

Dr. Carl Auer von Welsbach has worked out several different methods of obtaining his osmium and thoria filaments, but so far these methods are merely laboratory processes. Lamps, it is true, have been made which, according to Dr. Auer, give very remarkable results, and he claims that a phenomenal high efficiency lamp, with a long, economical life, can be produced. While the inventor has not made any public statements as to the exact efficiency and life of his filaments, it is reported, on no particular authority, that the wattage per candle is under 2, and even as low as 1·5.

Osmium has never been fused. At the point at which iridium melts the osmium goes off in fumes, which take fire in the air and form tetroxide of osmium. It is possible to obtain it in an amorphous powder which can be converted into crystals. Osmium is the heaviest of metals, its specific gravity, determined from the crystalline form, being 22·477. It is undoubtedly the most refractory metal.

Dr. Auer claims that osmium does not volatilise at the highest temperature obtainable if confined in a vacuum or if surrounded by reducing gases. He does not make clear what he means by surrounding with reducing gases, but presumably it is that the gases are present in such a way as to exclude oxygen, because it is undoubted that with free access of oxygen osmium does vaporise.

One of the methods Dr. Auer employs to obtain his osmium filament he describes as follows:—A platimum wire of 0·02 mm. diameter is fixed in a vacuum surrounded by vapour of hydro-carbon, greatly diluted with water into which small quantities of tetroxide of osmium are blown from time to time. The wire is glowed in this atmosphere, and a thin layer of metallic osmium is deposited thereon. The deposit must be effected slowly, and from the context of the description of the process it inferentially appears that a number of very thin layers must be obtained. There is difficulty in obtaining perfectly uniform deposits, anything like warts, or nodules, of course, would affect the regular resistance of the filaments. The fragility of the coated wire as it comes from the flashing apparatus is admitted to be great, because the layers contain some oxide, *i.e.*, the layers are not in this stage pure metallic osmium. Therefore the glowing is continued until the very thin platinum core is volatilised, and the osmium coating becomes homogenous, and you have a tube of pure osmium. This is described as being elastic and nearly the colour of platinum.

The coating may also be effected by drawing the fine platinum wire through a solution of a sulphide or tetrahydroxide of osmium, and then glowed in a vacuum. If this method is employed, the operation must be repeated at least 100 times, in order to obtain the requisite thinness of layers.

There is also an electrolytic method mentioned, but there is no description of the method of preparing the electrolyte of osmium, or of the current required in this operation. It is, however, stated that the glowing of the wire must be carried out as in the other methods after the electrolysis is concluded. This part of the specification is exceedingly vague; but before a German or an American patent is obtained, fuller explanations of the electrolytic method will doubtless have to be supplied.

Vegetable or animal fibres can also be employed as the foundation for the osmium coating. A liquid pulp is made by mixing the finely triturated osmium oxide with sugar, or organic cementing material and water, and the impregnated thread of fibre, after drying, is brought into the required shape for the lamp, and slightly glowed in a reducing atmosphere. From this it appears that the osmium particles secure conduction. A carbon skeleton, carrying osmium unconsolidated, is thus obtained. It can be fixed in the lamp bulb, which is filled with reducing gases, and the glowing proceeds slowly, steam being also admitted to the bulb. The intensity of the current is gradually increased, until a very high temperature is reached. To secure uniformity of resistance, the filament so produced is normalised by flashing in a vapour of tetroxide of osmium and hydro-carbon.

Nitro-cellulose may also be saturated or mixed with pulverised pure osmium—the amorphous form, of course—or sulphide of osmium, or tetrahydroxide, and the mixture is then formed into threads by squirting, or otherwise, denitrated, and heated in the same manner as the fibres.

Instead of cellulose or fibres, a soft, slightly twisted cotton thread may be impregnated in a thin pulp of finely divided osmium sulphide and water, mixed with a cementing medium, as, for instance, sugar. The thread is dryed, and then carbonised in a reducing gas, such as illuminating coal gas.

Dr. Auer's method of obtaining his thoria filament is interesting. He states a fact which is not generally known, but which is quite true. A platinum wire brought to a white heat by an intense current, or other means, melts. A very thin platinum wire held in the hottest zone of a Bunsen gas flame will melt; but if the wire is coated with a firmly adhering cover of thoria, it will not melt at any measurable temperature. This is due to the fact that a great part of the heat energy, coming in contact with the absolutely fireproof material covering the wire (for instance, in the Bunsen flame) is converted into light radiating energy, or light emissiveness. This is as equally true of electric energy as with the gas flame. The intense power of the cover to emit light and heat withdraws energy from the metallic conductor.

Gradually raising the energy in intenseness, a dazzling white spot of light will occur at a place in the filament, and spread slowly (sometimes quickly) over the whole length. About this time a minute ball will be seen by the close observer to spring from the thread. This phenomena is caused by the volatilisation of the thin platinum core under the intense heat obtained by increasing the current tension. There is now left a tube of thoria, which will withstand still higher current tension, and the brilliancy of the light emission increases correspondingly. The curious part is, that at a current tension which fuses, or destroys any other substance, there is very little heat radiated by the brilliantly incandescing thoria filament. Continuing the increase of current tension, a point is reached at which the thoria tube bursts with a slight explosion. The thickness of the thoria cover need be but some tenths of a millimetre. A mere film will answer, in which case the colours of the rainbow will, at one stage of the experiment, appear.

It is evident, although not so stated in the specification, that the thoria covering must be dense, and in no wise porous. To obtain such a covering is exceedingly difficult.

Dr. Auer states vaguely that he uses "a preparation of thorium, which gives back an oxide when being glowed." A nitrate or a selenate of thorium will do this. The process described in the specification of forming the cover, doubtless, will answer in the laboratory, but in manufacture upon a commercial scale it must inevitably prove impracticable. The thin platinum wire 0·02 of a millimetre in diameter, approximating to the tenuity of the split cocoon silk filament, is drawn through elastic cheeks, which are moistened with the solution of thorium. After each drawing the wire is glowed. The drawing through the moistened cheeks, and the glowing, must be repeated at least 50 times. To reach perfection by this method the solution employed to moisten the cheeks through which the wire is drawn, must be very dilute, and the drawing and glowing must be repeated several hundred times. A wire of a compound of platinum and osmium answers better than pure platinum, because more infusible. A compound wire of platinum osmium, ruthenium and rhodium or iridium, answers better than platinum.

It is to be noted that in practice the platinum core is not volatilised. The experiment above described is merely to illustrate the enormous heat resistance of pure thoria.

Although not expressly stated in the specification, it is evident that the best results can only be obtained with the filaments of Dr. Auer by the employment of alternating currents.

The cost of producing either the osmium or the thoria by the processes described must be considerable. Platinum wire costs in proportion to the tenuity to which it is drawn. Ordinarily pure platinum costs, say, 50s. to 55s. an ounce. To draw down to 0·02 of a millimetre adds enormously to the price, for workmen can only be engaged in the operation a few hours on account of the strain upon their eyesight, to say nothing of the other difficulties encountered in the drawing. Then the repeating the process of coating and glowing several hundred times, no matter what mechanical devices are used, means great expense. It is true many filaments are obtained from 1,000 metres in length, but incandescent electric lamps are produced by the million.

There is one noticeable feature of Dr. Auer's specification, and that is the omission in the descriptive part to allude to the electrolytic way of producing on a platinum core, or any other conducting core, a dense, firmly adhering thoria coating or covering. It is well known to a limited number of experts, who have experimented with thoria, that such a coating or covering can be obtained by electrolysis. This coating can be deposited on platinum in any desired thinness from an electrolyte properly prepared, and readily and comparatively cheaply. Dr. Auer mentions the electrolytic way of securing his osmium coating, but for some reason he does not mention in the body of his specification the electrolytic method of obtaining a thoria coating; nevertheless, in his claims he very adroitly covers, indirectly, in the Hungarian patent, the electrolytic process of coating with thoria. Why this indirection?

Because the electrolytic way is not patentable!

Neither is it new that thoria is an absolutely fireproof material, nor is it novel that a very slight coating of thoria protects platinum from the effect of high temperature by transforming heat energy into light emission.

It is not new that platinum wire coated with an enamel-like covering of thoria has an enormously increased electrical resistance, and consequently a minimal volume of high tension current will give intense light emission.

CORRESPONDENCE.

Recent Smashes at Brighton.

In the ELECTRICAL REVIEW, appearing rather ominously on April 1st, there appears an alarming report to the effect that Mr. Crompton distinctly stated in his speech at the Institution last Thursday evening, that there have been recently a great many smashes at the Brighton Electricity Works, and implied that these were due to the use of high tension steam dynamos, and to the breaking of steam pipes. Perhaps it will be sufficient for me to say briefly:

1. There have been no smashes at Brighton recently, or during the last seven years.
2. High tension steam dynamos are not used at Brighton.
3. There are no steam pipes in proximity to high tension apparatus.
4. No breakage of steam pipes has occurred.

From the above, it is very evident that there is a "Nigger" somewhere in the reported speech of Mr. Crompton, who is the very last person to intentionally mislead his audience.

Arthur Wright.
Per L. A. D.

Weatherproof Wire.

As a subscriber for four years past to the Electrical Review, as well as the writer of the article on "Weatherproof Wire," noticed in your editorial of March 11th, I suppose I should answer the questions asked in the latter part of the editorial.

To the first one, "How it is possible to maintain such circuits in wet weather?"—the inquiry referring to the so-called weatherproof wire strung in the ordinary American fashion on glass insulators—I beg to reply that so long as the wires remain on the insulators and do not swing into contact with other conductors or semi-conductors, the maintenance of the circuit presents no difficulty. The insulation resistance of such a circuit is, of course, proportional to the number of insulators, and the resistance per insulator depends on the shape and size of the insulator, but is usually above 10 megohms during and after a soaking rain. With poles spaced 50 per mile, the total leakage from a line of any ordinary length is of no commercial consequence. If concentrated on one insulator it might become of consequence by breaking down the insulation, but the leakage is not concentrated and the glasses do not break down in practice.

The result of such construction is, in wet weather, a line of low total insulation but of sufficiently high insulation at each point of support; in other words, a line on which the leakage is uniformly distributed. This condition really tends to steady running with the large series arc dynamos. It is not theoretically perfect but practically it is good enough.

As a contrast to the satisfactory results obtained with "weatherproof" main line, there are in this country several stations where circuits have been installed to conform with theoretical requirements *as taught in the schools*. I know personally several underground systems which test excellently but break down whenever there is any unusual surge, such as will occur in service in spite of all customary care. The American practice of using series dynamos of high voltage for the supply of street arc lights has developed a few machines which are unsteady as well as some others which are remarkably free from that vice; and the combination of a surging machine built for 125 or 150 arcs with cables insulated by $\frac{1}{8}$th inch (or thereabouts) of good rubber has caused much sorrow to engineers responsible for the combination. Even an alternating circuit will surge occasionally in consequence of a local short-circuit, and cables which would pass Board of Trade inspection, puncture after a fashion that is very trying to a man accustomed to overhead lines. The overhead lines do not break down under such conditions.

In reply to your second question, as to whether superintendents are not tempted to let linemen take risks in bad weather, I regret to say that superintendents are much the same all the world over, and that such officers have at times risked their own lives, and other men's lives, to avoid shutting down of circuits, which is not a practice to be commended. Nevertheless, there have been few accidents on main lines under the conditions that you suggest; because main lines seldom get in trouble; because the risk is well known; and because in most cases a makeshift repair can be made in a manner not involving any personal risk. A hand line, usually a cotton sash-cord well soaked with tallow, is part of the equipment of a trouble-man; and an old hand does very neat work, when occasion requires, in the way of lassoing a "crossed" wire and bridling it up out of mischief. In a well regulated station the trouble-man has the right to order any circuit shut down, and is expected to avail himself of this right as often as he thinks advisable. The superintendent who sends men into danger has always been the exception, and I think is disappearing altogether from our ranks. The superintendent who goes in himself, will, I suppose, always remain with us. Some of us are not entirely ashamed of scars got in our younger days in just this way. Our comment is, when the subject is mentioned, that we are now old enough to know better; that it takes a youngster to be so foolish.

You will allow me, as a stranger to your columns, the privilege of explaining that I have been for years an advocate of underground wires, and that the circuits which I have placed underground have been free from breakdowns. And you will appreciate that when I speak of theory as taught in the schools, I mean the incomplete theory which has grown out of practice, and which, therefore, is usually a year or two (at least) behind practice. The theory of the line on which the leakage is uniformly distributed has been studied only by the telegraphists, and their results are only of indirect service to the electric light man. The schools, so far, condemn low total insulation on any circuit, and are just beginning to understand that a leaky circuit which will not break down has been for years the accepted standard of American overhead practice. American underground practice was influenced at first by the school theory, and the early failures were due to a belief that high measured insulation was all that was requisite. Within the last five years we have added a breakdown test to our insulation test in writing cable specifications, and some of us now buy cables without any test but a breakdown test. In this we are approximating our underground theory to our overhead practice. We have not any overhead theory; therefore there continue to be inquiries such as yours as to why such circuits as ours are possible. My article, on which you commented, was not so much a defence of our overhead construction as an invitation to some of our scholastic friends to consider the facts, and to evolve from them a theory which would be acceptable to both students and workers.

Alex. Dow.

Detroit, U.S.A.

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending April 5th, 1897.	£	s.
Albany	32	0
Alexandria. Teleg. mat.	61	0
Amsterdam	175	0
Antwerp	22	0
Bilbao	32	0
Bombay...	13	0
Brisbane	150	0
Brussels...	918	0
Buenos Ayres. Teleg. cable	4,495	0
Bunderberg	15	0
Calcutta...	691	0
" Teleg. mat. ...	44	0
Cape Town	185	0
Cologne...	28	0
Colombo	20	0
" Teleg. mat.	24	0
Copenhagen. " "	23	0
Delagoa Bay	50	0
Durban	165	0
Flushing	14	0
Fremantle. Teleg. mat.	6,318	0
Hong Kong	50	0
Jersey. Teleg. mat. ...	35	0
Malta. Teleg. cable ...	8,280	0
Ostend	25	0
Paris. Teleg. mat. ...	26	0
Pernambuco. Teleg. cable	9,000	0
Port Elizabeth... ...	119	0
Rangoon	10	0
Singapore	156	0
" Teleg. cable	14,109	0
Stockholm	8	0
Sydney	315	0
Wellington	251	0
Yokohama	143	0
Total ...	£46,005	0

Week Ending April 5th, 1898.	£	s.
Adelaide	334	0
Alexandria. Teleph. mat.	16	0
Amsterdam	60	0
Barcelona	41	0
Boulogne	84	0
Bombay	333	0
Calcutta...	329	0
Cape Town	139	0
Colombo	51	0
East London	51	0
Flushing	36	0
Genoa	500	0
Gibraltar	199	0
Malaga	196	0
Maderia...	40	0
Melbourne	135	0
" Teleg. mat....	500	0
Odessa	90	0
Port Elizabeth... ...	670	0
Reval	315	0
Rio Janeiro	63	0
Stockholm. Teleph. mat.	100	0
Sydney	347	0
Trieste. Teleg. mat. ...	400	0
Trinidad.	16	0
Yokohama	225	0
Total ...	£6,870	0

Foreign Goods Transhipped.

	£	s.		£	s.
Sydney	66	0	Oporto	191	0

The Alexandra Palace.—In our "Note" last week re the electrical features of the Alexandra Palace, we omitted to mention that the lighting and motor power work of the Palace and grounds is being carried out by Mr. Percy Huddleston, on behalf of the Acme Motor and Traction Company. It is running at a voltage of 250 volts, and the work is being done according to the Phoenix Fire Insurance rules. The motive power plant employed includes two 10-H.P. nom. Crossley gas engines and a 20-H.P. nom. compound Fowler undertype engine. The dynamos and motors were specially made at the Acme Motor Company's works at Brentford. The arc lamps used are by the British Blahnik Arc Light Company, Limited.

New Offices.—Messrs. Dick's Asbestos Company, of Canning Town, have taken offices at 51 and 52, Fenchurch Street, E.C.

Electrical Wares Exported.

Week Ending April 12th, 1897.

	£	s.
Alexandria	144	0
" Teleg. mat.	99	0
Amsterdam	100	0
Antwerp	17	0
Auckland	231	0
Bombay	134	0
Brisbane. Teleg. mat ...	738	0
Buenos Ayres	77	0
Casino. Teleg. mat. ...	26	0
Calcutta	50	0
Cape Town	538	0
" Teleg. mat...	3,536	0
Colombo	12	0
Delagoa Bay. Teleg. mat.	5,837	0
Durban	261	0
East London	174	0
Flushing	92	0
Gothenburg	19	0
Hamburg. Teleg. mat.	158	0
Madeira	25	0
Madras	45	0
Malta	90	0
Marseilles. Elec. launch	225	0
Melbourne	99	0
Ostend	76	0
Paris	380	0
Port Elizabeth	558	0
" Teleg. mat.	155	0
Quilimane. Teleg. mat.	482	0
Reval	113	0
Rockhampton	350	0
Santos	202	0
Shanghai	189	0
" Teleg. mat....	820	0
Singapore	54	0
Stockholm. Teleg. mat.	55	0
Suez. Teleg. mat. ...	190	0
Vigo. " ...	26	0
Wellington	48	0
Yokohama	200	0
Total	£16,612	0

Week Ending April 12th, 1898.

	£	s
Albany	15	6
Amsterdam	100	0
Antigua. Teleg. mat.	16	0
Calcutta	56	0
Cape Town	1,102	0
Delagoa Bay	16	0
Durban	201	0
Gothenburg	22	0
Hong Kong	812	0
La Plata	12	0
Lisbon	75	0
North Atlantic. Teleg. cable...	11,520	0
Port Elizabeth	258	0
Sydney	653	0
Wellington	100	0
Total	£14,958	0

Books Received.—"Alternate Currents in Practice," translated from the French of Loppé and Bouquet by F. J. Moffett, B.A. Whittaker & Co., 15s.

"Theory and Practice of Electrolytic Methods of Analysis," by Dr. Bernard Neumann, of Aachen, translated by J. B. C. Kershaw, F.I.C. Whittaker & Co., 10s. 6d.

"Radiography and the X Rays: In Practice and Theory," by S. R. Bottone. Whittaker & Co., 3s.

Catalogues.—We have received from Messrs. Gent and Company, of Leicester, a copy of their price list of pneumatic and electric bells, telephones, batteries, wires, &c., in which are given numerous illustrations of these classes of apparatus and sundry accessorial parts. From the same firm we have also received a pamphlet on electric lighting, giving general instructions for both town and private plants. The machinery and apparatus, and the many small fittings necessary for a lighting installation are illustrated and described in the pamphlet. Both lists contain prices.

Messrs. Dobson & Curtis Bros., Limited, of Suffolk Street, Dublin, send us a copy of the third edition of their catalogue of electric bells, telephones, &c. This firm, which has also a Birmingham branch, has carried out many large contracts in both England and Ireland, the most recent in England being for the Cycle Components Manufacturing Company, of Birmingham, the Dunlop Pneumatic Tyre Company, of Coventry, and Mr. Harvey Du Cros's private residence at Cornbury Park, Oxfordshire.

The Corporation of London v. City of London Electric Lighting Company.—At the Guildhall last week, before Alderman Sir J. T. Ritchie, an application was made concerning the City of London Electric Lighting Company, Limited, by the City Solicitor on behalf of the Corporation to ascertain the fees and reasonable expenses of an electrical inspector employed by the City, who claimed to the amount of £1,142 2s. 7d. under Section 47 of the Electric Lighting Orders Confirmation Act, 1890. Mr. Rose-Innes represented the Corporation of the City of London, and Mr. Roskill appeared for the company.

Mr. Rose-Innes opened the case, and pointed out that so far as the public was concerned it was essential that the electric light supplied should be kept up to a certain standard. The Electric Lighting Order of 1892 provided that an electrical inspector should be created by the Local Authority—in the present case the Corporation—and that all fees and reasonable expenses, unless agreed upon, should be ascertained by a court of summary jurisdiction, or, where appointed, the Board of Trade. What the Alderman had to decide was the amount to be paid by the electric light company to the Corporation for the inspection of meters. The electric inspector was to be "an impartial person standing in a judicial position," and the point which arose for determination was—apart from the salary which the Corporation saw fit to allow this gentleman—what were the fees and reasonable expenses in regard to the work which he had done.

Mr. Roskill said he did not dispute the scale of fees settled by the Board of Trade.

Mr. A. A. Voysey, electrical engineer to the Corporation, said in respect of his employment as electrical inspector, he received a salary from the Corporation. He was familiar with Sections 35 to 47, showing his duties. He found it necessary to have a testing office; this was near the Wool Exchange. The rent was originally £195 a year, but it was afterwards reduced to £170. This was paid by the late Commissioners of Sewers. His duty was to test meters with a view of deciding disputes between the lighting company and the consumer. The witness gave the various items of office expenses, which he said were paid by the Corporation. Mr. Voysey said he was aware that other public bodies had electrical inspectors—the London County Council, for instance.

Mr. Roskill: Are you aware that they never test meters, except on the premises of the consumer?

The Witness: Certainly not.

Mr. Roskill: Then you would be surprised to hear that that is so?

The Witness: Yes. I should not believe it.

Sir James Ritchie: In my neighbourhood the County Council have a beautiful building, and outside is written "County Council Testing Station."

Mr. Roskill said he was now informed that the County Council did have their own testing stations, but they made no charge on what was technically called the "undertaker."

Mr. Voysey, in answer to further questions, said he did other work besides testing in his office.

Mr. Roskill then at some length argued on the construction of the words "reasonable expenses." He contended that such expenses meant those incurred by the inspector travelling to test meters, and so forth, but how the Corporation could contend that the company were liable for any portion of the items put forward passed his understanding. The contention of Mr. Rose-Innes was this: That the Corporation appointed an inspector, supplied him with offices, instruments, and assistants at any cost they pleased, and then charged the electric lighting company for these things.

The Alderman: I have come to the conclusion that these are not reasonable expenses within the meaning of the Act, but I suppose one will have to hear evidence of what may be reasonable. I do not think that the electrical company are bound to provide offices and so on for these inspectors.

Mr. F. Bailey, chief engineer to the City of London Electric Lighting Company, having given evidence,

Sir James Ritchie said if a higher Court held that the items mentioned could be included amongst "reasonable expenses," in order to save the parties coming before him again, he would fix an amount. Inasmuch as the inspector had said that he gave about two-thirds of his time to testing he would reduce the amount to £937 11s. 8d. This was merely a formal matter to save the case being brought before him again to settle this question should a higher Court decide against him.

Mr. Roskill: Then the summons is dismissed subject to a special case.

Dissolution of Partnership.—Messrs. H. W. Ellis and E. W. T. Ward (Ellis & Ward, electrical engineers, Edmund Street, Birmingham) have dissolved partnership. Mr. Ellis will continue the business at the old address under the same name as formerly.

Electric Clocks.—The Swansea Public Library has deferred the question of electric clocks for the library for six months.

Electric Winding Plant.—On February 7th an electrical winding plant was inaugurated at the No. 2 south Great Eastern mine in the presence of an influential company from Gympie and Brisbane. The plant was manufactured and erected by Messrs. Trackson Bros., of Brisbane. A generator made by Laurence Scott & Co., supplies current to the motor, the shaft of which is coupled to the worm gear, which operates a gun-metal worm wheel keyed upon the shaft, which carries the winding drums. The distance between the generator in the engine room and the winding plant below is close upon 2,000 feet. The directors and manager expressed themselves perfectly satisfied at the way the plant handled various loads at different speeds. The design and erection of the plant has been supervised by Mr. P. Trackson, A.I.E.E.

First Meeting.—The first meeting of creditors in the bankruptcy of J. Fletcher and J. A. Hirst (Fletcher, Hirst & Co., electrical and mechanical engineers, of Chester and Derby) is to be held at the official receiver's office, Byrom Street, Manchester, on April 19th, at 3.30 o'clock. The public examination is fixed for April 29th, at 11 o'clock, in the Court House, Burnley.

Liquidation Notices.—At meetings of the British Electrozone Corporation, on February 8th and March 8th, resolutions were passed winding up voluntarily, and appointing Mr. A. E. Edwards, of Broad Street Avenue, E.C., liquidator.

A meeting of Messrs. J. C. Howell, Limited, is to be held at 6, Old Jewry, E.C., on May 16th, at 11 o'clock, to receive an account of the winding up operations from the liquidator, Mr. S. F. Lit.

Parliamentary Bills.—The *Daily Chronicle* had an article on Wednesday giving particulars of the progress of the numerous private Bills which are now before Parliament. There is an increase in the number and value of the Bills deposited for this session. There are 30 Bills relating to tramways, and the proposed capital involved in them is upwards of £1,800,000. Gas Bills ask £1,732,000, and electricity Bills come in with a modest million, and measures under the provisional order system account for a further sum of three millions odd, which the promoters seek to raise in respect of schemes for tramway, gas and water, electric lighting, &c. Five Bills to authorise the construction of new underground railways in the metropolis were deposited. The Charing Cross, Euston, and Hampstead Railway Bill has been read a third time in the Commons; another—the City and Brixton Bill has been reported by the Committee which considered it, and awaits third reading, and the Great Northern and City Railway, which is for an extension of the authorised undertaking, awaits second reading. Power to work by electricity is also being sought in the Metropolitan Railway Bill, and has been granted by the House of Commons Committee, to which the measure was referred. Notwithstanding the facilities given to promoters by the Light Railways Act, there are but three measures containing schemes for light railways and one for the acquisition of a railway which it is proposed to work as a light railway. Upwards of 80 provisional orders have been made by the Board of Trade under the Electric Lighting Acts, with a view to their submission to Parliament for confirmation; and there are besides four Bills relating to the supply of electrical energy seeking powers beyond the scope of the general Electric Lighting Acts. Some of the important questions so raised stand referred to the consideration of a Joint Committee of both Houses, which will sit again after Easter, and whose report will be awaited with interest.

Tasker & Sons, Limited, v. London & County Hotels Company, Limited.—This case came before the Coventry County Court on Tuesday last week. The plaintiffs, electric light engineers, of Andover, Coventry, and other places, sued the defendants for goods and work done in the construction of electric light apparatus at the King's Head Hotel, Coventry. It appeared that the plaintiffs supplied the hotel in May, 1897, with an installation of four electric arc lamps, using the city current. Defendants found the humming noise of the lamps annoyed their customers to such an extent that the lamps could not be used, and plaintiffs were asked to remove them. Mr. J. W. Manley, plaintiffs' local manager, stated that this humming noise was caused solely by the fact that the city current was an alternating one. His firm had on one or two occasions made alterations suggested by defendants' manager, with a view to mitigating the noise caused by two of the lamps being hung under a glass roof. The defendant company's case was that their manager was advised by an engineer of the plaintiff company to instal arc lamps, when nothing was said about the noise. They did not allege defective construction of the arc lamps, but the noise caused by them caused the customers to leave the hotel. His Honour gave judgment for £59 8s. 9d. for plaintiffs, striking out some extras for the fitting of speaking tubes which formed part of the claim.

Siemens & Halske.—Messrs. Siemens & Halske, of Berlin, are increasing their capital to £2,000,000. The Austrian and Hungarian branches of this firm are, it is reported, to be formed into a separate joint stock company.

Volenite.—Lord Lurgan, the chairman of the Fish Oil and Guano Company, had a good deal to say to his shareholders on the 5th inst. about volenite, to exploit which his company is bringing out another company. He said that tests of volenite had proved it equal to gutta-percha and superior to vulcanite. Its electrical resistance was really extraordinary. They were anticipating the results of some tests for the possibility of covering cables with this material, but a test of 10 to 12 months would be necessary, and they had seriously considered whether to wait that time before producing it, or whether they would find out to what other uses and purposes volenite might be applied. They decided to make the latter tests at once, and they very soon discovered that volenite was just as valuable for the purpose of steam boiler and steam engine packing as it was for electric cable work. Therefore, in view of its use for various purposes, they decided that they were justified in issuing volenite at once. It was now almost ready for registration. The prospectus was prepared. His lordship read reports made upon the material by Mr. Philip C. Pope, consulting electrical engineer, and Mr. J. W. Bevan, and opinions of other gentlemen. With regard to the manufacture of volenite it is intended to at present confine it to the United Kingdom. Favourable offers had been made for the sale of the patent for America, but it had not yet been decided whether to increase the capital and make it for all the world, or to sell the patent for different countries.

ELECTRIC LIGHTING NOTES.

Ayr.—Mr. Fuller's report as to extensions has been adopted by the Commissioners at a cost of £1,187.

Balmoral.—The daily papers say that the Queen has decided to light Balmoral Castle by electricity, and an enormous quantity of large iron pipes has already been delivered. These pipes are intended to convey water power from the Gelder, a stream running into the Dee at a point about 1½ miles from Balmoral, and the dynamos will be driven by water power.

Barnsley.—The Park and Lighting Committee report having held three meetings for the consideration of Mr. Miller's scheme for electrical supply to the borough. Mr. Miller attended and explained the scheme, and the further consideration stands adjourned until a special meeting on the 23rd inst.

Bath.—Mr. Hammond is to prepare a statement for the Council, showing the amount expended upon the electricity works together with the outstanding liabilities on the balances of contracts, and a special meeting is to be held to consider it. The Electric Construction Company has consented to give a guarantee in connection with the erection of arc lamps without having a preliminary test. Thirty out of 40 new lamps have been erected, and will be connected as soon as the circuit is completed.

Belfast.—The statement of accounts for the year ended December 31st, 1897, showed the electricity undertaking to be in a sound financial condition and progressing rapidly in the public estimation, and in view of the probability of having a considerable sum to pay this year by way of interest on the large capital expenditure connected with the new station which cannot be productive for some time, the balance carried forward from last year was ordered to be allocated for this purpose. The meters necessary on the introduction of Wright's system of charging for electric current on July 1st, are to be purchased, and also a fourth Lancashire boiler to complete the first section of the new station.

Blackpool.—The Corporation passed the following resolutions on 5th inst.:—"That subject to the confirmation of the Local Government Board to the requisite loan, the tenders of the firms undermentioned for extensions at the Corporation Electricity Works be accepted, viz.: Boiler and superheaters, Messrs. Babcock and Wilcox, Limited; condensers and storage tanks, Messrs. Cole Marchent & Morley; rectifiers, Messrs. S. Z. de Ferranti, Limited; boosters, Mr. Chas. J. Cowan; cables, British Insulated Wire Company; transformers, Messrs. Nalder & Hilton, Limited." "That the approved standard clauses issued by the Electrical Engineering Plant Manufacturers' Association, and the Municipal Electric Association, for the adoption among the general conditions of specifications for electrical engineering plant, be referred to the town clerk and borough electrical engineer for inclusion, if they think so fit, in any conditions of specification for electrical engineering plant issued by the Electric Lighting Committee."

Bournemouth.—The following tenders were sent in for supplying and fixing cables, conductors, lamps, columns, fittings, &c., for the lighting of the pier and Lower Pleasure Grounds:—

	£	s.	d.
Messrs. Johnson & Phillips	2,255	18	0
Brush Electric Engineering Company	1,740	0	0
Messrs. Fippard & Cooper	1,521	18	0
Mr. L. G. Tate	1,602	0	0
Messrs. Laing, Wharton & Down, Limited	1,707	0	0
Messrs Cash, Robinson & Co.	1,252	17	0
Bournemouth and District Electric Supply Company	1,415	0	0
British Insulated Wire Company, Limited	1,583	14	9
Mr. E. G. Bryant	1,458	6	0
Messrs. Crompton & Co., Limited	5,204	0	0

The surveyor recommended the tenders of Messrs. Cash, Robinson and Co., and the Bournemouth and District Electric Supply Company for consideration. The Council had a discussion as to whether, seeing that the Corporation license from the Board of Trade for electric lighting purposes had only three years to run, it would be wise to lay down plant and spend £2,000 if the plant would be of no use at the end of that period.

On Thursday last week a Local Government Board inquiry was held *re* several sums to be raised for public works by the Corporation, including £2,500 for the electric lighting of the pier and pleasure gardens.

Bradford.—The Gas and Electricity Committee have decided to reduce the price of electricity for lighting by a ½d. per unit, and have also fixed a sliding scale for motors, making prices range from 2½d. to 1d. per unit.

Brighton.—The Town Council on Thursday last week had a debate upon a proposal by the Lighting Committee to reduce the price of the electric current after the first hour's usage from 1½d. to 1d. per unit. The accounts for the year ended December, 1897, showed that, after making provision for the annual charges for interest and the repayment of loans, there remained a net profit on the year's working of £2,864. Out of this amount the Committee proposed to apply £2,000 to the relief of the rates and to add the £864 to the reserve fund. The Council divided on an amendment by Mr. Buckwell that the price should not be reduced, and this amendment was carried by 18 votes to 17.

Bulawayo.—At a recent meeting of the Municipal Council a letter was read from Colonel Heyman, stating the terms upon which the contractor (being the Electric Light Company), was prepared to supply the light to the Council. This was stated to be 1s. 7d. per unit. It was further stated that the Government was prepared to vest its lighting contract in the Council. This matter was referred to the P. W. Committee.

Camberwell.—The General Purposes Committee has had under further consideration the question of the proposed purchase of the undertaking of the County of London and Brush Provincial Electric Lighting Company, Limited, and has received a statement that the estimated cost of the work done in the parish up to date was £3,200. The committee recommended that the proposed purchase be not proceeded with, and this has been agreed to.

Cardiff.—The Lighting and Electrical Committee has agreed that the conditionally accepted tender of the Atlas Engineering Company, Canton, for the supply of a number of junction boxes for the electrical department be rejected, as the company does not comply with the fair wages clause. The contract has been given to Mr. Wilkinson, of Cardiff.

Dewsbury.—The Electricity Committee has approved of the doubling of the existing trunk mains at a cost of £5,000, of an extension of mains in a part of the borough not yet served at a cost of £2,500, and of the purchase and laying down of an additional engine and dynamo at a further charge of £2,450, including the cost of an extension of the building at the central station. The electrician (Mr. Mitchell) having resigned, to take a situation at Southend-on-Sea, it was decided to postpone the carrying out of the extension scheme until the appointment of his successor. The General Purposes Committee has considered a recommendation that the new electrical engineer should be paid a salary of £200, and be allowed to take a pupil, but has decided to pay £250, and not to allow a pupil to be engaged.

Douglas.—Prof. Fleming was yesterday to have an interview with the Douglas Town Council for the purpose of advising them as to the electric lighting of Douglas.

Dublin.—At the last Corporation meeting the Lord Mayor moved the adoption of a report of the committee of the whole house recommending the application of the Corporation to the Local Government Board for a loan of £20,000 for new electric cables and works connected therewith, and for the establishment of subtransformer stations. A proposal from the Dublin United Tramway Company to take over the lighting of the city on certain conditions, and an offer of a similar nature from Messrs. Jameson, Cobb, Pearson and Co., of London, were considered simultaneously with the report, and his lordship moved that they be taken as read. The report stated the committee considered a report from Prof. Kennedy, consulting electrical engineer, and finally decided on his advice to adopt cables insulated with vulcanised bitumen as made by Messrs. Callender & Co., and of a system of low-tension distribution.

Durham.—The Town Council is considering the question of electric lighting. The Gas Lighting Committee recommended that specifications and estimates be obtained of the cost of erecting plant, but an amendment referring the matter back to the Committee to obtain terms upon which electric lighting companies would supply the Council for street lighting and private consumers was adopted.

Dundee.—Mr. Tittensor, the electrical engineer, submitted a lengthy report to the Gas Committee last week with reference to the extension of the electric lighting area of the city. He gives a statement of the development of the lighting within the old area since the opening of the supply in 1893 as follows:—

	Lamps connected.	Units sold.	Increase.
1893	8,470	66,228	—
1894	11,860	156,843	90,615
1895	14,001	202,437	45,594
1896	17,945	254,278	51,841
1897	22,897	323,187	68,909

The length of streets through which mains were laid for supply up to the end of 1897 was four miles. The extended area gives a total length of street of eight miles. In the new districts he anticipated a demand for 25,000 lamps after five years, exclusive of public lighting. The distribution mains of the new area would be fed from the present generating stations through four sets of feeder mains. The whole of the extended area could be supplied from the present station, and the following additions would be required:—The present engine and boiler house would have to be extended. The additional plant required would be:—Boilers equal to 900 horse-power, engines and dynamos equal to 900 horse-power, together with the necessary steam pipes, pumps, economiser, and switching gear. He estimated the cost of all these extensions as follows:—Distribution mains, £14,400; feeder mains, £4,000; buildings, &c., £3,600; boilers, seatings, and fittings, &c., £1,800; engines, dynamos, &c., £8,000; steam pipes, &c., £1,200; switchboards and instruments, £1,400; economisers, &c., £600—total cost, £35,000. This included spare culverts along the existing tramway routes for the reception of feeder mains in the event of electrical traction being adopted, as recommended by Messrs. Urquhart & Small. The most suitable system to adopt for the extended area would be a three-wire system distributing at 200 volts at consumers' terminals. This would enable the whole of the plant and batteries now in use at the generating station to be used in conjunction with the new plant without much alteration, and would also make the new system of mains gradually take up the increasing load on the old area, which would thus develop itself into a three-wire system at 200 volts similar to the extended area. He did not consider that a higher pressure of supply than 200 volts was necessary within the limits of the extended area, as the higher the pressure adopted, the greater the disadvantage to those customers using arc lamps, in the increased cost of current for the same. At the present time there were 22,897 lamps connected in the old area, of which 16,000 were supplied at the old pressure of 100 volts, the remaining 6,897 being supplied at 200 volts, in accordance with the statutory notice given in June, 1897. It would be of great advantage if the whole were converted into a 200-volt supply, although it would entail serious disadvantages to several of the customers. If a compulsory change were made all over the city, the expense would devolve upon the Town Council, which would include replacing all 100-volt lamps with those at 200. It would also be necessary to exchange all arc lamps burning in pairs at 100 volts for those designed to burn in pairs at 200 volts, and all motors in use at 100 volts would have to be rewound. The total cost of this would be about £1,800. The most serious objection to such a sweeping reform was that those customers (of which there were several) having at present only one arc lamp installed, would be paying at the rate of 9d. per unit for current for the same lamp at 200 volts, being just double their original rate. No doubt this objection would be overcome at no distant date by the introduction of new and improved lamps. He would therefore recommend that all those mains supplying customers at 200 volts be connected up to the new system to be laid as a three-wire system at 200 volts, and those mains supplying the older customers at 100 volts be "inter" connected as a modified five-wire system supplying at 100 volts, until such time that it might become necessary or expedient to gradually change on to the 200-volt supply, after which the whole of the old and new area would resolve itself into one three-wire system at the higher voltage. He recommended that the laying of the mains should be proceeded with gradually as the demand arose, thus spreading the cost over several years. The present requirements would be the extension of the present buildings at the generating station, the laying down of the three-feeder mains to the north, east, and west districts, and the erection of one boiler, engine, and dynamo, with the necessary piping, &c., at a cost of £9,300. The committee resolved to consider the whole question at another meeting.

The Gas Committee recommends that Mr. Tittensor's salary be advanced £50 per annum.

East Grinstead.—There was a long discussion at the District Council last week on the proposition made by Mr. Steer that application be made for a provisional order as soon as the probable cost to be incurred in carrying out a scheme is ascertained. The resolution was carried.

Eccles.—The electrical engineer (Mr. Clirehugh) has reported upon the progress of the electricity works. The buildings had progressed very slowly. The main laying will be commenced during this week. The cables are now all manufactured. Mr. Clirehugh's draft of charges to be made for electrical energy has been approved.

Edinburgh.—The Cleaning Committee recommended the Council to light a number of additional streets by electricity, but after discussion the matter was re-committed. Mr. Mackenzie, in supporting the Committee's proposal, said that the number of lamps sanctioned formerly by the Council, including 37 for Portobello, was 540. The Council sanctioned 91 additional, which included 12 for the Middle Meadow Walk, which had since been withdrawn at the request of the Parks Committee, who considered that the Middle Meadow Walk was not suitable for the electric light. If these 59 new lamps were sanctioned the Electric Light Committee saw its way to reduce the cost per lamp all over the city from £16 to £14. The Electric Lighting Committee recommended that the charge for electric energy as from May 15th next be 3½d. per unit with discount, the charge for each public lamp £14 per annum, and the charge for motor power 1½d. per unit. On the motion of Bailie Mackenzie, the first part of the motion was agreed to, and the second portion was re-committed, in view of the discussion that had taken place on the report of the Cleaning and Lighting Committee.

Folkestone.—At the West Cliff Hotel electricity has been installed throughout. In all there are 640 lights.

Halifax.—The Gas Works Committee entertained the members of the Town Council at a banquet recently, and in some remarks made by Mr. Wilmshurst, the borough electrical engineer, it was stated that the fact that the Electricity Committee had provided for many years extension undoubtedly militated against their making an immediate profit, but he thought there was a prospect of turning the corner this year. The prospects for the future were very good. On March 31st, 1895, they had 92 consumers; a year later they had 179; on March 31st, 1897, they had 235, and for the year ending March 31st, 1898, 309. So that although they had not made a profit, yet they were building up a very sound business.

Hastings.—The Electric Light Company is to light the front during April and May at £4 per lamp per month, and during June and July at £3 per month.

Hereford.—The Electric Lighting Provisional Order has been referred to a special committee for consideration and report.

Ilfracombe.—The District Council proposes to expend £10,000 in the construction of electric plant, &c., for the purpose of illuminating the town by the electric light.

Inverness.—The Town Council has been discussing the feasibility of introducing the electric light into the town. Messrs. Fraser & MacCallum, solicitors, had written to the effect that a local company was about to be formed with the view of lighting the borough and vicinity by electricity, and asking if the Council would agree not to oppose the undertaking. It was considered by the Council that the works should be done by the municipality, and a committee is to be appointed to ascertain whether there is such a demand for the light as to justify the Council in taking steps to introduce it.

Lancaster.—Mains are to be laid for supplying current to the Bowerham Board School. The Lighting Committee recommends the Council: "That the Electricity Committee be asked to discontinue the charging of rent for the street arc lamps, in order to place a larger sum of money at the disposal of this Committee for street lighting purposes." The consideration of the matter is to be deferred for six months.

Leith.—The Town Council has resolved: "That, owing to the great cost of carrying out the electric lighting scheme, and the probability that, for a number of years at least, it will be a serious burden upon the ratepayers, the Electric Lighting Committee be instructed to use the utmost economy, consistent with efficiency, in carrying out the work, and that no new expenditure be incurred beyond that already sanctioned without first reporting and obtaining the authority of the Town Council." The chairman remarked that the estimates had already been cut down by £3,000.

Lewes.—A special meeting of the Council is to be held to consider what steps shall be taken regarding the electric lighting provisional order when it has been confirmed by Parliament.

Liverpool.—The City Council has resolved that from April 1st, 1898, the prices to be charged for the supply of electrical energy at a pressure of 230 volts be:—For general lighting, 5d. per unit for each unit up to 1,000 units per quarter, and 4d. per unit for each unit in excess of 1,000 units; for Corporation departments, 4d. per unit; for street lighting, 3d. per unit; for power purposes, 2d. per unit.

London County Council.—The Council has decided to lend £13,660 to the Vestry of Islington for electric lighting extensions. The Finance Committee stated that the Vestry proposed to add to the Eden Grove generating station two water-tube boilers, one 500-H.P. engine, and one 300-kilowatt alternator, and to extend the mains in Liverpool, Wellington, and St. James's Roads. The Council is withholding its consent from the County of London Company re-laying mains in several Dulwich and Peckham roads for the present, on account of the appointment of the Parliamentary Committee on electrical matters which is shortly to sit. It will be remembered that last February the Council accepted the tender of the National Electric Free Wiring Company to carry out the electric light installation at the chief station of the fire brigade for £992, less the amount of the wages of certain of the Council's employés to be engaged on part of the work. Referring to this matter, the Fire Brigade Committee has now reported that, on further consideration, it has come to the conclusion that it would be better for all the work to be carried out in its entirety by the company's employés. The company had acquiesced in this, and the Council's servants employed on the work had been withdrawn.

Lyndhurst.—Messrs. Warburg, Dymond & Co., of London, have informed the New Forest District Council that it was proposed to form a limited liability company with the object of putting down a plant for the electric lighting of Lyndhurst, and that they purposed purchasing a suitable site at Glasshayes. It was their intention to apply forthwith for a license from the Board of Trade. The Lyndhurst Parish Council is to have the opportunity of considering the matter and taking the opinion of a parish meeting upon it.

Oldbury.—The District Council has withdrawn its opposition to the provisional order of the Midland Corporation, Limited.

Ossett.—The Town Council has received a provisional order authorising the Council to lay down electric lighting plant, and to supply the borough.

Paddington.—The Guardians' Visiting Committee is inquiring into the cost of installing the electric light in the north block of the workhouse, the chapel, and the dining hall.

Rathmines.—At the last meeting of the Commissioners Mr. Booth called attention to a report made about 12 months ago by Mr. Hamwood, electrical engineer, setting out two methods by which the electric lighting of the township might be carried out. Mr. Hamwood was in Dublin in January last, and then promised to draw up an amended report for 25 guineas. In that report several of the previous proposals would be altered, owing to the improvements that had recently taken place in this branch of science. He proposed that the board should accept this offer. It was resolved to request the Electric Lighting Committee to meet and consider what steps the board should take to save their rights under the order in Council, and to take such action as they may deem advisable.

Reading.—The Highways and Lighting Committee has received a letter from the Board of Trade, enclosing an amended description of the systems proposed to be adopted for the supply of energy under the Reading Supply Order, 1893. The committee also received Mr. Bowen's report, and on his recommendation approved the proposed works, subject to a number of amendments and conditions suggested by him.

Salford.—The Council has approved the proposal of the Electric Light Committee to purchase land abutting on Bedlam Lane, off Strawberry Road, as a site for a new generating station for the electric light. The Council were asked to vary the resolution of the Council of January 5th last, authorising an application to the Local Government Board for power to borrow £50,000 for the purposes of electric lighting. It was now, under different circumstances, proposed to ask for £33,000. The resolution was adopted.

Shoreditch.—The cost of laying larger cables in Curtain Road, Great Eastern Street and Old Street (authorised by the Vestry) will be about £2,000.

Southall.—The Town Council has received a letter from Messrs. Brewer & Meaby, with reference to supplying electric light. This has been referred to the Committee.

Southport.—The Gas Committee recently opposed a proposal on the part of the Electricity Committee to add 42 arc lamps to the street lighting, and it was withdrawn. The salary of the electrical engineer (Mr. C. D. Taite) is to be advanced from £230 to £280.

Stirling.—Mr. R. F. Yorke has submitted a lengthy report to the Police Commissioners on the water power available at Touch for the electric lighting of Stirling. He shows that by utilising the water power which exists in connection with the Touch reservoirs, they could, with a moderate expenditure of some £13,000 to £14,000, deal effectually with the lighting of the extended area, viz., 8,000 lamps connected; and that by charging for the private lighting at the rate of 4½d. per unit, there would be a considerable surplus as soon as the total number of lamps have been taken up. His estimate for capital outlay is as follows:—

	£
Two 54-H.P. turbines, with frames, suction pipes, delivery and erection..	540
Two dynamos	380
Switchboard	80
Buildings..	200
Fittings, &c.	20
Underground cable—3½ miles concentric 37/13, with laying and jointing..	2,495
Accumulators—250 cells = capacity 308 amperes, for three hours, or 154 amperes for six hours = 4,466 lamps for three hours	2,525
Stands and converting buildings	100
Allow for continuation of two 12-inch pipes, with laying and jointing..	200
Allow for trench for cables	100
Engineer's fees and contingencies ..	410
	£7,000
Allow for distribution—mains, meters, &c.	6,500
	£13,500
Working expenses	£650

For repayment of generating and distributing plant, with interest, allow 5 per cent. of total cost of £13,500 = £675. Although 8,000 lamps connected is a large proportion for the number of the inhabitants, it will be possible, by utilising the additional power from another reservoir, to supply current for another 4,000 lamps, *i.e.*, a total of 12,000 lamps connected. Mr. Yorke's scheme includes turbines by Messrs. Gilkes, dynamos by Laurence Scott & Co., cables by the British Insulated Wire Company, and accumulators by the Chloride Electrical Storage Syndicate. The Commissioners remitted it to the Lighting Committee to see whether the necessary consents and wayleaves can be obtained, and to report, so that they are not at present committed to anything.

Swansea.—Mr. Manville's report on the electric lighting scheme puts the capital expenditure, after adding 7½ per cent. for contingencies, engineering, &c., at £35,936. In his estimate of the revenue derivable, he gives 15,700 8-C.P. lamps for private lighting, which would, at 4½d. per unit, bring in £4,444, whilst the public lighting would bring in £733, making a total of £5,177.

Wednesbury.—The Town Council last week resolved by eight votes to five, to make application for a provisional order. There was a lengthy discussion.

Woking.—The Electric Supply Company has undertaken to have all the street lamps overhauled immediately and renewed where necessary.

Yarmouth.—The Council has decided to borrow £4,800 more for further additions to the electric lighting plant, making £40,000 in all. In the last three months considerably over £500 has been earned beyond the actual cost of production. Mr. George Bryant, assistant engineer of the electrical supply station, has been appointed chief engineer, in succession to Mr. A. W. Ranken, who had resigned.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Argentine. — At last week's meeting of the Anglo-Argentine Tramway Company, held in London, the Chairman said that with regard to the question of electric traction, the Board had come to the conclusion that favourable results might be obtained by using electricity on certain parts of the line. An offer had been made by a body of financiers to find the necessary capital for the conversion of the system, but he was unable at that moment to enter into details. The shareholders would be consulted before any binding agreement was entered into.

Blackpool.—At last week's Council meeting Mr. J. Brodie, the chairman of the Electric Lighting and Tramways Committee submitted the report of a deputation which had visited Paris, Berlin, Hanover, &c., to study the system of tramway traction. It was the unanimous recommendation of the deputation that the overhead system be adopted. If the Council favoured the accumulators, well and good, but they must be prepared to run the tramways at a loss.

Brighton.—The Council has refused to grant a license to a Montreal firm to construct and operate an electric trolley system in the borough.

Derby-Ashbourne. — The promoters of this proposed light railway have decided to apply to Parliament for further powers, this step having been rendered necessary by the decision recently arrived at to alter the original plans as to the termini.

Dudley.—On Tuesday last week the mayor stated to the Town Council that the previous day Mr. Albright, Mr. Addenbrooke, and Mr. Lowe, of the Midland Electric Power Distribution Company, had attended a meeting of the Electrical Railway and Tramway Committee and quoted prices for local supply of electricity. The company would supply electricity and lay mains for the first 100 hours at 5½d. per unit, and at 2½d. per unit for subsequent supply. If the Corporation provided the mains the prices would be 5d. and 2d. The company would supply the electricity in bulk at a uniform price of 3½d., they laying the mains; or 2¾d. if the Corporation laid the mains. The price for public lighting would be 1·6d per unit, and for electric traction 1½d. per unit. It was understood that the current would only be brought to a given point in the town. Subsequently Alderman Garratt and Alderman Bagott were added to the Committee, and Alderman Bagott made a hopeful statement as to the future of the tramway undertaking. He was, he said, sure that with good management the proposed electric tramways would be a source of great profit to the borough. The Council confirmed formally the recommendations to take the necessary steps for taking over the lines.

Dudley and Stourbridge.—The British Electric Traction Company, which recently purchased the Dudley and Stourbridge Tramways for £44,000, has entered into a contract for the transposal of the existing steam tramway from Stourbridge to Hart's Hill, Dudley, into an electric system. A site for a power station has been secured by the company near Canal Street, Brierley Hill, and electric cars will be run from Hart's Hill to Stourbridge within about six months, and through Dudley as soon as, and if, arrangements can be effected with the Dudley Corporation. The contract for the alterations to the permanent way and for the electric equipment has been secured by Messrs. Dick, Kerr & Co. It may be remembered that the British Electric Traction Company, after acquiring the line from Stourbridge to Hart's Hill, obtained an order to construct a new tramway to Cradley Heath from Dudley, and to Kingswinford and Stourbridge. The Dudley Town Council, however, are opposing the Dudley and Cradley Heath order given by the Light Railway Commissioners on the ground that they are desirous of making the line themselves. The lease of the portion of the Dudley and Stourbridge line from Dudley to the boundary at Hart's Hill expires at the end of about five years, and it is the intention of the Dudley Corporation, as the matter stands at present, to seek to work that portion also.

Folkestone.—The promoters of the Folkestone District Light Railways have intimated their intention of not proceeding with the application to the Commissioners for the construction of the proposed railways in Folkestone, Sandgate and Hythe.

Liverpool.—At the last City Council meeting, Sir Arthur Forwood, chairman of the Tramways Committee, moved a recommendation that the necessary steps be taken to construct a new road continuing Park Road into Aigburth Road. They were laying down a new system of electric tramways to the Dingle. At present the lines running from Peel Street, Park Road, to the Dingle dipped 15 feet, and from the Dingle to Aigburth Road they rose again 12 feet. The suggestion of the committee was to acquire the property between the corner of Peel Street and Aigburth Road voluntarily, so that they might then make a direct connection between Aigburth Road and Park Road almost on a dead level at a reasonable cost. After discussion the proposal was taken back.

Llandudno.—The Town Council last week agreed to a scheme promoted by a syndicate for the construction of a light railway connecting Colwyn Bay, Llandudno, and Deganwy.

Newcastle.—At a meeting of the Tramways Committee on 4th inst., Mr. Laws, city engineer, reported that the total amount of double track upon the seven sections already decided on by the committee amounted to 12 miles 394 yards. He estimated that the cost of laying down this distance, either with cables or the overhead electrical system, would be £245,000. It was agreed, acting under a resolution passed by the Council, that Mr. Laws should be requested to furnish the committee with the names of two experts—one to advise the committee with respect to the cable, and the other with respect to the overhead electrical system. Mr. Laws will present the names of the experts whom he deems most suitable for this work to the next meeting of the committee, to be held on May 3rd. The resolution provides that the committee "shall have the power to engage an expert or experts to advise with respect to the best system to be adopted, such experts to be gentlemen who are not connected financially with any system of tramways, or any company for the promotion of tramways."

Northampton.—In our note regarding the Northampton tramways last week, the word Nottingham in line 3, should, of course, read Northampton.

Norwich.—Notice appeared in the *London Gazette* last Friday of application being made by the Norwich Electric Tramways Company for additional provision for leave to introduce in their Bill various new powers for street widening and alteration, and for deviation of the authorised tramway.

Nottingham.—The report of the Committee recommending electric traction, which we briefly referred to last week, came before the Town Council on 4th inst., and after lengthy consideration had been given to the matter the following resolution was unanimously passed:—"That the report of the Tramways Committee now presented to the Council be received and adopted as and for the first reading, and that the second reading thereof be taken at the quarterly meeting of the Council in May next; that in the meantime the Tramways Committee be authorised to instruct the city engineer to proceed with the necessary surveys, plans, and sections which will be required for the purpose of enabling the Council to give notices and take all proper steps to promote a Bill during the next session of Parliament for carrying out the recommendations of the Tramways Committee now laid before the Council if that course be ultimately adopted."

Salford.—A sub-committee has been appointed by the Highways Committee of the Town Council to report upon the probable cost of taking over and working the tramways, and also the cost of electric traction. It has been reported to the Highways Committee, on the authority of Mr. Alderman Milling, that it is not the intention of the Manchester Corporation to engage an expert to advise them, but they will reply upon the advice of their own electrical engineer in any matters relating to the future working of the tramways of the city. Further that Dr. Hopkinson has been engaged by the Manchester Corporation to give evidence on their behalf before the Parliamentary Committee against the Manchester Carriage and Tramways Company's Bill.

St. Helen's.—The Electric Lighting and Traction Committee of the St. Helen's Corporation has definitely resolved that electricity on the overhead system be adopted and introduced as the motive power on the Corporation tramways, and that accordingly the town clerk be instructed to apply to the Board of Trade for their consent to the use of electricity for the trams, and also for their sanction to borrow £25,000, the estimated cost of the generating works and plant, and the distributing plant necessary for this purpose.

Stretford.—The District Council has decided to give notice to the Manchester Carriage Company that in July next, directly the statutory term of 21 years expires, it will promote a Bill in Parliament empowering the Council to work the tramways by mechanical power, including electrical haulage, and to borrow funds to defray the cost thereof.

Waterford.—The Corporation after an interview with Mr. Palmer in reference to his application for an electric tramway concession, has granted same on the following terms:—That a lease be granted for 75 years at a nominal rent for the first 10 years, and that subsequently a rent amounting to 5 per cent. on the amount of the dividend paid the shareholders be reserved to the Corporation. That the concession be from the Terminus of the Waterford, Dungarvan and Lismore Railway to the Bridge, along the Quays, the Mall, Parnell Street, portion of the Manor, Lombard Street, William Street, and up Newtown as far as the Municipal Boundary. The Corporation to reserve to themselves the right to seek for Parliamentary powers to purchase the tramway after the expiration of 50 years. All plans and specifications to be subject to the approval of the Council. Matters of detail to be subsequently arranged.

TELEGRAPH AND TELEPHONE NOTES.

Bristol.—The report of the Bristol Chamber of Commerce which will be presented to the annual meeting next week traces the rapid growth of the telephone in the West of England and South Wales. In 1893 there were 4,470 lines in this division, and there were now nearly 9,000, and the rate of increase was still growing. In Bristol, after considerable delay, the underground system was now being actively carried out, in Bath the work was approaching completion, and in several other towns in the district arrangements were in progress for substituting underground cables for poles and wires. Tenders for a large new building in a central position in Bristol were now under consideration by the London Board; there would be a very spacious switch room, and a large switchboard with all the latest improvements for ensuring correctness and rapidity in the transmission of messages. Unexpected delays had arisen in opening exchanges at the group of Wiltshire towns, but the Post Office was now constructing the connecting trunk between Bradford and Bath, and in a few weeks several of these towns would have exchanges opened in them and others would soon follow. The group included Bradford, Trowbridge, Melksham, Devizes, and Warminster in Wilts, and Frome in Somerset. An exchange had been opened at Pershore in connection with Evesham and Worcester. Hereford, after many difficulties and delays, had been opened, and Chippenham, Cirencester, and Dursley would soon follow. Efforts were being made to introduce the telephone at Wells, Glastonbury, Street, Cheddar, and Axbridge in Somerset. In Cornwall the use of the telephone was rapidly extending. Last year Falmouth and Penzance were the only exchanges in the county, now Truro, St. Austell, Fowey, and Par had been opened. And Newlyn and other towns were likely soon to be added to the list. In Devonshire exchanges had been opened at Barnstaple and Bridleigh, Salterton, and it was hoped that Bideford [and neighbouring places would soon follow.

Delays in Australian Telegrams.—Although no official notifications have been received from Berne, still we can gather from the Australian newspapers recently to hand that the Australian trunk landlines continue to be periodically interrupted. On February 26th we read, that European cable messages were subject to delay on the Port Darwin line. On March 1st the "telegraphic communication on the Port Darwin line which had been temporarily interrupted was again restored." Under date of March 7th we read that the Roebuck Bay landline had been interrupted for two days.

It will be remembered that the Roebuck Bay line is supposed to afford an alternative to the Port Darwin line; which latter on March 8th was interrupted near Port Darwin, and the cable traffic had to be diverted *viâ* the Roebuck Bay landline, then presumably convalescent. It is painful to find that as concerns this latter line, the Postmaster-General of South Australia expresses himself in ungrateful terms. He says it "is acknowledged to be the worst line in Australia, the many fogs on the coast rendering it very hard to get signals through." This may, however, only be the expression of friendly rivalry, as judging from the reports concerning the Port Darwin landline, for which he is responsible, it is difficult to say which is the worst of the two lines. On February 14th, Sir Charles Todd, in referring to the delay in the transmission of cable messages to England, is reported to have said: "the interruptions caused by the crossing of creeks and rivers have been very few. In fact, I can only remember four arising from that cause." It would be interesting to know the causes of the numerous other interruptions and delays on this line, which this gentleman appears to ignore, as we find that for the six months before the date on which Sir Charles Todd is reported as above, there were no fewer than 18 days on which the Port Darwin line was either totally interrupted, or on which messages on that line were greatly delayed. There may possibly be other interruptions and delays of which we are not informed, but this is only due to the fact that the authorities in Australia appear to neglect the rule of the International Telegraph Convention, of which they are signatories, by omitting to advise the Bureau International at Berne of such occurrences. On examination we find that since the beginning of September last there have been 24 days on which interruptions or serious delays have occurred on the Port Darwin line, and 17 days of interruptions or serious delays on the Roebuck Bay line; these interruptions sometimes occurring simultaneously, and the total of 41 days is probably much below the actual record of default. We observe that the public in Australia are at length making serious protest against the present inefficient system.

Dudley Telephones.—The Council has been considering the question of the telephone service. The granting of licenses is favoured, and the applications of the New Mutual Telephone Company and the Glasgow Corporation are supported.

Havana and Key West Cable.—We understand that the telegraph cables between Havana and Key West were interrupted and restored on Wednesday. This is the first interruption of communication since the repairs carried out by the Silvertown Company in 1882.

Hong Kong-Manila Cable.—The Eastern Extension, Australasia, and China Telegraph Company, Limited, with a view to improving telegraphic communication with the Philippines, by making it independent of the landline between Cape Bolinao and Manila, have extended their cable from Hong Kong to Manila direct.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1898 ...	...
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Cayenne-Pinheiro ...	March 24th, 1898 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Cable beyond Gurupa ...	April 4th, 1898 ...	
Cyprus-Latakia	Feb. 10th, 1898 ...	...
Sierra Leone-Accra	April 9th, 1898 ...	...
Bolama-Bissao	„ 12th, 1898 ...	...
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Cartagena-Barranquilla ...	July 4th, 1896 ...	...
Majunga-Tananarive ...	April 1st, 1898 ...	April 7th, 1898
Saigon-Bangkok	„ 5th, 1898 ...	„ 5th, 1898
„ „	„ 7th, 1898 ...	„ 7th, 1898
„ „	„ 9th, 1898 ...	„ 10th, 1898
„ „	„ 12th, 1898 ...	...

CONTRACTS OPEN AND CLOSED.

OPEN.

Accrington. — April 19th. The Corporation wants tenders for the supply and erection of three sets of steam dynamos, each set consisting of a triple expansion condensing steam engine of the inverted vertical type, 90 I.H.P., and of a shunt wound dynamo. Also a feed water heater, storage battery having a capacity of 750 ampere-hours, switchboard instruments, apparatus cables, wires, street boxes, connections, &c. For further particulars see our "Official Notices" April 1st. Consulting engineer, Mr. J. N. Shoolbred, 47, Victoria Street, S.W.

Belfast.—April 18th. The Harbour Commissioners are inviting tenders for the supply and erection in the electric light station, Abercorn Basin, Belfast, of three compound, two-crank, self-lubricating, single-valve quick revolution vertical engines, each capable of developing 70 H.P., with a steam pressure of 130 lbs. per square inch. Also for three belt-driven, continuous current, series wound dynamos, capable of giving 15 amperes, 2,850 volts, at a speed not exceeding 800 revolutions per minute for 18 hours continuous running, without undue heating. Specification and further particulars from the harbour engineer, Mr. G. F. L. Giles. See our "Official Notices" April 8th for particulars of these two contracts.

Belgium.—May 31st. The Municipal Authorities of Ixelles, a suburb of Brussels, are inviting tenders until May 31st for the exclusive concession for the supply of electrical energy for lighting and power purposes during a period of 26 years, that is, to September 1st, 1924. Tenders to be sent to the Secretariat de la Commune d'Ixelles, Brussels, from whence particulars may be obtained.

Bootle.—April 25th. The Corporation wants tenders for the supply and erection of arc and incandescent lamps, lamp-posts and accessories. Engineer, Mr. T. L. Miller, Liverpool. See our "Official Notices" this week.

Edinburgh.—April 23rd. The Midlothian and Peebles Lunacy Board is inviting tenders for the installation of electric light in the Asylum at Rosslynlee, near Edinburgh, including (1) generating plant, accumulators, switchboard, &c.; (2) wiring, fittings, &c. Particulars may be obtained on application to Prof. Bailey, Heriot-Watt College, Chambers Street, Edinburgh.

London.—May 17th. The Bethnal Green Board of Guardians invites tenders for the supply of plant, and installing the electric light at the new infirmary, Palestine Place. Plans, &c., to be obtained from the architects, Giles, Gough & Trollope, 28, Craven Street, Charing Cross, W.C. See our "Official Notices" this week for particulars.

Milburn, Esher.—Tenders are being invited, says *Daily Tenders*, for the running and maintenance for five years of an electrical installation, comprising gas engines, accumulators, dynamos, &c., and connected machinery. Further particulars from Messrs. O'Gorman and Cozens-Hardy, 21, Embankment Gardens, S.W.

Roumania.—April 30th. Tenders are being invited until the 30th inst. by the Roumanian Post and Telegraph Authorities in Bucharest, for the supply of 50 tons of galvanised iron wire, 10 tons of galvanised steel wire, and 5 tons of tinned copper wire. Particulars may be obtained from, and tenders to be sent to, La Direction Générale des Postes et Telegraphes, Bucharest, Roumania.

Sunderland.—April 29th. The Corporation is inviting tenders for the supply of a high-speed 225-kw. steam dynamo, and two Lancashire or Galloway boilers. Borough electrical engineer, Mr. J. F. C. Snell. See our "Official Notices" this week for particulars.

Switzerland.—April 30th. Plans and estimates are being invited, says the *Contract Recorder*, by the Government authorities of Fribourg, Switzerland, until April 30th next, for a projected electricity generating station to be established at Hauterine. Water-power is to be utilised, and the station will have a capacity of about 6,000 H.P. A premium of £120 will be awarded to the three schemes submitted which are considered to be the best. Plans and estimates are to be sent to the Department des Travaux Publics, Fribourg, Switzerland, from whence full particulars of the competition may be obtained.

The War Office.—April 27th. The Secretary of State for War is prepared to receive offers, competitive designs and specifications for the supply of portable electric search light apparatus. Particulars from the Director of Army Contracts, War Office, Pall Mall, S.W. See our "Official Notices" February 4th.

Victoria.—June 24th. The Council of the city of Hawthorne (Colony of Victoria, Australia) is inviting tenders for the supply and erection of buildings, boilers, engines, dynamos, transformers, mains, meters, arc lamps, poles; also running the plant for three years. See our "Official Notices" March 11th.

CLOSED.

Brighton.—The Council has accepted the tender of Messrs. Willans & Robinson for the supply of two steam dynamos for the electricity works for £9,591.

Derby.—The Town Council has given the contract for the supply of carbons to the English Carbon Company.

Rochdale.—The Council has accepted the tender of of Messrs. Siemens Bros. & Co. to supply steam dynamos (Belliss engines), balancer and booster, conditionally upon the granting of authority by the Board of Trade and the Local Government Board.

FORTHCOMING EVENTS.

1898.

Monday, April 18th, 8 p.m.—The Northern Society of Electrical Engineers, at Manchester. Paper on "Commercial Forms of Electrical Resistances used for Lighting and Power Purposes," by Mr. Ll. B. Atkinson.

At 8 p.m.—Society of Arts. "Sources of Commercial India-Rubber," by Dr. D. Morris, C.M.G. Two Cantor Lectures.

Tuesday, April 19th, at 8 p.m.—The Institution of Civil Engineers. Paper to be discussed:—"The Electricity Supply of London," by A. H. Preece, Assoc.M.Inst.C.E.

Thursday, April 21st, at 8 p.m.—Chemical Society, Burlington House. Papers to be read:—"The Carbohydrates of Barley Straw," by C. F. Cross, E. J. Bevan, and Claud Smith; "Isomeric Bornylamines," by M. O. Forster, Ph.D.; "Some Derivatives of Benzophenone," by F. E. Matthews, Ph.D.; "Researches on Camphoric Acid," by S. B. Schoyver, Ph.D. Ballot for the election of Fellows.

At 8 p.m.—The Institution of Electrical Engineers. "Cost of Generation and Distribution of Electrical Energy," by R. Hammond, Member. (Continuation of discussion.)

Friday, April 22nd, 5 p.m.—Physical Society. "On a Method of viewing Newton's Rings," by the Rev. T. C. Porter.

Tuesday, April 26th, at 8 p.m.—The Institution of Civil Engineers. Annual general meeting to receive report and to elect council and auditors.

NOTES.

The Electrical Resistance of Thin Films.—An article in the *Physical Review* (America) for January, by Isabelle Stone, gives an interesting account of experiments on the conductivity of thin films of silver deposited on glass by the Rochelle salt process. Many experimenters have endeavoured to construct portable standards of high resistance by means of lines and films of black lead, and of conducting powders, and have discovered how unstable such devices are. The authoress of the present paper has in each case calculated the thickness of the film from the area and mass of the deposited silver, assuming its density to be that of solid silver, and has given the resistance corresponding to that thickness. From films 10 cm. long by 1 cm. wide, and varying in thickness from about 1 to 22 millionths of a centimetre, she obtains two principle results. One is that the measured resistance is always enormously higher than the calculated, being in one case more than 100,000 times as great, and the other, that the resistance of the film always drops rapidly after formation, and continues to do so for an indefinite time, excepting in the case of very thin films, which could not be permanently maintained, and some few whose resistance, after a few days, began to increase. The changes were rapidly accelerated by heat. The experiments appear to show that the metal is deposited in an only partially coherent condition, and gradually settles down into a more compact mass. It would be interesting to know if magnetic oscillations affect the conductivity of such a film. The experiments were suggested to the authoress by Prof. Michelson, who, as is well known, uses semi-transparent films of this kind in his interferometer.

Does a Diaphragm Exist Preventing Diffusion, but not the Passage of an Electric Current?—This subject is discussed by K. Ochs in the *Chemiker Centralblatt*, No. 1, p. 289. A diaphragm that would prevent diffusion, but would allow the passage of a current, might be either (1) a membrane not permeable by the electrolyte, but permeable by the ions; or (2) a membrane permeable by the ions, and which would absorb the electrolyte, but not allow its transfusion; (3) or a membrane not permeable by either electrolyte or ions, but which allows passage of the ions when these have been deprived of their charges. Membranes of the first class are at present unknown. Those of the second order appear to be formed by precipitation of both ions in the pores of the membrane, as, for example, in the Reynier cell (a Daniell cell in which potash replaces dilute sulphuric acid), in which copper oxide forms in the pores of the cylinder, dividing the copper sulphate and potash solutions. With the continual formation of the precipitate in these cases, the resistance increases, so that any advantage obtained by the non-diffusion of the electrolyte is completely nullified. A membrane of the third order might be formed if a sufficiently thin film of mercury could be obtained, as a metal like zinc could diffuse through such a film. It does not appear, however, that such a membrane would be of any practical value. Diaphragms of the required kind for practical purposes are therefore at present unknown.

Some Researches on Electrical Conductivity.—Carl Fritsch has determined the conductivity of a number of solid substances, taken either in the form of precipitates or compressed plates, and further examined the effect which the addition of small quantities of a foreign solid has on the conductivity of the pure solid under examination. The effect of the addition of small quantities of a second salt to that which is under examination, is, in nearly all cases, to largely increase the electrolytic conductivity of the latter; this would appear to be best explained by assuming the formation of a solid solution, in which the solvent, lead chloride, for example, causes ionisation of the dissolved salt, say, potassium chloride. It is not impossible that the conductivity of the solid salts themselves is caused by the presence of traces of impurities, but this point would require specially investigating in each case. The conductivity increases rapidly with rising temperature, but the changes in the temperature coefficients are much smaller than those in the conductivities themselves. The above is an abstract from the *Annales de Physique et Chemie* (II.), No. 60, pages 300—313. Some interesting data have also been obtained by E. H. Loomis, and are given in the *Annales de Physique et Chemie*, (II.), No. 60, pages 547—551. Amongst the results the following are of interest:—

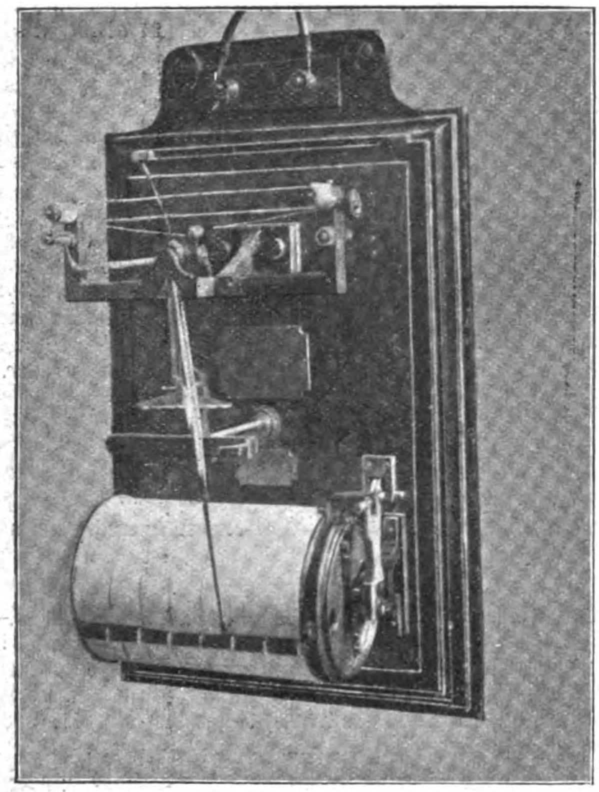
	Sp. Gr. 18°/4°.	K × 10^7 at 18°.
$NaOH$	1·0418	145
KOH	1·0481	170
HCl	1·0165	279
HNO_3	1·0324	278
$1/2H_2SO_4$	1·0306	183
$1/2C_2H_2O_4$	1·0199	55

The electrical conductivities are given in mercury units of the solutions examined.

The Chemical Action of Electrical Oscillations.—This interesting subject has been carefully studied by Alexander de Hemptinne. The apparatus employed for the production of the oscillations was similar to that of Lecher (*Annales de Physique et Chemie*, 1890 (II.) No. 41, 850), and allowed of the ready alteration of the wave length. A Wimshurst machine driven at constant speed by a motor was employed in most cases, but where greater tension was required, a Tesla transformer was used. Researches with ammonia at pressures of 5 mm., 15 mm., and 50 mm., showed that the velocity of decomposition decreases with increasing pressure, and a maximum was obtained in each case some time after the commencement of the decomposition, after which it decreased, indicating a final equilibrium. The velocity is also markedly influenced by the energy of the discharge. The percentage of ammonia finally decomposed varies with the pressure, being about 50 per cent. at 49 mm., and 95 per cent. at 20 mm., but the values do not agree with the expression $p_3{}^2 = k\,p_1\,p_2{}^3$, which should theoretically obtain in the case of a heat dissociation. The decomposition is further lowered by the addition of nitrogen or hydrogen, the latter having, as expected, the greater effect, but the quantitative results are not in accord with theoretical deductions. Under the influence of electrical oscillations, nitrogen and hydrogen combine to the extent of 3 or 4 per cent., the final quantity being apparently almost independent of the pressure. In all these cases, no action occurs unless the tube containing the gas becomes luminous; and it was observed that one tube may screen another, so that if two tubes at slightly different pressures be placed between the plates and the discharge adjusted so that only one tube lightens, a slight increase of pressure in this tube causes it to become dark, and the second tube to lighten and be decomposed. Carbon bisulphide is also decomposed, the velocity being well represented by the equation $dx/dt = k\,(a - x)$. Some thick liquids, such as glycerol, exhibit an increase of vapour pressure when exposed to the action of the oscillations, a similar effect occurring with oxalic acid, whilst calcium chloride appears to be entirely unaffected. The above is an abstract of a paper in the *Zeitschrift fur Physikalische Chemie*, 1897, No. 22, pages 360-372.

Lecture.—Bailie Mackenzie, convener of the Electric Lighting Committee of Edinburgh Town Council, on 11th inst. addressed the members of the Edinburgh Association of Science and Arts on "Progress of the Electric Light in Edinburgh."

Continuous Recording Voltmeter.—The use of recording voltmeters, as at present made, necessitate for every instrument the filing of 365 charts every year, as well as daily attention and changing of the same. It is true that there is an instrument in the market with a continuous strip which obviates the daily attention but does not reduce the trouble of keeping the records. To improve this, the engineer at the Cambridge Electricity Works devised and adapted instruments already in use to run on the same chart for a week.



The principle of moving the drum along its spindle most naturally suggested itself, and as a matter of fact was included in the application for patent, but to do this would render the horizontal length of the instruments much greater, and would not admit of the ready adaption of existing instruments to the continuous movement. The arrangement of cams and general principle is said to be shown on the accompanying illustration, but this is open to doubt. We understand that the principle is patented, and is applicable to most recording instruments.

Workmen's Compensation Act and Electricity Works.—At the St. Pancras Vestry's meeting of Wednesday evening it was reported with reference to the Workmen's Compensation Act, 1897, which comes into operation on July 1st next, that a letter had been received from the Home Secretary, in reply to a communication from the Vestry, stating that "he is advised that electric lighting works, where electricity is generated by the use of mechanical power, and is supplied to consumers, are factories within the Factory and Workshops Acts, and therefore the Workmen's Compensation Act will apply in all such cases."

The Shannon Electric Power Scheme.—A specially convened meeting of the Limerick Fishery Conservators was held on 7th inst. to hear a deputation from the Shannon Electric Power Syndicate with reference to the pending scheme for utilising the River Shannon in the production of electricity. Lord Lurgan, Colonel Sir Gerald Dease, Mr. H. J. Fuller, engineer, and other directors, attended to explain modifications of the original scheme. That scheme proposed the impounding of Lough Allen, and the conversion of the lake into a storage reservoir, the waters to be utilised on the gravitation principle. In reply to questions, Mr. Fuller said the horse-power to be used all the year round at the works at Castle Connell would be 5,000, the *maximum* being 10,000.

The Economy of the Corliss Engine.—The success of the Corliss engine, as a machine in respect of its steam economy, has, in a sense, not been an unalloyed blessing. That the engine was economical in steam may have been true, but the credit was given to the principle of variable expansion and sharp cut-off. Designers of engines sacrificed everything to a sharp cut-off corner in the indicator diagram, and this was very greatly over-rated, as though special economy arose from it. The claims of the Corliss engine are discussed by our American contemporary, *Machinery*, and the true cause of economy announced, or rather, re-announced. This, of course, is the use of separate valves for steam and exhaust, and the position of the exhaust valve on the lower side of the cylinder, whereby it is enabled to more readily drain the cylinder of water. If the ordinary arrangement be noted, it will be seen that the exhaust valve is so placed as to at once catch any water shot into the cylinder from the steam valve, and also to drain any water which tries to collect in the cylinder. The outrush of the exhaust carries a large proportion of water with it before re-evaporation can occur during the exhaust stroke. This is the great reason for economy. With exhaust valves placed in the cylinder covers, and thus not at the lowest part of the cylinder, we think there would be far greater steam consumptions registered. As we have already observed, the economy of the Corliss engine, really due to good valve arrangement, was long credited to fanciful notions as to shape of cut-off corners, and variable expansion, as though, for example, an automatic variable cut-off could have much influence on the economy of a cotton factory engine, which scarcely varies its power the day through; and the Corliss engine is not the only example showing wrongly credited economies.

Caoutchouc and Gutta-Percha Cements.—A gutta-percha cement for leather is obtained by melting together 100 parts gutta-percha, 100 parts asphalt or pitch, and 15 parts oil of turpentine. It is to be used hot. Elastic gutta-percha cement, especially for fixing soles to shoes, which does not crack in bending, on account of its great extensibility, is, according to an article in the *Färben Zeitung* translated in the *Scientific American*, prepared by dissolving 10 parts gutta-percha in 100 parts benzine and pouring the solution into 100 parts linseed oil varnish, shaking well. The leather must be roughened before using this cement, in order to insure greater durability. By a caseine-borax cement a handsome surface gloss is imparted to the leather. The borax is dissolved in boiling water and the borax solution poured into freshly prepared caseine. The durable thick cement is very serviceable. Good caoutchouc cements, for rubber strips or rubber goods on metal, are obtained by dissolving shellac in ten times its weight of ammonia. After standing for three to four weeks a transparent putty results, which is used without heating. The cemented places soften at first, but become hard and firm after evaporation of the ammonia, which may be assisted by heating. This cement is watertight and gasproof, and is also useful for hard rubber articles. A cement made of a mixture of gutta-percha with asphalt is serviceable for the same purpose. This has to be applied hot and the pieces are to be pressed together. Very useful cement for leather belting is manufactured by kneading 10 parts carbon bisulphide and one part of oil of turpentine with gutta-percha until a thick paste results. The portions of the leather where the cement is to be applied must be unoiled and roughened; the cement is put on and the ends are pressed together until the binding agent has become dry. Directions for caoutchouc cements are: 100 parts finely cut caoutchouc, 15 parts resin, 10 parts shellac, dissolved in sulphide of carbon. One part caoutchouc, seven parts mastic, and 50 parts chloroform, left to stand several weeks.

The Civil Engineers' Incoming President.—At the recent banquet of the Institution of Civil Engineers, Sir J. Wolfe Barry announced Mr. W. H. Preece, C.B., as the incoming president, and he dwelt upon the fact that Mr. Preece will be the first electrical engineer to occupy the chair. This may be taken as an index of the important position occupied by electrical science to-day in all branches of engineering, and we congratulate Mr. Preece upon being the first of a lengthy list of coming electrical presidents of this Institution.

A New Application of the Röntgen Rays.—The *Times* correspondent at Vienna says that some interesting particulars of a new application of the Röntgen rays for curative purposes were communicated by Dr. Edward Schiff, lecturer at the Vienna University, at the last sitting of the Imperial and Royal Medical Society. A series of experiments conducted by Dr. Schiff and his assistant proved that these rays could be used for the cure of disease in a manner capable of perfect control by means of a more or less intense application for a longer or shorter period, producing reaction in the exact degree required. In this way it has been possible for the lecturer, on the one hand, to remove hair from parts of the body where it constituted a disfigurement without causing the slightest inflammation, while, on the other hand, he has been able to treat lupus with uniform success by means of an artificial inflammation, the intensity of which he was in a position to increase or reduce at will. The results secured by the new method both in the removal of superfluous hair and the treatment of lupus were demonstrated in the persons of some of Dr. Schiff's patients.

Electric Drill in Shipyards.—We illustrate below an electric drilling machine engaged on drilling the rudder frame of the Japanese battleship *Shikishima*, 14,950 tons, at the works of the Thames Ironworks and Shipbuilding Company, Limited. This illustration shows very forcibly the advantage of being able to take such a tool to the work, instead of having to take the work to fixed machine tools in the shops. We understand that the performance

of the machine in question has been very good, as by its use one man and a boy have drilled $\frac{5}{8}$th-inch tapping holes, $1\frac{1}{4}$-inch deep, in the rough cast-steel of which the rudder is composed, at the average rate of rather more than 100 per working day of eight hours. This was not on test holes, or anything of that sort, but is taken from the weekly work record sheet, the time including all shifting and setting up of the machines, grinding drills, and so on. We understand that the Thames Ironworks Company makes these drilling machines in a variety of patterns and sizes.

Obituary.—We hear with great regret of the death, under very sad circumstances, of Mr. Nelson W. Perry, who until very recently was editor of New York *Electricity*. On March 26th he was experimenting in his laboratory at Brooklyn, and when the gas was turned out he drank bichromate of potassium instead of a glass of water. He immediately called for medical and other assistance, but all efforts were of no avail, and he died the following night. Mr. Perry was extremely popular among the electrical fraternity in the States, and his name is also well known in this country, his papers read before the American Societies on various subjects having been reprinted in the press on this side. He will also be remembered as an occasional contributor to *Cassier's Magazine* and other journals. Mr. Perry was only 45 years of age, and but for the sad accident mentioned would still be continuing his researches in electrochemistry and the other branches of electrical work to which he was devoted. In his earlier days Mr. Perry practised in mining engineering, and at one time held the chair of metallurgy at the University of Cincinnati. He went into electrical engineering in 1887, and was connected with several leading electrical manufacturing companies, and in 1891 became associated with *Electricity*. He was a member of various New York and Continental scientific societies. His lengthy contribution to the National Electric Light Association in 1895 on the storage of energy essential to economy of working in central stations appeared in the ELECTRICAL REVIEW during March and April of that year.

The Late Strike.—A "Working Man" writes a long letter to *Engineering* anent the late engineers' strike, with special reference to the bearing of Sir Richard Tangye, of whose gift of £500 to each side he does not approve. He thinks Sir Richard ought to have joined the Federation and locked out the men who were unionists instead of helping to prolong the strike by supplying funds more or less directly for the unionists to hand over to Mr. Barnes. "Working Man" also recommends working men to study the past eight months' newspapers, and they will find that the labour leaders have been addressing so many meetings at *so much and their expenses*, which means that these men were reaping a golden harvest while their dupes and paymasters were walking about in idleness. He further suggests that with the £500 returned to him by the employers and the £500 which the A.S.E. ought to return to him, Sir Richard should either make a payment to his 2,500 men, or should start a fund to send a few of the more intelligent and young men to travel abroad and visit the great foreign industrial centres so as to get at facts which, if known, would go far to prevent future strikes, and so make it necessary for labour agitators to work honestly for their living. If it had not been for the Employers' Federation it might have been Sir Richard would not have had £1,000 to give away, and if his men had been unionists all his boasted friendship with them would have availed nothing if the A.S.E. had ordered the men out, for out they would have had to come or lose all accumulated benefits. "Working Man" seems to know of what he speaks, and does not much love the conduct of the A.S.E., and makes a good point of his description of the behaviour of mild-mannered deputations to employers and the braggadocio of the same deputies when speaking at unreported meetings. He concludes that neither the men, the masters, nor the country at large have gained by the strike, but only the agitators, who have reaped gold out of their fellows' idleness and starvation.

The Voltmeter on Series Arc Lighting Circuits.—In an article which appeared recently in the *Electrical Review* of New York, our contemporary draws attention to the frequent neglect of the use of voltmeters on series arc circuits in America, although its employment in such a case is quite as necessary as that of an ammeter on a constant potential circuit, since on a constant current circuit it is the voltmeter reading which measures the output of the machine at any given moment. Besides being necessary for the measurement of output, the voltmeter is a most useful addition to the testing equipment, as, by its means, the existence, locality, and approximate resistance of a fault can be indicated whilst the circuit is running. The utility of the voltmeter as a testing instrument has long been recognised by English engineers, and we know of arc lighting circuits which are regularly tested by means of an electrostatic voltmeter, which is connected between one terminal of the circuit and earth, so as to show the potential difference between that terminal and the fault, and thus indicate its position if the drop of volts per lamp is known. The electrostatic voltmeter, however, gives no indication of the fault resistance, and, further, if the potential difference between one terminal and earth is half that between the two terminals, one cannot say whether there is a fault halfway round the circuit or not, as the same reading would be obtained if the insulation were practically perfect and the small leakages which must always exist were equally divided over the circuit. This difficulty is obviated by the use of an electro-magnetic voltmeter of known resistance, and our contemporary describes one which has been brought out by the Keystone Electrical Instrument Company, and which is said to give very satisfactory results, as it is dead-beat, direct reading with a practically uniform scale from zero to the maximum reading, and is made for use on circuits up to 6,000 volts, without requiring the addition of any external multiplying resistance box. With an electrostatic voltmeter, if A is the potential difference between the positive terminal and earth, and D the drop of volts per lamp, and if there are N lamps between the positive terminal and the fault, the position of this latter is indicated by solving the equation $N = \frac{A}{D}$. With the electro-magnetic instrument it is necessary to make two other measurements, B the potential difference between the negative and earth, and C that between the positive and negative, and the value of N is then given by the equation $N = \frac{A\,C}{D\,(A + B)}$. Also if the R is the resistance of the voltmeter, and R′ that of the fault, the value of the latter is given by the formula $R' = R\,\frac{C - (A + B)}{A + B}$. It will be noticed that if R′ is very small compared to R, the sum of the two readings A + B will be very nearly equal to C, and in the extreme case when equality exists the multiplier $\frac{C}{A + B}$ being unity, the equations for the two types of voltmeter become the same.

Operation of T.-H. Arc Dynamos.—As I have never seen anything in print about caring for Thomson-Houston arc dynamos, I venture, says Mr. C. C. Giles in the *American Electrician*, to send a few suggestions about these troublesome machines. In the first place, the commutator, brushes, and brush-holders should be well cleaned after every run. Adjusting the machine with too short a spark will cause "flashing." The spark can be lengthened by turning the commutator slightly forward on the shaft. This weakens the machine, however, and if it is well loaded, care should be taken not to weaken it so much as to cause the regulator to rest on the stop. The commutator should not be moved more than $\frac{1}{16}$ inch at a time. Much trouble is sometimes caused by the air-blast being worn out. The hubs should fit snugly in their bearings in the sides of the air-blast. I have seen them with as much as $\frac{1}{16}$ inch play. The General Electric Company will repair them much more cheaply than new ones can be obtained for. I have obtained the best results by adjusting the air-jets so that the blast will strike about $\frac{1}{4}$ inch in front of the brushes when the regulator is down. Of course, if the machine has to work with a light load, this cannot be done. If the load is very light the armature will get quite hot. This can be remedied by connecting a rheostat between the binding post and connecting-rod post on the right-hand leg of the machine. This weakens the field and causes the regulator to run lower. The height at which the regulator runs can be adjusted by turning the rheostat. It should not be more than $\frac{1}{2}$ inch from the top. When the rheostat is in use, the spark will be longer than usual, and may be a little harder on the segments and brushes, but these are cheaper than armatures. The rheostat should have not less than 60 ohms resistance.

Local Authorities and Electric Lighting.—The following letter on a very important subject appeared in the *Times* the other day above the signature "Electron." The writer says :—

A list has just been published of local authorities to whom provisional orders for supply of electricity have been granted by the Board of Trade, but in respect of which no works have yet been decided upon. The list in question contains the names of no less than 83 towns, the orders being granted between the years 1890 and 1897, of which number 11 have remained in force over seven years without being dealt with. Under the Electric Lighting Act and the practice of the Board of Trade a preference is given to applications by local authorities, commercial enterprise being excluded in the desire to promote the municipalisation of electric supply. This action has given, as may be judged from the above statement, great power to the gas interest and other adverse influences among town councils, vestries, and boards of works in preventing any practical application of the Electric Light Acts. I notice that an arrangement has recently been come to between the Board of Trade and the Marylebone Vestry for granting a provisional order to the vestry in the Session of 1899, on condition that the clauses authorising a transfer of the undertaking to private firms or companies are eliminated. If this be an indication of a change of policy on the part of the Board of Trade, the abuses I have referred to will be prevented in the future, but in order to deal with the deadlock in this important industry in the 83 towns of which the names have been published, I submit that a time limit should now be fixed by the Board of Trade within which the works are to be carried out or the powers transferred to others or absolutely revoked.

This letter is followed by a more lengthy one signed by "A Burner of Electricity and Ratepayer of Marylebone," who says :—

The Vestry of Marylebone is seeking powers to compete with the existing company supplying the district. The policy of allowing vestries to use the money of the ratepayers for large commercial undertakings is doubtful in any case, but where it is to be employed to compete with an existing company for electric lighting it is especially so. If it could be shown that in a particular parish private enterprise had failed to supply an efficient light, there would be some justification in the local authority undertaking the work; but for a vestry to deliberately embark in the lighting business in order to compete with an existing company requires strong arguments for its justification. In order to do this it would have to be shown that the costly competition would ultimately benefit the consumer by cheapening his light. A little consideration will show the fallacy of this assumption. In order to supply electric light cheaply, two conditions are essential; the one is to minimise the capital expenditure, the other to keep down the working expenses. Instead of doing this, the effect of the Vestry competing would be exactly to double the capital, and nearly to double the working expenses. There would have to be erected and equipped costly generating stations, and there would have to be buried in the ground hundreds of miles of cable. The stations would be in close juxtaposition to the existing works, while the cables would have to lie side by side with the present network, the existing works and cables being already amply sufficient. Then, when all the works had been constructed, the whole of the annual working expenses, maintenance, and supervision would have to be provided for. Now, who ultimately has to pay for all this useless expenditure? Undoubtedly the consumer will have to do so! Neither a vestry, any more than a private company, can afford to sell light at less than cost price; the only way, therefore, to benefit the consumer is to decrease the cost of production. This is what is occurring in districts now supplied by first-rate companies, who find that as the number of lamps connected with their systems increase so much the more cheaply in proportion can they supply the light. This, and not competition, is the explanation of the rapid reduction in price going on. Four years ago, in the parish in which I am writing, and in which, up to the present time, there has been no competition, we paid nearly double what is now charged for the light, and believe as the company increase their business so will it be their interest still further to reduce the price. The safety to the consumer consists, not in useless and expensive competition, but in the fact that every electric company is doing its utmost to produce cheaper, so that the price charged for electric light may compete successfully with gas and mineral oil. If the present companies are only allowed to develop without ruinous competition with the vestries the time cannot be far distant when every householder will get this healthy light at as cheap a rate as he now pays for his gas or lamp.

The Production of Electricity by Chemical Means.—Up to the present it can scarcely be claimed by any inventor that he has succeeded in producing electricity by depending solely upon chemicals. There are a great many whose attention has been devoted to this branch, but the problem of economical production yet remains to be solved. Ernst Andreas (*vide Zeitschrift fur Electrochemie*, 1895, No. 3, page 188), has recently been examining Borcher's cuprous chloride carbonic oxide cell, using carbon electrodes dipping respectively into solutions of cupric chloride in water, and of cuprous chloride in aqueous hydrochloric acid. A porous diaphragm separated the two solutions, chlorine being passed into the cupric, and carbonic oxide into the cuprous solution. After a time the current rapidly diminished, and it was found that the cuprous chloride was completely oxidised. The carbonic oxide had taken no part in the change. Of 1,950 cc. used in one experiment, 10 cc. only were oxidised to carbonic anhydride. Similar results were obtained with electrodes of platinum, palladium, or nickel at various temperatures. A gas battery, consisting of two pieces of platinum gauze separated by a sheet of filter paper moistened with the solution of an electrolyte, had a very low resistance, and gave very encouraging results with coal-gas and air, oxygen and hydrogen, or chlorine and hydrogen. The last combination, with the gases under a pressure of about three atmospheres, gave a current of about 1 ampere at 1·5 volts. Owing to the cost of the platinum, such a cell could not be a commercial success; but fairly good results were obtained by passing sulphurous anhydride on the one hand and chlorine on the other, under pressure, into carbon tubes dipping into dilute sulphuric acid. This combination gave 0·5 volt, with 1 ohm resistance in circuit, and the products are sulphuric and hydrochloric acids. With large electrodes, good results would probably be obtained with air and sulphurous acid, in which case the product would be sulphuric acid alone.

The Parliamentary Electricity Committee.—The Electrical and Allied Trades Section of the London Chamber of Commerce passed the following resolutions on March 24th:—

1. That the Electrical Section of the London Chamber of Commerce is of opinion that the principle of the reference to the Joint Committee of the Houses of Lords and Commons on electrical energy (generating stations and supply) should be supported.
2. That the various municipalities and companies interested in electric lighting be asked to support the principles contained in the reference to the Joint Committee.
3. That a Committee be appointed (with power to add to their number) to take such action with regard to the inquiry of the Joint Committee as may be deemed advisable.

Relative Economy of Steam Plant in Electrical Stations.—We quote from an article by M. Van Kesteren on the "Construction of Tramway Lines for Electrical Traction," that appeared in the *Bulletin* of the Association of Electrical Engineers of the Montefiore Institute, the following table, which shows the influence of the choice of the steam plant used on the maintenance and working expenses of electrical stations:—

Mode of production of electrical energy.	Price per car kilometre.
Direct-coupled Corliss engine, of a power above 1,000 I.H.P.	·137 to ·19 francs.
High speed compound condensing engine, with belting power above 600 I.H.P. ...	·206 to ·293 „
High speed compound tandem non-condensing engine, with belting power above 400 I.H.P....	·208 to ·296 „

E. P. (*L'Electricien*).

Geneva Electrical Trust.—The *Financial News* says that there has been a good deal of talk recently about the formation of an Electrical Trust, with a capital of a million sterling, at Geneva. The project has at length assumed definite shape. The chief mover in the matter is the Union Financiere. Berlin is finding some of the capital, but London is responsible for the major portion.

NEW COMPANIES REGISTERED.

Electric Light and Power Company, Limited (56,786).—Registered April 1st, with capital £6,000 in £1 shares (5,000 deferred), to carry on the business of an electric light company and supplier of motive power, and the business of electricians, electrical, mechanical, and general engineers, electrical apparatus manufacturers, &c. The subscribers (with one share each) are:—R. S. Rose, 44, Wharncliffe Gardens, N.W., stenographer; R. F. W. Martin, Clarendon Villa, Ashford, Middlesex, electrical engineer; P. H. Drake, 19, St. George's Road, Wimbledon, clerk; A. Scott, 11, Barton Street, Westminster, builder; D. Hays, 15, Montpelier Road, Ealing, electrical engineer; S. M. Powell, St. Faith's Road, Norwood, secretary; O. S. Phillpotts, 2, St. Mary's Terrace, Paddington, clerk. Registered, without articles of association, by Markby Stewart and Co., 57, Coleman Street, E.C.

New Electricity Supply Syndicate, Limited (56,815).—Registered April 2nd, with capital £40,000 in £1 shares to adopt an agreement with A. T. Salisbury-Jones, G. L. Bidwell, and F. W. Salisbury-Jones, and to promote, construct, equip, maintain, manufacture, improve, work and manage electrical works and appliances for electrical lighting. The subscribers (with 100 shares each) are:—Lurgan, Lowndes Square, S.W., peer; F. B. Jameson, 29, Kildare Street, Dublin, distiller; J. Hone, Roebuck Grove, Donnybrook, director; J. Chambre, Mespt House, Dublin, merchant: T. B. C. Hardman, 14, Molesworth Street, Dublin, solicitor; G. E. H. Trevor, 14, Onslow Square, S.W., gentleman; A. A. Baumann, 109, Queen's Gate, S.W., barrister. The number of directors is not to be less than two nor more than seven. The first are Lord Lurgan, and A. A. Baumann; qualification, 50 shares; remuneration, £2,000 per annum divisible. Registered by F. King, 28, Park Road, Wandsworth Common.

Yarmouth (Isle of Wight) Electricity Supply Company, Limited (56,884).—Registered April 7th, with capital £5,000 in £5 shares, to carry on in Yarmouth, Isle of Wight, and elsewhere, the business of electricians, electrical and mechanical engineers, suppliers of electricity, and electrical apparatus manufacturers. The subscribers (with one share each) are:—Heytesbury, Heytesbury, Wilts, peer; R. H. H. Eden, Heytesbury, Wilts, land agent; B. M. Aubyn, Tapnell Farm, Freshwater, Isle of Wight, land agent; F. Christy Chelmsford, electrical engineer; Mrs. C. Edmonds, The Retreat, Yarmouth, Isle of Wight; J. T. Harwood, Yarmouth, Isle of Wight, ironmonger; C. Edmonds, Yarmouth, Isle of Wight, solicitor. The number of directors is not to be less than three nor more than five; the first are Lord Heytesbury, R. H. H. Eden, C. Edmonds and B. M. St. Aubyn; qualification, two shares; remuneration, £50 per annum, divisible. Registered by Ford & Co., 6, Dowgate Hill, E.C.

J. Goodman & Co., Limited (56,886).—Registered April 7th, with capital £7,000 in £1 shares, to acquire the business of J. Goodman & Co., of 48, Commercial Street, London, and to carry on the business of electric supply merchants and dealers, electrical engineers, &c. The subscribers (with one share each) are:—J. Goodman, 11, Navarino Road, Dalston, merchant; D. J. Mihr, 7, Dempsey Street, Stepney, clerk; E. Gutmann, 17, St. Phillip's Road, Dalston, traveller; W. Musk, 30, Mount Street, Bethnal Green, E., lamp maker; W. Ashley, 76, Bird-in-Bush Road, Peckham, electric lamp maker; W. Tatum, 65, Shrubland Road, Dalston, painter; R Sendal, 21, Yotton Street, South Bromley, E., engineer. J. Goodman is the sole managing director. Remuneration as fixed by the company. Registered by H. C. Davis, 52, Allison Road, Harringay, N.

CITY NOTES.

The Indo-European Telegraph Company, Limited.

In the report for 1897 the directors express their deep regret at the loss of the valuable services of their late colleague, Mr. C. W. Earle, who died last June, and who had been connected with the company since 1881. The company's revenue from all sources for 1897 amounted to £130,347 3s. 5d., as compared with £123,539 17s. 11d. for 1896, showing an increase of £6,807 5s. 6d. The expenses were—on commercial and general account, £36,765 11s. 5d.; on maintenance account (expenses and charges) £32,613 2s.; total £69,378 13s. 5d., as against £68,105 10s. for 1896, an increase of £1,273 3s. 5d. Deducting the above expenses, taking credit for £7,704 3s. 2d. brought over from 1896, and debiting income-tax, there remains the sum of £66,573 4s. 1d. From this amount £15,000 has been placed to reserve, and that sum, together with £10,625 amount of interim dividend, have to be deducted, leaving a balance of £40,948 4s. 1d. The directors now propose the declaration of a dividend for the six months ending December 31st of 17s. 6d. per share, making, with the dividend already paid, 6 per cent., and a bonus of 20s. per share, both free of income-tax, making in all 10 per cent. for the year, carrying forward £9,073 4s. 1d. to the credit of 1898. The balance carried forward is rather larger than usual; there are, however, several items involving an increase of expenditure that will have to be provided for in the year 1898. The lines of the company continue to work satisfactorily, and the introduction of the Wheatstone automatic apparatus has proved successful: the system is being extended. Mr. T. W. Andrews has joined the board. The following directors retire by rotation, and offer themselves for re-election:—H. H. Meier, Esq., and J. Herbert Tritton, Esq.

In case any shareholder should be unable to attend the general meeting, he is requested to fill up and return the proxy form, duly signed, so as to reach the company's office not later than 12.30 p.m. on the 18th inst.

Oldham, Ashton, and Hyde Electric Tramway Company, Limited.

The first ordinary general meeting was held last week at Donington House, Norfolk Street, Strand, Mr. Emile Garcke presiding.

The Chairman stated that they had been called together to comply with the Companies' Act, which provided that a meeting should be held within four months from the date of the company's registration. The company was registered on December 18th, and the prospectus was issued in the following month. The whole of the capital offered for subscription, consisting of 4,000 5 per cent. cumulative preference shares and 4,000 ordinary shares of £10 each, was subscribed for and allotted. They lost no time in applying for a quotation on the Manchester Stock Exchange, and they were informed that, subject to their complying with a small formality, the quotation had been granted. The progress made with the works had been satisfactory. Out of the eight miles of tramways two-and-a-half miles were already constructed, and other portions were in course of construction. They were informed by the engineers that the work throughout was satisfactory; and the borough engineers of the district were, he was informed, also satisfied with it. Several gangs were employed on the works, which, they were given to understand, would in all probability be completed in July next. The contract for the electrical portion of the work was being carried out by the British Thomson-Houston Company, and they were informed that satisfactory preparations were also being made with the view to that part of the work being carried out expeditiously. They only hoped that there would be no delay on the part of the Ashton Corporation with the completion of their part of the work, so that they might have the tramway in full working order in the early autumn. The Ashton Corporation had made an agreement with the company, under which the latter would be supplied with electrical energy. He hoped when they met early next year they would be able to report, not only that the work was completed and the line opened, but that they had been already carrying and had secured a considerable amount of the local traffic. They would by that time be in a better position to state what the volume of their traffic was, but so far, they had seen no reason whatever to modify the estimates they had formed.

Mr. Alderman T. Heginbotham, the representative on the board of the Ashton Corporation, stated that the latter were doing all that they possibly could to get the engines at work, and they were well alive to what they had to do.

No business resolution was submitted to the meeting.

British Electric Traction Company, Limited.

The ordinary general meeting was held on Thursday at Donington House, Norfolk Street, Strand, Sir Charles Rivers Wilson presiding.

In moving the adoption of the report, the Chairman said he was glad to be able to state that already, at the end of their first year's operations, they had succeeded in establishing a business of considerable magnitude, and one which they had every reason to believe would become profitable to the shareholders. The gross profits for the 14 months covered by the accounts, from the date of the formation of the company to the end of 1897, amounted to £14,422, and after deducting such of the general expenses as were chargeable to revenue account, and also the expenses incurred in connection with schemes and undertakings they had thought it well to initiate, but which, for various causes, they had afterwards dropped, there remained a profit of more than £9,800. The directors did not consider it expedient that this net profit, which represented about 3½ per cent. on the capital employed during the year, should be distributed in dividends. The extensive business they were building up required that the company should occupy a strong financial position, and, in the opinion of the board, it would be more to the interests of the shareholders that the amount in question should be carried forward to next account. Original shareholders would remember that the whole of the ordinary shares were offered for subscription at the time of the formation of the company, but they were not all subscribed for, and in order to secure a quotation on the Stock Exchange the Electric and General Investment Company, and their friends, made up the subscription to 20,000 shares, and the remaining 10,000 shares were subsequently issued at a small premium. Last month the directors made an issue of 10,000 6 per cent. cumulative preference shares of £10 each, and the strong position the company occupied enabled them to be issued at a premium of £2 10s. per share. The proceeds of such issue would come into the accounts for the current year, and he might add that it was exceedingly probable that occasion would arise during 1898 for further issues of capital. He then referred to the various items in the balance-sheet and profit and loss account. With regard to the investments, £148,179, he said that this item would always remain relatively large, as it included debentures and shares held in certain associated companies, and the more they developed their business the larger would become their investments in subsidiary and other companies. The fact that the company had received nearly £3,000 in dividends in respect of the past year, although many of the investments were not made until towards the end of 1897, was evidence that they were of a remunerative character. Having alluded to a number of the important schemes which they were developing, he said it would serve to give the shareholders some idea of the magnitude of their business when he told them that they had upwards of 50 schemes under consideration, and that the agreements and contracts they had entered into and the concessions they had either obtained or applied for covered a total mileage of electrical tramways and light railways in the United Kingdom of more than 200 miles. Moreover, it was not looking too far into the future to say that a total capital expenditure of between £2,000,000 and £3,000,000 would have to be provided. Owing to the spirit which was abroad among the larger corporations to municipalise their tramways and similar undertakings, the board had, on more than one occasion, been discouraged from initiating undertakings within particular boroughs. To a certain degree that was a matter for regret. He was of opinion, not because he was associated with this company, that work of the sort in which they were interested could be better and more usefully carried out by means of a company such as theirs than by a corporation. A municipality was only able *prima facie* to carry out operations within the limits of its own boundaries, and inasmuch as for the economical and efficient working of tramways—particularly electric tramway enterprises—it was necessary there should be communication with outlying villages and other towns, they would see at once how desirable it was that the lines should be constructed on a uniform system and be, as far as possible within the district, under a single management. One might be in favour of municipalisation of electric lighting, because that was a business which could be confined within a given borough, but undertakings like tramways or railways, which depended for their success on the efficiency with which people could be moved about from one borough to another, were surely not suitable for municipalisation. He concluded by an expression of regret at the death of the Earl of Suffolk, who, he said, was only that day fortnight at a meeting of the board, of which he had been a member since the formation of the company.

Mr. Emile Garcke (managing director) seconded the motion, which was agreed to unanimously.

An extraordinary general meeting was then held, at which resolutions were passed approving several proposed light railway orders.

Douglas Southern Electric Tramway.—The directors of the Douglas Southern Electric Tramway, Limited, report a profit for last year of £736. Out of this sum, together with the balance brought forward, a dividend of 3 per cent. on the 7 per cent. preference shares is recommended, carrying forward the balance of £265. The retiring directors, Messrs. Lowcock and Fawcus, of Manchester, decline to offer themselves for re-election.

St. James's and Pall Mall Electric Light Company.—The amount of electricity sold for the quarter ended March 25th is returned at 1,016,642 units, estimated to produce £31,180, as against 907,919 units for the same quarter of last year, which produced a net revenue of £19,898. A further reduction in the scale of charges made by the company came into force on January 1st, 1898.

Oriental Telephone and Electric Company, Limited.—The directors have resolved to recommend to the shareholders, subject to the final audit of the accounts, a further dividend of 8d. per share, free of income-tax, making, together with the interim dividend paid in October last, 5 per cent. for the year ended December 31st, 1897.

The Submarine Cables Trust.—This company announces that, on and after April 15th, the coupon due on that date will be paid in full by Messrs. Glyn, Mills & Co., of 67, Lombard Street, E.C., between the hours of 10 a.m. and 2 p.m. The coupons should be left with the bankers for examination four clear days before payment.

British Columbia Electric Railway Company.—The half-yearly interest on the 4½ per cent. debentures, and on the 6 per cent. income bonds, due 15th inst., will be paid on and after that date at the offices of Messrs. Sperling & Co., 8, Austinfriars, E.C.

Eastern Extension Telegraph Company.—Numbers are advertised of 451 debentures of £100 each, which will be paid off at par on July 1st next at Messrs. Barclay & Co., 54, Lombard Street, E.C.

TRAFFIC RECEIPTS.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending April 8th, 1898, were £2,810 9s.; corresponding period, 1897, £2,078 0s. 3d.; increase, £732 8s. 9d.

The City and South London Railway Company.—The receipts for the week ending April 10th, 1898, were £884; week ending April 11th, 1897, £1,021; decrease, £137; total receipts for half-year, 1898, £15,823; corresponding period, 1897, £15,839; decrease, £13.

The Dover Corporation Electric Tramways.—The receipts for the week ending April 2nd, 1898, £117 16s.; total receipts to April 2nd, 1898, £1,395 14s. 7d. Week ending April 9th, 1898, £119 2s. 7d.; total receipts to April 9th, 1898, £1,514 17s. 2d.

The Liverpool Overhead Railway Company.—The receipts for the week ending April 10th, 1898, amounted to £1,539; corresponding week last year, £1,353; increase, £186.

The Western and Brazilian Telegraph Company, Limited.—The receipts for the week ending April 8th, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company Limited, were £2,581.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, April 5th	Closing Quotation, April 13th.	Business done during week ended April 13th, 1898. Highest.	Lowest
137,400*l*	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	...	...	100 —104	100 104	...	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	7 — 8	7 — 8	...	...
125,000	Do. do. 5% Debs. Red.	100	...	...	...	93 — 96	93 — 96	...	...
923,960*l*	Anglo-American Teleg., Ltd.	Stock	£2 9s.	£2 13s.	3 %	61 — 64	61 — 64	...	...
3,038,020*l*	Do. do. 6 % Pref.	Stock	£4 18s.	£5 6s.	6 %	111½ 112½	111½ 112½	112⅛	111½
3,038,020*l*	Do. do. Defd.	Stock	...	...	...	12¾— 13¼	12¾— 13¼	13	...
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	7 %	7 %	16½ - 17 xd	16½ — 17	16½	...
75,000*l*	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	...	...	112 —116	112 —116	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	4 %	4 %	...	3 — 3½	3 — 3½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	8 %	...	185 —190 xd	185 —190	...	...
918,297*l*	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	104 —106 xd	104 —106	105½	104½
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	2 %	...	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	7 %	6½— 7½	6½ — 7½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	14½ — 15½	14½ — 15½	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 11	10 — 11	...	...
30,000*l*	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	4½%	103 —106%	103 —106%	...	...
60,710	Direct United States Cable, Ltd.	20	2½%	2½%	...	10¾ — 11¼	10¾ — 11¼	...	...
120,000	Direct West India Cable 4½% Reg. Deb	100	...	...	...	99 —102	99 —102	...	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	...	17¾ – 18¼	17¾ – 18¼	18 1/16	17⅞
70,000	Do. 6 % Cum. Pref.	10	6	6%	...	18½— 19½	18½ – 19½	...	...
89,900*l*	Do. 5 % Debs., repay. August, 1899	100	5 %	5%	...	100 —103	100 —103	101½	...
1,302,615*l*	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4%	...	128 —131	128 —131	128½	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7%	...	18¾ – 19¼	18¾— 19¼	19	18¾
25,200*l*	{ Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	}100	5 %	5%	...	99 – 103	99 – 103	...	...
100,500*l*	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5%	...	100 —103	100 – 103	...	...
320,000*l*	Do. 4 % Deb. Stock	Stock	4 %	4%	...	128 —131	128 —131	...	...
35,100*l*	{ Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	}100	5 %	5%	...	99 —103	99 —103	...	...
46,500*l*	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5%	...	100 —103	100 —103	...	...
300,000*l*	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4%	...	102 —105	102 — 105	...	...
200,000*l*	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4%	...	107 —110%	107 —110 %	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅛%	4½%	...	11¾ - 12¼	11¾ - 12¼	12	11 11/16
180,042	Do. do. 6 % Pref.	10	6 %	6%	...	17½ — 18	17½ — 18	17 9/16	17½
150,000	Great Northern Teleg. Company of Copenhagen	10	10 %	10%	...	29½ — 30½	29½ — 30½	...	...
160,000*l*	Do. do. do. 5 % Debs.	100	5 %	5%	...	100 —103	100 —103	...	...
97,000	{ Halifax and Bermuda Cable Co., Ltd., 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	95 —100	95 —100	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10%	...	52 — 55	52 — 55	...	...
100,000*l*	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6%	...	106 —109	106 —109	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	4 %	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5½%	5½%	6 %	5½— 6	5½ — 6	5⅝	...
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 18	16 — 18	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5½ — 6	5½ — 6	5½	...
1,329,471*l*	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	100 —105	100 —105	103	101
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	⅝ — ¾	⅝ — ¾	...	...
100,000*l*	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	...	105 —108	105 —108	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	8 — 9	8 — 9	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	140 —145	140 —145	...	..
58,000	United River Plate Teleph., Ltd.	5	4 %	5 %	...	4 — 4½	4 — 4½	4 7/16	...
146,733*l*	Do. do. 5 % Debs.	Stock	5 %	...	...	105 —108	105 – 108	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	*nil*	...	3½ - 4½	3½ - 4½	...	...
213,400*l*	Do. do. do. 5 % Debs.	100	5 %	5 %	...	99 —102	99 - 102	100½	...
64,269	Western and Brazilian Teleg., Ltd.	15	3 %	2 %	...	12 — 12½	12 — 12½	12¼	12⅛
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	...	7¾— 8¼	7¾— 8¼	7¾	...
33,129	Do. do. do. Def. Ord	7½	1 %	*nil*	...	4½— 5	4½— 5	4⅝	...
389,521	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	106 —109	106 —109	106	...
88,321	West India and Panama Teleg., Ltd.	10	⅜%	1 %	...	½— ¾	½— ¾	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	7½— 8	7½— 8	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	5 — 7	5 — 7	...	...
80,000*l*	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	...	105 —108	105 —108	...	...
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7%	...	105 —110	105 —110	...	...
160,100*l*	Do. do. 6 % Ster. Bonds.	100	6 %	6%	...	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share.	1895.	1896.	1897.	Closing Quotation, April 5th	Closing Quotation, April 13th.	Highest.	Lowest
30,000	Charing Cross and Strand Electy. Supply	5	5 %	6 %	7 %	13½— 14½	13½— 14½	...	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	...	...
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 19,277 ...	5	5 %	5 %	...	10¼— 10¾	10¼ — 10¾	10¼	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	4½%	4½%	...	115 —117	115 —117	...	...
50,000	City of London Elec.Lightg. Co., Ltd., Ord. 40,001—90,000	10	5 %	7 %	10 %	26 — 27	26 — 27	26⅝	26½
10,000	{ Do. do. Prov. Certs. Nos. 90,001 to 100,000 £5.	}10	...	...	...	19 — 20	19 — 20	...	...
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17½ — 18½	17½— 18½	17¾	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	129 —134	129 —134	...	...
30,000	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—30,000	10	*nil*	*nil*	*nil*	14¾— 15¼	14¾ — 15¼	15⅛	15
20,000	Do. do. do. 6% Pref., 40,001—60,000 ...	10	6 %	6 %	6 %	15½— 16	15½— 16	...	...
17,400	Edmundsons Elec. Corp., Ltd., ord. shares 1—17,400 ...	3	...	...	...	3¼— 3¾	3¼— 3¾	...	...
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5	...	...	...	10½— 11½	10½— 11½	...	...
10,000	Do. do. 7 % Cum. Pref. ...	5	...	...	...	11½ — 12½	11½— 12	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	4 %	5 %	6 %	20 — 21 xd	19½ - 20½	20½	19½
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem. ...	10	...	...	3 %	20½ – 21½	... — ...	...	...
220,000*l*	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½ %	117 — 121	117 —121	118⅝	118
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	2 %	4 %	6 %	20 — 21	20 — 21	20 5/16	...
31,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord.	5	7½%	10½%	14½ %	18 — 19	17½ — 18½	...	...
20,000	Do. do. 7 % Pref., 20,001 to 40,000	5	7 %	7 %	7 %	10 — 11	10 — 11	...	..
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	4 %	107 —110	107 —110	...	..
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2½— 2¾	2½— 2¾	...	...
79,900	Westminster Electric Supply Corp., Ord., 101 to 80,000 ...	5	7 %	9 %	12 %	17 — 18	16½ – 17½	...	...

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, April 5th.	Closing Quotation April 13th.	Business done during week ended April 13th, 1898. Highest.	Lowest.
30,000	British Electric Traction	10	.	.	...	16 — 16½	16 — 16½	16½	16
90,000	Brush Elect. Enging. Co., Ord., 1 to 90,000...	3	2½%	*nil*	*nil*	1⅞ - 2	1⅞ 2	1 15/16	1⅞
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	*nil*	4 %	2¼ - 2½	2¼— 2½	2⅜	2 5/16
125,000*l*	Do. do. 4½ % Perp. Deb. Stock... ...	Stock	...	...	...	110 — 114	110 114	...	...
50,000	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	102 —105	102 —105	...	...
19,894	Central London Railway, Ord. Shares	10	...	...	...	10¼— 10⅝	10¼— 10⅝	10⅝	10½
129,179	Do. do. do. £6 paid	10	...	...	...	6¼— 6⅝	6¼— 6⅝	...	...
59,254	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1½— 2	1½— 2	...	...
67,680	Do. do. Def. do. £5 pd. ...	...	...	...	...	4⅝— 4⅞	4⅝— 4⅞	...	...
630,000*l*	City and South London Railway	Stock	1 3/16%	1 3/16%	1⅞%	67 — 69	68 — 70	69½	69
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	...	...	1⅞ - 2½	2 — 2½	2¼	...
99,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 99,261	5	5 %	5½%	...	2¼ - 2⅝	2¼ 2⅝	...	...
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5½%	...	4 — 5	4 — 5	...	...
194,023	Do. do. do. 4% Deb. stock Red. ...	100	.	...	...	103 —105	103 —105	...	...
116,660	Electric Construction, Ltd., 1 to 116,000		5 %	6 %	...	2⅝ 2⅞	2⅝ 2⅞	2⅝	...
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 ...	[illegible]	7 %	7 %	...	3⅛ 3⅜	3⅛ 3⅜	...	...
111,100	Do. do. 4% Perpetual 1st Mort. Deb. Stock	Stock	...	...	...	106 —108	106 —108	...	...
91,196	Elmore's Patent Cop. Deposg., Ltd., 1 to 79,863	2	...	...	...	[illegible]	[illegible]	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	...	...	...	[illegible]	[illegible]	...	...
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	10½%	7 %	7 %	9 — 11	9 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	8 %	10 %	12 %	22 - 23	22 23	22½	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½ - 19½	18½ - 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½%	110 —115	110 - 115	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ..	10	10 %	10 %	10 %	21 — 22	21 22	21⅝	21½
300,000	Do. do. do. 4 % 1st Mort. Debs	100	.		...	102 —106	102 —106	...	...
87,100	Liverpool Overhead Railway, Ord.	10	2⅞%	2⅞%	3½ %	10⅝ 10⅞	10 11/16 10 13/16	...	...
18,000	Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15⅞ 16¼	15⅞— 16¼	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	15 %	15 %	35 38	35 — 38	36⅞	36
150,100	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 -105	102 —105	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	...	...	135 - 138	135 —138	137	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

* Birmingham Electric Supply Company, Ordinary £5 (fully paid) 10½.

House-to-House Company, 4½% Debentures of £100, 108—110.

Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 16¾—17¼; 1st Preference Cumulative 6 %, £5 (fully paid), 8¼—8¾. Dividend, 1896, on Ordinary Shares 7 %.

* From Birmingham Share List.

London Electric Supply Corporation, £5 Ordinary, 4—4½.

* T. Parker, Ltd., £10 (fully paid), 14—15.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8—8½. Dividend for 1896—6 %.

Bank rate of discount 4 per cent. (April 7th 1898.)

SOCIETY OF CIVIL ENGINEERS OF FRANCE.

Sitting of February 4th, 1898.

M. Le Roy read a paper on "Electrical Heating," and first spoke of the inconveniences of the various other modes of heating (wood, coal, gas) and then proceeded to discuss the methods used up to the present day for heating by electricity. At present, heating by electricity is effected by making the electrical energy pass through fine metallic wires, offering great resistance to the current, so that these wires become heated and by conduction transmit the heat which they give off. The heat is transmitted from the wires to the insulating material that encloses them, and then to the metal surface constituting the apparatus itself, saucepan, boiler, radiator, &c. This necessitates the burner being enclosed in the apparatus itself.

For domestic purposes, therefore, it is necessary to buy quite a fresh set of kitchen utensils and train our servants to use them. From a practical point of view, these articles are, from their very construction, subject to rapid deterioration. Repairs are expensive and very difficult.

In planning his system, M. le Roy had a double object in view.

(1) To construct simple and convenient apparatus, capable for domestic purposes of being used with the ordinary kitchen utensils; saucepans, irons, &c., so that no material changes need be made.

(2) To find out theoretically what substances possess the electrical and physical properties most suited to the development of heat, and so to determine the choice of the resistance.

Of all the substances or compounds that M. le Roy has experimented upon at Prof. Troost's laboratory at the Sorbonne, crystallised silicium or graphitoid alone seems to give the desired results.

In a note, presented by M. Troost to the Académie des Sciences* at the sitting of January 17th last, M. Le Roy gave details of the resisting properties of silicium.

The coefficient of specific resistance of crystallised silicium is 1,333 times greater than that of coal used for lighting, and 235,294 times greater than that of German silver.

* See *L'Electricien*, No. 372, p. 101.

By these researches, therefore, one of the problems set was solved.

From the point of view of practical utilisation, we might construct resistances of great section and short length capable of being introduced in derivation in quantities of 1, 2, 3 or 4 into burners similar to those of gas stoves.

M. Le Roy explained in detail the theoretical considerations that served him as a basis; he concluded from them that the choice of metal for forming a resistance to be employed for heating purposes is absolutely irrational.

He then discussed the mean relative prices of the various kinds of fuel used for heating.

If we consider the various renderings of the apparatus of utilisation, the number of calories given off by each kind of heating agent would be as follows:—

Coal	... ...	1,500,000 large calories.
Gas	for rooms	1,312 " "
	" "	525 " "
	" cooking ...	2,100 " "
Electricity	for rooms ...	864 " "
	for cooking ...	777 " "

Assuming that

The ton of coal costs	50 francs
The cubic metre of gas costs	·30 "
The kilowatt-hour costs	·25 "

The price of 1,000 large calories would be:

Coal	... ...	·033 francs
Gas	for rooms	·228 "
	" "	·550 "
	" cooking	·140 "
Electricity	for rooms	·289 "
	for cooking	·321 "

From this it follows that, leaving aside the comparison with coal, and only establishing one with gas, which is the most important point, for the heating of rooms with the most approved gas apparatus, we shall spend 100 francs where with electricity we shall spend 120 francs, and with apparatus like the block burners, electricity will come out half as dear as gas.

Cooking at an expenditure of 100 francs worth of gas will correspond to 230 francs expended on electricity.

M. Le Roy observed that the efficiencies claimed for various gas appliances assume that the mixture of gas and air necessary for combustion always takes place under the desired conditions: now, these conditions are rarely fulfilled in practice; according as the tap is more or less turned on, the proportions of the mixture vary and the efficiency is considerably lowered. With electrical apparatus the efficiency remains constant and does not depend on the skill of the operator.

M. le Roy then explained his system, on which two typical appliances, a heating stove and a little cooking stove, had been working since the commencement of the sitting.

This system consists essentially of the *electric block* which is constituted of a rod of pure silicium agglomerated and enclosed in a glass tube suitable for subjecting it to oxidation.

For the passage of the electric current this block is brought to a temperature of about 1,000°. The appliances for utilising the system can take any shape and any dimensions.—*L'Electricien.*

THE ELECTRICITY SUPPLY OF LONDON.*

By ARTHUR H. PREECE, Assoc.M.Inst.C.E.

The supply of electricity on a commercial scale had been started in London after the passing of the Act of Parliament in 1888, which amended the Act of 1882, principally by extending the date for compulsory sale to the local authority from 21 years to 42 years. In 1888 many companies applied for provisional orders, and, in determining which were to be granted powers, and the districts over which the powers were to extend, the Board of Trade decided that competition would be advantageous to the public, and that it was advisable to allow one direct current system to compete with one alternating current system.

There were now in London 11 important companies and five vestries supplying electricity, and three other companies and three vestries were taking steps to start works. The capital invested in the industry amounted to £6,000,000, and plant was installed to the extent of 80,000 H.P., the equivalent of 2,000,000 8-C.P. lamps being connected to the mains. The total annual revenue was £800,000, and the total annual expenditure, £450,000.

Of the systems for supplying electricity in London, the alternating current was applicable to large areas where consumers were scattered, and it enabled the generating works to be established by the riverside, or where land was cheap and coal was easily unloaded. The undertakings using this system were: the City of London Company, the Metropolitan Company, the London Electric Corporation, the County of London Company, the House-to-House Company, the Hampstead Vestry, the Islington Vestry, and the Hammersmith Vestry. The direct current systems were divisible into two classes, the high pressure and the low pressure. In the former rotary transformers were used to reduce the high pressure to a low pressure, while the latter produced and distributed electricity at the same pressure at which it was supplied to consumers. The direct current systems were applicable to compact areas, and, with the use of high pressure, to scattered or isolated compact areas. The chief advantages of the direct current system were the possibility of using storage batteries, which could not be employed with the alternating current systems, greater efficiency in distribution, and greater adaptibility to motive power. The undertakings using the system were: the Chelsea Company (high pressure), Charing Cross and Strand Corporation (high pressure), the Westminster Corporation, the St. James's and Pall Mall Company, the Kensington and Knightsbridge Company, the Notting Hill Company, the St. Pancras Vestry, and the Metropolitan Company (at one works).

The generating works of the several undertakings in London contained many interesting features. No less than 20 different works had been erected. The boilers used comprised the water-tube, marine, Lancashire, and miscellaneous types; but the preference for the water-tube boiler was very marked. The works were liable to sudden demands through fogs, and the quick steaming properties of this type of boiler were of great advantage. The boilers were fired chiefly by hand with Welsh coal, but in the works of the City of London Company and the County of London Company mechanical stokers and cheaper coal were used. The use of extensive systems of steam pipes was now being dispensed with. The multiplicity of valves was unnecessary, and the number of valves was being reduced, and arrangements were made as simple and with as few joints as possible.

The present tendency was towards engines of the marine type for large outputs. The high speed engine was not used for larger powers than 750 H.P. Some engineers, however, found engines of 350 H.P. sufficiently large and the most convenient unit to adopt. The dynamos were similar in most works, and were always connected direct to the engines. Storage by secondary batteries was not extensively employed in London, as their maintenance had hitherto proved expensive. But a few works used them entirely for maintaining the supply after midnight, and in the daytime in summer. The author gave the results of a test of a small marine engine and alternator, showing the combined efficiency to be 85·5 per cent. The question of vibration had been of great importance in many works; no cure had been found effective when once vibrations were set up. High-speed engines must have three cranks to be free from appreciable vibration.

The favourite methods of distributing electricity were to transmit current at a high pressure in heavily-insulated cables in iron pipes, and current at a low pressure in insulated cable in stoneware conduits, or in cables heavily armoured and laid direct in the ground. Rubber was now little used, paper and jute, impregnated with insulating compounds, having been extensively adopted.

The usual system of measurement of the electricity supplied was by meter, and the average charge was 5½d. per unit. The average charge in 1890 was 7½d., so that the price of electricity had been reduced in eight years no less than 25 per cent., equivalent to a reduction in the price of gas from 4s. to 3s. A curve was given to show the variations in the price of gas since 1870. The average price had varied between 4s. and 2s.; it was now 2s. 7d. The cost of generating and distributing electricity had been greatly reduced in the last few years. In 1892 it was seldom supplied for less than 4½d. per unit. The usual cost was now 2½d. to 3d. The actual cost of generating was about 1½d. per unit, and the cost of management, &c., about 1d. The direct current was everywhere produced at a cheaper rate than the alternating current. The difference was between ½d. and 1d. per unit, or 20 per cent. cheaper.

Since 1888 an important inquiry had been held by the Board of Trade regarding the maximum pressure permissible in consumers' premises. The result of this inquiry, in 1896, was to increase the pressure from 150 volts to 250 volts.

A comparison was made between the two largest companies in London, namely, the City of London Company, which supplied alternating current, and the Westminster Corporation, which supplied direct current. Both companies had nearly the same number of lamps connected to their systems, the number of 8-C.P. lamps connected being 270,898 and 269,939 respectively. The capital expended was respectively £945,829 and £546,434; the annual incomes per 8-C.P. lamp 11s. 9d. and 7s. 9d.; the annual expenditures per 8-C.P. lamp, 4s. and 3s.; and the costs per unit, 7·6d. and 5·8d.

The industry was growing so rapidly, that most undertakings had to seek new sites for generating works, and the tendency was to erect large works on the outskirts of London, where coal could be conveniently brought to the site, and where water could be obtained for condensing. The powers granted under provisional orders were limited as regards the compulsory purchase of land, and further powers were being sought by some companies from Parliament, so that they might be placed on the same footing as railway companies. No less than 40,000 H.P. was now being installed in London in order to meet the demand for electricity in the immediate future.

* Institution of Civil Engineers, London, April 5th.

SOME RECENT IMPROVEMENTS IN ACCUMULATORS AND THEIR APPLICATION TO TRACTION ON COMMON ROADS.*

By J. T. NIBLETT.

(*Continued from page* 491.)

A material for making the elements of secondary batteries quite distinct from any of those already considered is known as lithanode. The credit of devising lithanode is doubtless due to Mr. Desmond FitzGerald, whose labour in the field of electro-chemistry is well known. Batteries, with improvements made on Mr. FitzGerald's original invention, are now made by the Lithanode Electric Storage Company.

Lithanode is not compressed peroxide of lead, as is sometimes supposed, for, however strongly this lead peroxide may be compressed, the resulting mass will disintegrate when immersed in a liquid electrolyte. It is produced from litharge made into a pasty mass with a solution of sulphate of ammonia, which causes the material to "set," so that it will no longer disintegrate when placed in a fluid. The "forming," according to the original idea, was performed in a bath of sulphate of magnesia. In ordinary practice the elements are made up of a number of small slabs of lithanode, whose outer edges are V-shaped. These slabs or pellets are arranged in a casting mould of any suitable dimensions, and are placed at such a distance apart and from the edges of the casting frame as to allow of sufficient space for the requisite quantity of metal to run in and impart adequate mechanical strength to the completed element. After the pellets have been arranged in this manner, an alloy of lead and antimony is run into the interstices, and thus a complete plate is formed.

Before being cast up the positive pellets are converted into peroxide of lead in a forming bath; those for the negative plate are simply dried and cast up direct, the lithanode in the latter case being reduced to a condition of spongy lead by the ordinary electrolytic method.

Where lightness is a desideratum, as in the case of a traction cell, the pellets in the positive plates are made larger, while the negative plate is constructed of lead gauze, having its outer edge strengthened by a rim of lead. The gauze is filled in with the prepared litharge which entangles itself in the thin lead wire, and thus produces a plate of great lightness, and one little liable to fall to pieces.

Lithanode may be obtained in varying degrees of porosity. For high discharges it is made of a highly porous nature, the porosity being produced by incorporating in the material cystals of some salt, which is practically inert, and which is dissolved out during the forming operation.

The rate of discharge obtainable from lithanode batteries varies

* Abstract of paper read before the Self-Propelled Traffic Association, Liverpool Centre, on March 29th.

between very wide limits, and is regulated by the character of the lithanode, whether made hard, medium, or soft. The ordinary working rate of discharge is $\frac{1}{14}$th of an ampere per square inch of lithanode plate, but owing to recent improvements very much higher rates of discharge can be obtained.

The electrical capacity of lithanode, when discharged at the above rate, is almost exactly one ampere-hour per ounce, so that in a lithanode element weighing 1 lb. a current capacity of 16 ampere-hours is obtained. In practice, however, this high capacity is never reached.

Thinking it may be of interest I have prepared the following particulars taken from one of the company's most popular types of portable battery:—

DATA OF COMPLETE 30 AMPERE-HOUR LITHANODE BATTERIES, INCLUDING WOOD CASES.

No. of cells.	Outside dimensions of battery.			Open E.M.F. of battery.	Approximate gross weight of battery.
	Length.	Width.	Height.		
	inches.	inches.	inches.	volts.	lbs.
1	3·75	7 00	6·37	2	8¼
2	5 12	7·00	6·37	4	16
3	7 27	7·37	7·00	6	22¼
4	9 50	7·37	7 00	8	29
5	11·60	7 37	7 00	10	36
6	13 75	7·37	7 00	12	43
7	15 78	7 37	7·00	14	50
8	18·00	7·37	7 00	16	56¾
9	20·12	7·37	7 00	18	63¾
10	22·24	7·37	7 00	20	70¾
11	24·36	7 37	7 00	22	77¾
12	26·50	7·37	7 00	24	84½

DETAILED PARTICULARS OF CELL.

Vulcanite containing cell	6·25 inches long. 2·12 „ wide. 5·25 „ high. weight, 10 ozs.	
Positive element ...	Two plates in each cell,	5·9 inches long. 3 9 „ wide. 0·25 inch thick. weight, 1 lb. 1½ ozs.
Negative elements...	Three plates in each cell,	5 9 inches long. 3·9 „ wide. 0·13 inch thick. weight, 11½ ozs.

Weight of connectors, 3 ozs.
Weight of cover, vent plug, sealing, and separators, 2 ozs.
Quantity of electrolyte, 15·5 fluid ozs.
Gross weight of complete cell, 6 lbs. 7 ozs.
Normal charging rate, 3 amperes.
Normal discharging rate, 3 to 4 amperes.
Maximum safe discharging rate, 9 to 12 amperes.
Approximate internal resistance, 0·015 ohm.

The data given will give a fair idea of what is obtained in actual working with this form of cell. Other batteries of larger capacity are, of course, made, and as the capacity increases, the proportional weight and bulk slightly decreases. These batteries have been used extensively for lighting vehicles, actuating coils for X ray photography, and for propelling electric launches and light forms of motor-cars.

The Chloride Electrical Storage Syndicate make their accumulator plates on a somewhat similar plan to that adopted by the Lithanode Company. In this case, however, instead of using litharge, chloride of lead is employed to make the pellets.

Chloride cells are well known and largely used for traction purposes in America, and they are very well received in this country also.

A form of cell which is just now exciting much attention on the Continent is known as the "Marschner" cell. The Marschner battery is at present being used on the Dresden tramways, and it is said to be behaving in a very satisfactory manner. The plates are stated to consist of the ordinary oxides of lead, incorporated with powdered amber and an essential oil. This mixture is said to "set" very hard, the resultant plate being of a tough metal-like nature. On the Dresden car 144 cells of this type are being used. Each cell contains 13 plates, and is said to weigh only about 28 lbs. The weight of the complete battery is given as 5,290 lbs. Its efficiency is stated to be over 90 per cent., and if discharged at its normal rate—that is, 65 amperes—an energy capacity of 13 watt-hours per pound of cell is obtained.

When devising cells for traction purposes many difficulties have to be overcome. Owing to their high initial cost, a small number of cells should be made to suffice, and these should be so constructed that they will run a vehicle for a reasonable number of hours with one charge. They should be capable of being charged and discharged at rapid rates. Above all, they should be able to withstand the jolting and jarring incidental to their being run over rough and uneven roads. The cell should be so constructed that the wash of the electrolyte does not remove the active material.

There is at the present moment an enormous field for an inexpensive cell which will combine large capacity with small weight and great solidity. Some form of mechanically solid cell seems to offer the best solution for this problem. Some little time ago great hopes were entertained that the solidity problem had been solved by the introduction of Dr. Schoop's solid electrolyte. This so-called solid electrolyte was made by adding silicate of soda to the ordinary solution, which caused it to set and become of a gelatinous nature. In this country some practical tests have been made with Mr. Barber-Starkey's method of making solid cells by substituting for the electrolyte a mixture of wood sawdust and plaster of Paris, which when set was moistened with dilute sulphuric acid.

The accumulator known in America as the "Hatch" is of a mechanically solid nature. In this case metallic frames are not employed for supporting the lead salts, as they are held within a porous earthenware grid serrated on one side, and, having small square recesses on the other. Plain lead plates are used as conductors, and these are bedded on the moist lead salts. According to this arrangement there is no clear liquid space between the elements, as the serrated earthenware plates touch one another, and are so placed that the ridges on one plate are placed at right angles to those on the other. Wooden clamping plates with India-rubber bands placed around them are fixed on the outside of each end element, and these serve to give the requisite elasticity. The "Pumpelly" cell is another American production, and in this case the mechanical solidity of the cell is arrived at by inserting plain, thick, porous earthenware plates between the elements. In this case, however, the plates are placed horizontally instead of vertically as in the "Hatch."

One great drawback to the employment of a viscous, gelatinous, or semi-solid electrolyte arises from the fact that when such substances are interposed between the plates no free circulation of the liquid is possible. In all secondary batteries, as already shown, the activity of the elements depends entirely upon chemical action, and as the electrolyte is a medium through which all these reactions occur, it seems highly probable that anything which prevents its free access to the active material, or in any way impedes its circulation, must be detrimental, and consequently lead to loss of efficiency and capacity.

Some few years ago, having in view the advantages likely to be derived from the employment of a mechanically solid cell, for traction purposes, the author gave some attention to this particular form of battery, and a number of cells were constructed having this object in view. In most cases the elemente consisted of a highly cellular mass of active material which was capable of absorbing a sufficient quantity of electrolyte for the due performance of all the necessary chemical actions. Between each mass of active material was inserted a thin, highly porous, inert diaphragm, which was not found to materially increase the internal resistance, and served to complete the solid character of the cell. A large number of different combinations with various kinds of active material were tried. Owing to the cellular nature of these elements the liquid contained in the mass continually circulated, the slight evolution of gas which occurred during both the charging and discharging operations being quite sufficient to affect this. The active material was in all cases so placed that it could not be dislodged. It was found that the cellular character of the electrodes gave them a peculiar power of regulating their own internal resistance: for if the cell was being charged at too high a rate, or when it was on the point of being fully charged, the gas generated tended to drive the liquid out of the pores of the electrodes and remained imprisoned therein, thereby greatly increasing the resistance and stopping the flow of current. On the discharge, the occluded gas appeared to re-enter into the chemical combination and allow the liquid to refill the pores, thereby exposing more active surface. Little or no commercial use was made of this plan of construction, as at the time the author's attention was diverted into other channels, and the matter was dropped.

(To be continued.)

REVIEWS.

The Engineers' Year-Book, 1898. By H. R. KEMPE, A.M.I.C.E. London: Crosby, Lockwood & Co., 1898.

This valuable office book of reference has reached its fifth year, and has fairly kept to its original intention—that of keeping with the times—the various formulæ and descriptions being overhauled from year to year, so as to keep the book up-to-date.

In this year's section new matter has been added to the Earthwork Tables, and to that of Railways in respect of "Crossings," and the abstract of the Board of Trade regulations, which have been carried out by Mr. C. Seymour, of the Midland Great Western of Ireland. Information on gas engines has been supplied by Mr. H. Scholey, the section being entirely re-written. It is now in better form than before, but may still be desirably extended by illustrations and descriptions of other gas producers, and, we think, fuller reference might be made to the Thwaite system of blast furnace gas utilisation, a system which is bound to come to the front. Numerous other additions have been made, and the book contains 850 illustrations and nearly 700 pages of letterpress and index. We are inclined to think that much space might be saved by reducing some of the tables to smaller print. For example, there is a very extended table of specific gravities. It might be reduced by two pages, or even more, if many of the articles were taken out of it. This table is very full, but the equally important table of specific heats is paltry in the extreme. We required to use this, and failed to find the specific heat of glycerine, but we could find the specific gravity of juniper wood. We never knew of anyone who ever needed to know this. Juniper berries are used to flavour gin, but of what special use is the wood? Further additions might be made in the notes on water softening, which are very scanty.

We should like also to see a little fuller information on fuels. We find no statement of the calorific capacity in B.T.U. of any fuels solid or gaseous, but only of liquid fuels. More might now be given as to liquid fuels, say, an illustration of one or two examples of liquid fuel application to boilers, rivet furnaces, &c. Who knows, for example, that when using liquid fuel, it will not be practicable to mix tar with petroleum with any idea of thinning the mixture and increasing its fluidity. The petroleum will simply draw out the more liquid portion of the tar and send the pitch to the bottom to the choking of valves and pipes.

There is no information on coke ovens or residuals recovery plant—both of some engineering importance. The *fan* section might be extended and so also the pump section, two special varieties of which we see are omitted—the Hamilton and the Poblè. We note an error in the formula for radial axle boxes. The expression to the right of the = should have a denominator 2, the true formula being—

$$x = \left[\frac{(a + b) - \dfrac{a^2}{a + b}}{2}\right]$$

Makers of radial axle box vehicles have been lax in their proportioning, and this accounts for the bad running and unpopularity of radial boxes. The formula is due to Mr. Baldry who was once in the office of Sir John Fowler and, we believe, worked out the proportion of the radius bar for the eight-wheeled passenger carriages sent out under Sir John—then Mr.—Fowler's directions to New South Wales.

In sewage treatment there should be something given on the new system of bacteriological treatment which appears likely, as far as present indications point, to prove successful.

In pointing out these items, we would not imply that we look on their omission as serious, but they are items which may well be included in the next edition.

Magnets and Electric Currents. By J. A. FLEMING, M.A., D.Sc., F.R.S. London: E. & F. N. Spon, Limited, 1898.

This is described as "an elementary treatise for the use of electrical artisans and science teachers." The scientific knowledge of the reader is assumed to be practically *nil*, and the subject is taken up from the very beginning.

"Electrical artisans" of average intelligence who have scientific tendencies will undoubtedly find much to interest them in the author's admirable and lucid descriptions of how to make various pieces of electrical apparatus, from the simplest primary battery to the most perfect reflecting galvanometer, with things found about the house; and if they will only put such pieces of apparatus to the uses for which they are intended, and at the same time devote their attention to some of the less fascinating passages in the book, they will most certainly tend to become more useful members of the electrical community.

With regard to science teachers, these are of various kinds. Dr. Fleming is probably addressing himself to those whose teachings are intended to be of use to the electrical artisan, and not to the more familiar class of teachers whose teachings produce teachers.

From the reviewer's point of view, the preface is one of the most interesting portions of this substantial volume of 400 pages, because it gives him some assistance in discovering the lines upon which the author's mind has been working.

Dr. Fleming is a staunch supporter of Mr. Heaviside in his determined endeavours to eliminate, at all costs, the noxious multiplier 4 π from a large number of magnetic formulæ. He is also passionately fond of words, apparently for their own sake, and he cannot resist the temptation of giving names to things, even to mere ratios and multipliers, quite apart from the question as to whether these latter have a physical meaning or not.

We all use the word "voltage"; it is a word which was wanted, and for this reason it came—quite of its own accord; it was never invented. But Dr. Fleming now suggests *voltivity* for "voltage per centimetre." *Amperage* is also a word he enjoys writing, and when he gets to *gaussage* and *gaussivity* he is really happy. All this we can stand, within limits; but when he suggests *fluxage*, we think he is going a step too far. "Flux" was good enough for us in *our* young days, and the word is only a makeshift in any case. Then there is *coercivity*, which is not wanted, and *retentivity*, about which there is something aggressive which annoys us.

We do not say of a dinner plate that it possesses a property called greasic retentivity or greasivity, simply because, when insufficiently washed, it may retain traces of the food which has been placed upon it: there is, perhaps, no valid reason why we should not use such expressions; but, on the other hand, there is no necessity for them; and although it is well for the electrical artisan to know what is meant by residual magnetisation, he does not require to be told that it is the result of a certain quality of the iron called magnetic retentivity.

There are many other expressions which the electrician of the old school will assimilate with difficulty: thus, on page 127, is a table giving the "resistivity" of metals in "microhms per cubic centimetre," which is equivalent to what we have known for many years as the specific resistance in microhms per centimetre cube.

Returning to the preface, the author, after introducing a host of new names, remarks with reference to Faraday's beautiful conception of "lines" or "tubes" of force (which has never failed as yet), that the practical student would benefit by discarding such notions, and thinking only of a "physical state existing in a magnetic circuit, which is measured in webers and microwebers," the active cause of which is called *gaussage*, and the thing itself *fluxage*. Is he sure of this, or is it not possible that he may be mistaken, and that the practical student, of all people, is the one to whom it is essential that he should be allowed to *picture* in his mind these same magnetic lines or tubes, which have to be *cut* by a conductor in order that the latter may have an E.M F. generated in it? It is to be feared that, however much the said practical student may *think* of a physical state (called *fluxage*), this will not lead him to great things unless he be a born mathematician.

Dr. Fleming is to be congratulated upon having abandoned much that is old-fashioned in his treatment of the subject of magnetism; the strength of field is, however, still occasionally considered in relation to the tendency which would be experienced by a free magnetic pole (if let loose) to travel down it; and there are references to the demagnetising forces exerted by the poles of a magnet, which do not fit in well with the more modern conceptions of the magnetic circuit.

The last few pages of Chapter III. deal with Mr. Heaviside and the "disfiguring" 4 π. A list of Mr. Heaviside's suggested units expressed in terms of the present C.G.S. units is given, and the advantages of the new system (which are undoubtedly well worthy of consideration) are pointed out; but it is to be feared that the average Englishman will resist any attempt to change his present electrical units, for the same reasons which induce him to resent the mere suggestion of altering his delightful system of weights and measures.

In Chapter II. the author generalises on the subjects of matter and energy, space, time, and force, and describes the C.G.S. and other systems of units; and in Chapter V. he takes up a certain amount of more or less valuable space by giving us the legal definition of the ohm, ampere and volt, accompanied by all the customary rigmarole, beginning "Whereas," and ending with Her Majesty's expressions of pleasure in approving the "several denominations of standards set forth in the schedule hereto appended." Chapter VI. deals with electro-magnetic induction, and Chapter VII. is devoted to electro-magnets. The relation between the directions of the magnetic flux and induced E.M.F. is stated in various ways, but not always successfully. For instance, the "practical" student who is told to thrust his arm through an imaginary ring and give it a *positive* twist by rotating his hand in a *counter*-clockwise direction, may be expected to smile, and refuse to do it.

What is meant by mutual induction, or mutual inductance as Dr. Fleming calls it, is not made sufficiently clear. What the student generally does not understand is, where the *mutuality* comes in, and this is not explained.

In Chapter VIII., which deals with alternating currents, the much abused word "inductance" plays an important part. Dr. Fleming uses it to denote (as is customary nowadays) the quantity which is better known as the coefficient of self-induction; but it is a word with a considerable amount of latitude, and as used in many instances it would appear to be synonymous with what, towards the end of the chapter, is called the *reactance*.

Consulting engineers should read the section on transformers with the utmost caution, in order that they may not come upon the following sentence too suddenly:—"The transformer must have cooling surface enough to dissipate all the core losses without rising above the temperature of boiling water." They will do well to give this idea time to soak in, and who knows but what some of them may, in the future, have the sense to leave questions of temperature rise to the manufacturer. It is true that Dr. Fleming appears to have been carried away by a slight excess of common sense; but he shows a total and fearless disregard of public opinion which is highly commendable.

The last two chapters deal respectively with electric measuring instruments and the generation of electric currents. On page 295 is a table giving the safe working currents which may be carried by Hadfield's *resista* wire, and on the following page, a similar table for German silver wire. The temperature of the wires is, in each case, supposed to be such as "can be easily borne by the hand." It is, therefore, interesting to note that, in some of the smaller sizes, the safe current for the *resista* wire is three times as great as that given for German silver; and as the conductivity of the latter metal is four times as great as that of resista metal, it follows that, for the same amount of cooling surface, and approximately the same temperature rise, the watts lost in the one case will be 36 times greater than in the other.

Having picked out, and sufficiently magnified a few of the weak points in this book, it is only fair to add that, as a whole, it has much to recommend it. The author has done his best to treat each subject in as clear and simple a manner as possible, and he is to be congratulated upon the admirable way in which he has accomplished an exceedingly difficult task.

PERIODIC CURRENTS.

By W. G. RHODES, M.Sc.

THE tendency of late years has been to forsake the old methods of conducting alternating current calculations and to reduce the difficulties to the physical conceptions of the various phenomena. Formerly, no student not well equipped with a first rate mathematical training could hope to read intelligently the then existing literature on this subject. It was not until the application of graphical methods by Mr. Blakesley that alternating currents came at all within the scope of the ordinary electrical reader. Many writers followed suit, and nearly all writings teemed with diagrams, very interesting and useful to readers, but apparently demanding an altogether outrageous expenditure of mental energy on the part of the original writer. Who can look at the writings of Bedell and Crehore, Blondell and others, without being struck with the idea that the graphical representations of the currents and E.M.Fs., their magnitudes and phase relationships in multiple circuits and combination of circuits, must have required an altogether exorbitant amount of mental effort? That this feeling is becoming universal is evident from the fact that nearly all the prominent writers on alternating currents now use methods which, while of an analytical nature themselves, are easily capable of graphical interpretation and representation. All these methods depend upon the fact that the electrical quantities considered are capable of being represented by lines drawn of suitable lengths and along proper directions relative to each other, and upon the ability to represent algebraically directions of lines relative to one another by the help of the imaginary $\sqrt{-1}$.

Steinmetz, with the method of the complex variable, has materially advanced our knowledge of induction machines, and has carried the subject probably further than would be possible with the aid of graphics alone.

M. Vaschy has recently noticed that on the assumption that alternating electromotive forces and currents can be represented by simple sine functions of the time, if e is any such periodic function, then $\frac{d\,e}{d\,t}$ may be replaced by its geometrical equivalent, $p\,e\,\sqrt{-1}$, where $p = 2\,\pi\,n$, and n is the frequency of the function in question.

In the *Annales Télégraphiques* for November—December, 1897, M. Pomey draws attention to the writings of Vaschy, and shows how, for instance, the transformer equations

$$\left.\begin{aligned} L_1 \frac{d\,i_1}{d\,t} + M \frac{d\,i_2}{d\,t} + r_1\,i_1 &= e \sin p\,t \\ L_2 \frac{d\,i_2}{d\,t} + M \frac{d\,i_1}{d\,t} + r_2\,i_2 &= 0. \end{aligned}\right\} \quad (1)$$

where L_1, L_2 are coefficients of self-induction; M, that of mutual induction; r_1, r_2, resistances; i_1, i_2, currents; and $e \sin p\,t$, the applied E.M.F. are geometrically equivalent to the equations

$$\left.\begin{aligned} p\,L_1\,i_1\,\sqrt{-1} + p\,M\,i_2\,\sqrt{-1} + r_1\,i_1 &= e \\ p\,L_2\,i_2\,\sqrt{-1} + p\,M\,i_1\,\sqrt{-1} + r_1\,i_2 &= 0. \end{aligned}\right\} \quad (2)$$

It should, however, be particularly noted that equations (1) are more general than equations (2). The complete solution of (1) gives the values of the currents for all time subsequent to the *instant of closing the primary circuit*, whereas from equations (1) only the steady values of the currents can be obtained. Further, equations (1) are perfectly general whatever be the nature of the applied E.M.F., but for equations (2) to hold good both the applied E.M.F. and the currents must be capable of representation as a simple sine function of the time.

The writer has recently shown in a short series of articles* the application of a method leading to equations of a type similar to (2), which is essentially a vector equation of E.M.Fs. It is further demonstrated that vector equations can only exist between E.M.Fs. so as to form a vector E.M.F. equation, or between currents forming a vector current equation. It is seen that by the combined aid of analysis and graphics, problems which are otherwise formidable are solved with ease, and the analysis itself only demands quite an elementary mathematical knowledge. It is of great value that any step in the process should be capable of being readily represented in a graphical form, thus enabling a better physical conception of the problem to be obtained.

It is with no hesitation that I say that vector algebra, or allied processes, must eventually—and that before long—form the basis of calculation for all *useful* text books on alternating current phenomena, and that it is to the application of these methods we must chiefly look for further advances in the theory of the subject.

THE TRAMWAYS INSTITUTE.

THE end of March or the beginning of April might fairly be considered rather a late period at which to issue a publication bearing date of *January*, and on receipt of the *Tramways Institute Journal* the other day, we could not quite understand the belatedness of the copy sent us, except on the supposition that copies are sent out in a leisurely fashion.

The January issue, however, contains plenty of February news, so that the Institute, and its officials responsible for the journal, are not quite so out of date as would appear on the surface.

When the tramway interests of this country are strong enough, or rich enough, or united enough to support a

* "The Application of Vector Algebra to Alternating Currents," by W. G. Rhodes, M.Sc., ELECTRICAL REVIEW, January 7th, 14th, and 21st, 1898.

flourishing Institute, with an editor on the premises, this journal (if it survive so long) may then, perhaps, serve as a suitable record of proceedings; but in its present form it hardly justifies any existence at all, in view of the excellent appearance given by the electrical and railway journals that make a special feature of tramways and things appertaining thereto.

The advertisement pages of this journal afford very interesting and instructive matter for thought. Varnishes, metal for bearings, tramcars, tickets, ticket punches, rails and paving materials—all these are in order, and will probably be required even when *all* our lines are worked by electricity; but what is to be said in this present year of grace of advertisements in a tramway publication dealing with the advantages of antiseptic ointment and other medicines for horses, patent steel whipple trees, fodder of all kinds, chaff cutters and similar machines, harness, and horse rugs?

We should have thought that the benefits of advertising such materials in a *tramway* paper would not be very excessive, so far as future orders are concerned.

True, we find a few counteracting notices of electric tramway contractors and manufacturers of plant: but they don't wear a happy look in such company. The whole publication, in regard to advertisements, has the appearance of the American street railway journals of many years ago.

Turning to the inside pages, the electric car has there a field all to itself; the horse is ignored, and cables only mentioned once or twice.

Although, as stated, some of the items in the letterpress are rather more recent than the date on the outside cover would appear to convey, yet we cannot say very much for the contents. It is, and must be, extremely difficult to give *news* in a publication that appears once a quarter or so, and then three months behind time; but on the other hand, a complete summary of the quarter's proceedings—which alone would otherwise be worth consideration—would entail great labour on the part of an editor (who should have special knowledge and experience), whilst the resulting publication to be of service, would have a much greater bulk than that now before us.

However, we would not wish to detract from any efforts to encourage electric traction, and therefore welcome the evident desire of the Tramways Institute to deal more with this subject than in time past has been the case.

THE PREPARATION OF COPPER SAMPLES FOR CONDUCTIVITY TESTS.*

By Dr. S. SHELDON, Polytechnic Inst., Brooklyn.

WHILE the electrical fraternity is interested with the subject of standardisation of electrical apparatus I should like to call attention to the necessity of adopting a standard condition of softness for samples of copper whose conductivity is to be tested. Of course, users of copper wire are interested in the conductivity of the wire in the condition in which it is furnished to them—not in the conductivity which might have been given to the wire, if it had been treated differently. While the copper losses in most electrical machinery are but a small percentage of the output, and while the temperature at which the machinery will operate is uncertain, owing to the uncertainty of the factors entering into the heat escape, still in many cases a reduction of the copper losses by a few per cent. is worth struggling after. The determination of the conductivity of wire used for such purposes is an easy matter. On the other hand, the requirement of a definite conductivity, frequently found in specifications for construction work, where rubber-covered or similar wire is to be employed, gives no opportunity for the verification of the fact that the requirements of the specifications have been complied with. It is impossible to determine the cross section of the wire and the value given by the manufacturer must be accepted. Again, the tinning of the wire makes the resistance measurement valueless. These difficulties are met in some cases by the purchasers sending inspectors to the factories to determine the conductivity before the wire is covered. This is, perhaps, the best solution of the problem under the circumstances, and, according to Abbott, is the practice in American aerial line construction. To electrolytic copper refiners and all buyers and sellers of bulk copper for electrical purposes, a standard method of treatment of test samples is of utmost importance. Cases have been known where copper, contracted for future delivery at a certain price, has been rejected at the time of delivery because of too low a conductivity, the ruling price at the time of delivery being less than at the time of making the contract.

The American Institute of Electrical Engineers has adopted as its standard of conductivity for copper the value given by Matthiessen for soft copper. This is contrary to the original advice of the Committee on a Standard Wiring Table, and resulted from statements made in the discussion of the report that there were many degrees of hardness, implying that a soft condition was easily obtainable, and could be reproduced. To ascertain whether this were true or not, I had two students of last year's class at the Institute, Messrs. Alfred Muller and Herman Wallatt, investigate the influence of softness upon the conductivity. A sample of wire was passed several times through holes in a drawplate in such a manner as to yield a very hard wire. This wire was cut up into separate lengths. The assumption was made that the resistivities of these lengths were equal. The lengths were then separately subjected to different annealing temperatures for a fixed interval of time, the sample, in one set of experiments, being placed in a vacuum, and, in another set, in hydrogen. The different temperatures were produced by sending different currents through the samples. The temperatures were calculated from current measurements and measurements of voltage between separate potential terminals on the samples, Kennelly's temperature coefficient being assumed as correct. After treatment, the conductivities of the samples were calculated from measurements of resistance, length, weight, and specific gravity. The results obtained for samples annealed in a vacuum are given in the following table:—

Number of sample.	Annealing temperature.	Per cent. conductivity.
1	20°	101·5
2	37°	101·5
3	54°	101·5
4	118°	101·6
5	215°	102·0
6	300°	102·1
7	600°	102·4
8	755°	102·7
9	930°	99·0

The results for samples which were annealed in hydrogen are given in the following table:—

Number of sample.	Annealing temperature.	Per cent. conductivity.
10	20°	99·0
11	45°	99·0
12	105°	99·3
13	234°	99·8
14	360°	101·0
15	483°	101·9
16	1,050°	89·3

One end of sample 16 melted after annealing current had been flowing for about a minute. A sufficiently long wire remained for the conductivity test. This sample was very soft, and had lost much of its tensile strength.

These results show that annealing to a softness, which shall give a maximum conductivity, must take place at a high temperature regulated within rather narrow limits. The maximum mechanical softness would be obtained if the sample were melted, and, after being cast in a graphite mould, were allowed to cool off slowly. Very smooth filiform samples can be obtained in this manner. But the conductivity of copper is so dependent on the amount of sub-oxide of copper which is present in it, and this amount is altered to such an extent by melting, that the conductivity determinations on such samples give no indications of the electrical properties of the original samples. As has been recently stated by Swan, the electrical conductivity of electrolytic

* New York *Electrical Engineer*.

copper is reduced by more than 1 per cent. by melting and casting into the form of wire bars. It would, therefore, appear to be better to subject all samples to the hard drawing process. Conductivity tests would then properly indicate the original electrical quality of the copper.

COMPARATIVE COST OF STEAM AND ELECTRIC POWER.

IV.

In continuation of Mr. Taylor's articles, the water and fuel costs are elaborately tabulated, the steam consumption being found by Prof. R. C. Carpenter's method. We need not repeat the voluminous figures for the different cases, but merely summarise the results under the head of total cost for each case of 10, 25, 50, and 100 H.P., with coal at 8s. and 16s. per ton.

Coal at 8s.

—	10 H.P.	25 H.P.	50 H.P.	100 H.P.
Case I.	d	d.	d.	d.
Cost per H.P.-hour. Coal at 8s.	2·16	1·5	1·07	1·4
Coal at 16s.	2·46	1·73	1·27	1·07
Case II.				
Coal at 8s.	4·09	2·67	1·93	1·45
Coal at 16s.	4·59	3·05	2·24	1·70
Case III.				
Coal at 8s.	10	6·36	4·52	3·29
Coal at 16s.	11·02	7·14	5·11	3·78

Considering now the cost of electric power, the point of comparison is made at the point of delivery of brake horse-power.

The same elaboration of detail is gone through, which we cannot follow; sufficient that the results are given as below:—

H.P. of plant.	Description.	Cost of power. Pence per B.H.P. hour.		
		Load factor 1.	Load factor ·46.	Load factor ·18.
10	Electric motors ...	1·95	3·45	5·01
	Engines, coal at 16s.	2·46	4·59	11·02
	" " 8s.	2·16	4·19	10·0
25	Electric motors ...	1·79	2·03	3·99
	Engines, coal at 16s.	1·74	3·05	7·14
	" " 8s.	1·50	2·66	6·36
50	Electric motors ...	1·73	1·93	2·48
	Engines, coal at 16s.	1·27	2·23	5·11
	" " 8s.	1·07	1·93	4·52
100	Electric motors ...	1·70	1·69	2·44
	Engines, coal at 16s.	1·07	1·70	3·78
	" " 8s.	1·40	1·45	3·29

We give the above for what they are worth: the author has spent an enormous amount of labour on his calculations. The difficulty of all such estimates comes in with other items apart from the power plant in use. We think it difficult to work out the matter as Mr. Taylor has attempted. Yet, an experienced engineer, with little electrical knowledge, would walk through a works, note the general appointment of the power plant and of the existing modes of transmission, and make a shrewd guess at the desirableness, or otherwise, of changing the motive power. The actual question will very frequently lie between the inside manufacture of electricity and its transmission through the works and its purchase from outside supply companies.

Too frequently it will be a question as to the particular supply company one may be on. The calculations for the City of London Company, or for the County of London Company, to take two extreme cases, would obviously show an enormous difference.

NEW METHOD OF MEASURING THE INTENSITY OF MAGNETIC FIELDS.*

By E. BOUTY.

I have recourse to the induction, reciprocal of that employed by M. Lippmann in his mercurial galvanometer. A liquid conductor, which may be simply river water, flows at right angles to the field to be measured. The constant electromotive force induced between two opposite faces of the stream is determined by means of a capillary electrometer; whence, knowing the flow, we can deduce the intensity of the field. To take a simple case, suppose the velocity of the flow, v, to be uniform over the whole section of a rectangular stream of depth, e, measured in the direction of the lines of force, and of width, l, measured in a direction perpendicular both to the lines of force, and to the stream. The induced electromotive force is constant, and has a value E,

where $$\mathrm{E} = \mathrm{H}\, v\, l. \quad (1)$$

The flow is $$\mathrm{D} = v\, e\, l. \quad (2)$$

Whence $$\mathrm{H} = \frac{\mathrm{E}\, e}{\mathrm{D}}. \quad (3)$$

We have to apply this very simple formula.

Equation (1) shows that the induced electromotive force is independent of the nature of the liquid conductor. I employed at first solutions of sulphate of copper, both saturated and very dilute, flowing through a rectangular conduit or tube of ebonite. Two electrodes of copper ·01 metre long, and of a width, e, exactly occupy the side surfaces of the tube between the back and front faces of the stream. Having ascertained that the electromotive force measured is perfectly independent of the concentration of the solution, I was able, without making any other change, to substitute water from a tap for the sulphate of copper: the facility of making measurements remaining the same. Polarisation of the electrodes introduces no disturbance.

Using water as the liquid conductor, high velocities of flow can be employed, and the sensitiveness of the method indefinitely increased.† With velocities varying from ·5 metre to 17 metres per second, I have proved that the electromotive force is exactly proportional to the speed, and have detected fields of the order ·5 C.G.S. unit. I see no reason to think that I have reached the limit of possible sensitiveness.

For comparative measurements neither the depth, e, of the tube nor the rate of flow, if it be kept constant, need be measured, and the tube may have any convenient form; but perfect insulation of the electrodes is absolutely necessary. For absolute measurements, a standard tube must be procured in which e is of such a size that the value of v may be treated as sensibly uniform over its sectional area, as we have supposed to be the case in the equations.

The copper electrodes of width, e, the depth of the tube, must be inserted into the walls so far from the inflow‡ that the velocity of the stream may be uniform over the area between them. Moreover, a correcting coefficient is required, differing however but little from unity, for the reduction of speed near the walls of the tube. For tubes from 1 to 6 millimetres deep, I find an expression e + ·13 mm., representing the effective depth, may be substituted for e in equation (3).

Since the electromotive forces measured with different conduits are rigorously proportional to the field and to the stream velocity, one may determine by comparison with a standard tube the effective depth of any other tube, which may be extremely shallow, and afterwards use the latter as a secondary standard.

In cases where the electrometer is inconveniently sensitive, a large condenser, say of 2 or 3 microfarads, may be charged by the induced electromotive force and discharged through a ballistic galvanometer. Fields of 50 C.G.S. units may be readily recognised in this way.

I have already used my method in the study of the curves of saturation, and of residual magnetisation of electro-magnets, and propose to apply it in other ways.

* Translation of a note presented to the French Academy of Sciences, January 17th, 1898.

† It is only limited practically by the maximum stream at one's disposal.

‡ Five cm. at least for a tube of 5 mm. in depth.

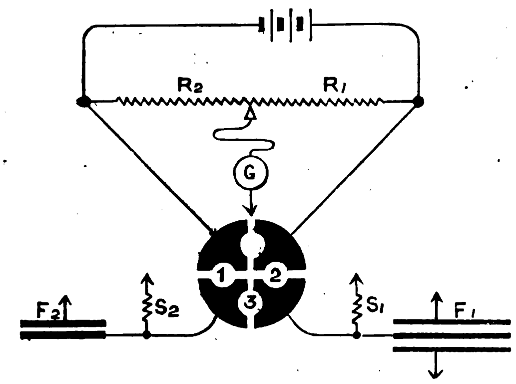
NOTE ON CONDENSER SHUNTS.

By E. RAYMOND-BARKER.

Messrs. H. K. C. Fisher and J. C. H. Darby, of the "Eastern Extension" Cable Company's staff, have lately brought out a book entitled "Students' Guide to Submarine Cable Testing."

There is one matter which might, with advantage, have received some attention from the authors of this admirable and very practical treatise. This matter relates to capacity tests on long cables in connection with the rule first suggested by "F. W.," of Alexandria, in the *Electrician* of February 5th, 1892, namely, that if the dielectric resistances of cable and condenser be in inverse ratio of the respective capacities, a dead-beat Thomson or Gott balance can be obtained without any attendant necessity for correction for difference in absorption.

This means, in other words, that cable and condenser, either one, or both, must, for the rule to apply, be so shunted that the dielectric resistance (D R) *per microfarad* be the same in both the inductive systems.



s_2 and s_1 in above block should be reversed.

A moment's thought shows the correctness of this rule, and one or two illustrative examples in this connection may not be amiss in this "Note."

A pretty exemplification, by the way, of the above rule is the practice, adopted when feasible, of using a real cable of comparatively short length, and therefore easily standardised, as a standard against which to compare a much longer cable, the capacity of which is required to be known as a check on factory values for, let us say, final tests after the laying of a cable. Where this device is practicable, and the cores are of similar material, and of like characteristics in regard to D R and capacity, a Thomson capacity test requires no correction.

This simplification becomes all the more certain in effect if attention be paid to the law enunciated for the first time by Messrs. Fisher and Darby in their afore-mentioned treatise, viz.,

Time of charge = K R *seconds*.

where K = total capacity of cable in *farads*.

R = total conductor resistance in ohms.

Since the D R of a given core varies directly, and its capacity inversely as $\log \frac{D}{d}$, the D R of any given core clearly varies inversely as its capacity, and where, after a correct time of charge, this relationship exists on both sides of a Thomson or Gott capacity balance, the expression $\frac{F_1}{F_2} = \frac{R_2}{R_1}$ holds good without need of correction.

A slight fault in either cable, in the above-mentioned example, or a decided difference in the D R characteristics in the gutta-percha used in the two cables, would necessitate application of the shunting principle. Much more would this be so when a cable of comparatively low D R per microfarad is balanced against a standardised paraffin-paper condenser of very high D R per microfarad.

The following is a practical example:—

F_2 = capacity of standardised condenser = 100 microfarads.

F_1 = known approximate capacity of cable = 750 microfarads.

I_1 = total D R of cable = 7·2 Ω.

I_2 = D R to which standardised condenser with a total D R of 315 Ω (I_3) has to be reduced in order to be proportionate to I_1 inversely as the respective capacities.

$$\frac{I_2}{I_1} = \frac{F_1}{F_2}.$$

So $$I_2 = \frac{F_1}{F_2} I_1 = \frac{750}{100} \times 7{\cdot}2 = 54\ \Omega.$$

What then will be resistance of shunt S_1 which, applied to I_3 of 315 Ω, will reduce D R to 54 Ω?

It is clear that $$I_2 = \frac{I_3\, S_1}{I_3 + S_1},$$

from which $$S_1 = \frac{I_3\, I_2}{I_3 - I_2} = \frac{315 \times 54}{315 - 54} = 65\ \Omega,$$

the application of which resistance between the condenser terminals equalises the respective D R's per microfarad, viz.:

Condenser:—54 × 100 Ω microfarads = 5,400 Ω per microfarad.

Cable:—7·2 × 750 Ω microfarads = 5,400 Ω per microfarad.

The shunt of 65 Ω may be found inconveniently high; the plan may, therefore, be adopted of shunting the cable down to, say, 1 Ω (I_4), the condenser shunt being then re-adjusted to suit new conditions.

I_1 of 7·2 Ω to be reduced to I_4 of 1 Ω must be shunted by

$$S_2 = \frac{I_1\, I_4}{I_1 - I_4} = \frac{7{\cdot}2 \times 1}{7{\cdot}2 - 1} = 1{\cdot}16\ \Omega,$$

which may be distributed in two leaks, each of 1·16 × 2 = 2·32 Ω, one at each end of the cable.

Resistance I_2 to which I_3 of 315 Ω has, under the new conditions, to be reduced

$$= I_2 = \frac{F_1}{F_2} I_4 = \frac{750}{100} \times 1 = 7{\cdot}5\ \Omega,$$

and for this effect to be produced I_3 has to be shunted by

$$S_1 = \frac{315 \times 7{\cdot}5}{315 - 7{\cdot}5} = 7\ 68\ \Omega.$$

The respective D R's per microfarad have now become:—

Condenser:—7·5 × 100 Ω = 750 Ω per microfarad.

Cable:—1 Ω × 750 = 750 Ω per microfarad.

By means of glass tubes of distilled water with non-oxidisable terminal wires, high resistance shunts are easily extemporised and adjusted.

Distilled water in a tube of 50 mils. (approx.) interior diameter was found to give 4·13 Ω per inch of tube against an approximate 0·21 Ω per inch for tap water, both at 60° Fah.

With glass tubing bent under heat into a compressed helix with non-oxidisable contact wires introduced at short intervals, a convenient and compact adjustable high resistance may be devised.

Other liquids of greater or less resistance may be used as circumstances suggest. Under certain conditions, plumbago or lead pencil lines of various thicknesses on a smooth but unpolished ebonite surface prove of service, but liquid resistances show a steadier constancy.

Anent the Thomson capacity test, Messrs. Fisher and Darby remark that it is omitted from their book as the test requires a special key. The above diagram shows how an ordinary quadrant pole-reverser may be used: 1 and 2 being plugged for charge, and 3 for mixing. The best key for this test is the Silvertown mixing key designed by Mr. W. A. Price. It is, electrically, the same as the Lambert mixing key, but enjoys the advantage of good rubbing contacts, and extreme simplicity in construction.

NEW PATENTS.—1898.

Compiled expressly for this journal by W. P. Thompson & Co., *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.*]

7,398. "Improvements in dynamical machines." F. Stolze. Dated March 28th.

7,408. "A new or improved electricity meter." W. Holmes. Dated March 28th.

7,423. "Process for the extraction of pure metals or metallic alloys and carbides by electric heat." H. Aschermann. Dated March 28th. (*Complete.*)

7,450. "An underground electric current delivery for street railways." H. Daniel. Dated March 28th. (*Complete.*)

7,455. "Improved method of making the active mass in accumulators." F. Frentzel. Dated March 28th.

7,467. "Improved means applicable for use in operating electrically illuminated signs, advertising media, or the like." W. T. Bell. Dated March 28th.

7,470. "Improvements in apparatus for effecting electrolysis." W. L. Wise. (Solway & Co., Belgium.) Dated March 28th.

7,471. "Improvements in electrolysis." W. L. Wise. (Solway and Co., Belgium.) Dated March 28th.

7,487. "Improvements in electric batteries." B. M. Minton-Senhouse and G. F. Emery. Dated March 29th.

7,514. "Improvements in plates for battery and other purposes, and method of making same." A. Warburton. Dated March 29th.

7,545. "Apparatus for electrically winding springs or weights for clock movements." G. K. B. Elphinstone. Dated March 29th.

7,566. "Improvements in systems of electrical distribution." W. L. Bliss. Dated March 29th. (*Complete.*)

7,569. "Improvements in electric furnaces." H. H. Lake. ("Volta," Societe Anonyme Suisse de l'Industrie Electro-Chimique, Switzerland.) Dated March 29th.

7,570. "Improvements in, and relating to, means for connecting electric cables." F. Clouth. Dated March 29th.

7,575. "Improvements in furnaces for manufacturing calcium carbide, &c." W. P. Thompson. (C. L. Wilson, C. Muma, J. W. Unger, H. Schneckloth, A. P. Brosius, and J. C. Kuchel, United States.) Dated March 29th. (*Complete.*)

7,577. "Improvements in electrical batteries." N. B. Stubblefield. Dated March 29th.

7,583. "Improvements in and connected with electrical switches." H. C. E. Jacoby and White, Jacoby & Co., Limited. Dated March 29th.

7,586. "Improvements in magnetic separators." A. M. Clark. (The Metallurgische Gesellschaft A. G., Germany.) Dated March 29th.

7,700. "Improvements in and relating to shields for incandescent electric lamps and the like." J. Dewar. Dated March 31st.

7,725. "Improvements in holders for incandescent electric lamps." J. M. Huisman and H. C. Gover. Dated March 31st.

7,731. "An automatic electric fog and general signal apparatus." C. Cropp. Dated March 31st.

7,754. "Improvements in and connected with electric motors for motor vehicles, launches, and for other driving purposes and in gearing to be used therewith." J. T. Robson, C. H. Marsden, and H. W. Headland. Dated March 31st.

7,764. "An improved apparatus for the electro-deposition of metals." J. H. Hope. Dated March 31st.

7,825. "Improvements in interchangeable electric signs and the like." C. Raleigh. Dated April 1st.

7,855. "Improvements in transmitting electric impulses and signals and apparatus therefor." E. Wilson, H. Godsal, and C. J. Evans. Dated April 1st.

7,862. "New or improved combined globes and shades for incandescent electric lamps and for electric arc lamps and for facilitating the application of advertisements thereto." E. Bohm. Dated April 1st.

7,873. "Improvements in telephones, electric bell pushes, and the like." A. Anders and Veritys, Limited. Dated April 2nd.

7,895. "An improved construction of fusible cut-out for electric circuits." T. Barton. Dated April 2nd.

7,903. "Improvements in electric interrupters." J. M. D. Soule. Dated April 2nd. (*Complete.*)

7,907. "An improved electrical cut-out." L. Greig. Dated April 2nd.

7,929. "High insulation electric light switch." T. L. Jones. Dated April 2nd.

7,940. "An improvement in coin-freed electric meters." T. H. Minshall. Dated April 2nd.

7,941. "An improvement in holders for electrical glow lamps." P. F. W. Simon. Dated April 2nd.

7,958. "An improved system of electric propulsion for ships, yachts, submarine torpedoes and other purposes." J. H. Barry. Dated April 2nd.

7,961. "Improvements in electric switches." A. Wilson. Dated April 2nd.

ELECTRICAL PATENTS OF 1884, EXPIRING IN APRIL, 1898.

We are informed by Messrs. W. P. Thompson & Co., that about 90 applications for electrical patents were filed in the month of April, 1884. Out of these only four have been maintained to run their full length of term, viz., 14 years, and being of considerable interest we give short abstracts of them below :—

6,288. "Improvements in the adjustments of the mariners' compass." S. M. Moore. Dated April 12th, 1884. Relates to magnetic compasses. The correctors for controlling the errors of the compass are attached to the bowl itself, instead of to any fixed part of the case, thus securing an invariable position and action of the correctors to the compass needle. The magnets for the cardinal errors are placed in a chamber fixed below and forming part of the bowl. They consist of brass rods with a core of magnetised iron of various thickness and are made of uniform size to allow of their being readily interchanged. They are clamped in brackets working in slides of the sides of the chamber, and can be adjusted to any position and fixed by set screws. The quadrantal correctors consist of two balls of soft iron placed in a line with the magnets of the card and adjustable to and fro by screws. They may be fitted either inside or outside the bowl with fluid compasses; they are enclosed in brass cylinders if in bowl. The final adjustment to make the card horizontal is effected by the eccentric weight. 3 claims.

6,414. "Improvements in apparatus for the extraction of metals from their haloid compounds by means of electrolysis." L. A. Groth. (R. Gratzel, Germany.) Dated April 16th, 1884. The haloid salt of a metal such as magnesium or aluminium is melted in a vessel. The positive and the negative electrodes, the latter, and sometimes the former, are surrounded by a cylinder of non-conducting material. The negative electrode may or may not project through the open bottom. The vessel is closed and a pipe is provided for the escape of the haloid gas. "Regenerative" pieces, consisting of an oxide of the metal and carbon may be placed around the positive electrode. Several pairs of electrodes may be placed in the one melting pot.

6,734. "Improvements in electric generators and in working them by fluid pressure." Hon. C. A. Parsons. Dated April 23rd, 1884. Relates to dynamo-electric machines which are specially constructed to be driven by the high-speed turbines described in specification No. 6,735, A.D. 1884. The turbine and dynamo have a common axis, and are mounted on the same bed-plate having a bearing between them. The bearings are specially constructed to permit a slight lateral play, as described in the above-mentioned specification. Lubrication and cooling are effected by the circulation of oil supplied by a pump, which is forced through the hollow shaft. The armature is of the drum type, and the core consists of a number of insulated iron discs arranged on the hollow shaft. At the ends are insulating washers, followed by brass washers forced up by a nut. The iron discs are pierced with channels for the reception of the conductors, or the conductors may be bound with pianoforte wire. The commutator consists of several rings of gun-metal segments held by locking steel rings.

6,770. "Improved means for measuring electric currents." H. Aron. Dated April 24th, 1884. Relates to apparatus for use as a coulomb meter or wattmeter, in which the current is caused to regulate the rate of a clock by acting upon the pendulum or balance-wheel, a magnet or coil attached thereto being acted upon by a stationary coil or coils, or magnet, in such a way as to vary the rate of the clock, and the effect being sometimes increased by iron cores or pieces. In the case of a clock with a balance-wheel, the spring itself may be magnetised. The measurements are made by comparing a clock, influenced by the current, with a normal clock, or by using two clocks, one or both of which may be acted upon by the current, which impart their motion to a differential counter. Various modifications are described.

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THE LIVERPOOL OVERHEAD RAILWAY AND DOCKS.

A TIMELY article in *Cassier's*, by Mr. S. B. Cottrell, of the Liverpool Overhead Railway, will be welcome to those who hold that there is no necessity to go to America for electrical railway plant. Everyone seems to have forgotten the excellent working of this line.

The bulk of Mr. Cottrell's article is descriptive and general; but we may, at the risk of repetition, give again the salient figures of the motive power. The trains originally consisted usually of two 45 feet double bogie cars; the bogies, at 32 feet centres, have each four 33-inch wheels. Each car carries 58 passengers, first and second class. There are now three cars to a train. The motor armatures are series wound and ungeared, being direct on the axles of the cars, no special locomotive being used. Each motor gives 1,790 lbs. traction with 120 amperes, or 107 lbs. per ton of train.

A fully loaded train of three coaches weighs 57 tons, of which 9 tons 10½ cwt. is due to the motor equipment. There were originally six 30 feet × 8 feet Lancashire boilers and four horizontal compound 400 I.H.P. engines, each driving a dynamo of 500 amperes × 400 volts. The combined efficiency is 85 per cent. at full load. The additions since starting have been two more condensing engines of surface condensing type, and also of 400 I.H.P. each, at 100 revolutions, with 120 lbs. boiler pressure. The fly-wheels are 14 feet diameter, grooved for 19 1¼-inch ropes.

As usual with rope-driven dynamos, we observe that the dynamo pulley is placed lower than the top of the fly-wheel, so that the ropes, as they travel to the dynamo, are always tending to throw off the face of the pulley. This is wrong practice. Sudden changes of load are apt to cause the ropes to leap in a huge hump and slip badly on the dynamo pulley. A dynamo pulley top ought to be higher than the top of the driving pulley, so that the rope, running towards the dynamo, tends to run under the driven pulley, to encircle as much of the pulley rim as possible, and so prevent the humping which occurs on change of load. Rope driving is condemned by many electrical engineers. We cannot call to mind any place, unless it be at the large Deptford station, where proper considerations of the dynamics of rope driving have been allowed to influence design. Dynamos are almost always placed so that the ropes run down hill to the driven pulley. This is never done in factory driving, and rope driving is successful there, but the lowest set of ropes is often but little removed from the wrong placing, and the slack sides of this set of ropes is often noticeable as running so much less steadily than the up-running ropes.

The later dynamos at Liverpool are 500 amperes × 500 volts each, and they weigh each 24½ tons. About 80 acres of surface have to be painted every two years. By pneumatic process the cost of this painting, including all materials, has been reduced from 2·25d. to 1·24d. per square yard. The motors run 40,000 miles before repairs are required. They earn £200 in that time, and can be rewound for £25.

The importance of Liverpool is to be judged by the fact that it is equal to London in the value of its trade, and much exceeds London in bulk of trade, dealing in articles of less mass value. Liverpool is the biggest grain centre in Europe. It is also remarkable in that its docks extend in a continuous line along a river front for several miles, and it is the passenger traffic of this line of docks and accessories which is served by the electric line. The old 'bus route only carried 2½ million passengers annually; the electric line carries now nearly 9 millions. Yet it is certain Liverpool has not increased in either trade or population by a tithe of the increase of passengers.

In face of this remarkable fact, we have the management of the London Underground shivering on the brink of electrical enterprise, seeing their trade liable to slip away any day in dirt, gloom, and sulphur, yet afraid to make the plunge necessary to success. The success of the Liverpool line ought to be sufficient to show how traffic may wait for facilities and expands as soon as facilities are afforded. Of course, there is no comparison between the convenience of the electrical line and of the old 'bus line which used the rails of the dock railway, but the old 'bus line was practically the only means of travel along the line of docks, and might have been argued to take all possible traffic. Given the facilities for more convenient travel, and the travel has at once sprung up. It is simply by acting on this principle that America owns its thousands of miles of electrical railway, while there are so few in England, even with so good an example as Liverpool for encouragement.

Weatherproof Wire.

In his interesting letter published in our last issue, Mr. Dow has unfortunately misunderstood the first of our questions, "How is it possible to maintain such circuits in wet weather?" Our query did not refer to the maintenance of a high insulation resistance, which we consider, in agreement with Mr. Dow, is quite unnecessary for the working of the line so long as the leakage is uniformly distributed and is not due to one or two weak places; but did refer to its maintenance in good repair. The question was asked, because in one part of the paper on which we were commenting, Mr. Dow stated that the first rainy days of autumn might always be expected to produce a fair crop of burn-outs and earths, and in another part he stated that work bringing the linesmen into proximity with the wires should never be attempted during bad weather; and it appeared to us difficult to understand how the line was to be maintained in good working condition, and a good service given, if repairs were not to be attempted without stopping down all the circuits.

Testing an Enormous Electric Beacon.

Some interesting tests are now being made at the general depôt of the United States lighthouse establishment at Tompkinsville, Staten Island, upon a gigantic electric beacon known as the Lepaute bivalve or lightning lens light. We are indebted to the *Electrical World* (N.Y.) for some interesting details respecting this installation. The lantern consists of two lenses, each 9 feet in diameter, enclosing between them an electric arc of great power. In the central portion of each lens is a disc having two prismatic rings. Outside of this are 190 prismatic segments so arranged that the light of the arc is totally reflected in each and thrown out in a beam practically non-divergent. In this way nearly the total light of the arc is concentrated in two great beams, 9 feet in diameter, directed toward opposite points on the horizon. The whole apparatus is floated on mercury, and is driven by a powerful clockwork actuated by a spring. The period of revolution is once in 10 seconds, so that every point on the horizon receives a flash from the lens in each 5 seconds, these flashes being of about $\frac{1}{10}$th of a second duration. The lamp, lenses, and supporting framework weigh about 20 tons, and the friction is so reduced by the use of the mercury float that the whole apparatus can be easily turned by the pressure of one finger. The arc lamps, of which the lens contains two, one at its focus and the other arranged to be brought into play immediately upon the failure of the first, are of a curiously complicated structure, and yet very simple in principle. The arc is struck by hand. The two carbon holders are connected together by means of a chain actuated by clockwork, the last wheel being a detent, in which is engaged a small pawl, operated by an electro-magnet in shunt around the arc. When the arc lengthens out and its resistance increases, this coil pulls away the detent and permits the clockwork to feed the carbons together. The lamps are of the most elaborate construction and finish, but it cannot be said that the complexity commends itself to the engineering sense. Both lamp and lens were made by Henri Lepaute, Paris, and the whole outfit was exhibited at the World's Fair, and subsequently at Atlanta and Nashville. It was purchased by the United States Government, but its location has not yet been determined upon, though it will likely be installed at some point along the Atlantic coast, if the tests now in progress are satisfactory. There is every indication that they will fulfill every condition imposed upon the apparatus. The lamps are arranged to carry carbons of from 15 to 60 millimetres (⅝th to 2½ inches) in diameter, and the current consumption varies, of course, with the size of the carbon. The original apparatus was provided with an alternating current generator of French make, but it has been decided to use with the lens an alternating generator made by the General Electric Company, driven by a 25 H.P. Ideal engine, which takes its steam from a 25 H.P. Fitzgibbons boiler. The present tests are being conducted with current taken from the local lighting service, the frequency being 140 cycles per second, and the consumption with 30-millimetre carbons being about 60 amperes at 55 volts. It is estimated that the horizontal candle-power of this arc without the lenses is not less than 9,000. Mr. C. A. Lamy, superintendent of the lighthouse depôt at Tompkinsville, estimates that the total candle-power of the two beams of light is not less than 90,000,000. He arrives at this figure by adding together the candle-powers of the various beams emerging from the prismatic part of the apparatus and the lenses. The beam is of enormous power, and will be easily visible at a distance of 100 miles, if mounted in a sufficiently high tower. The light can be located even when mounted in towers of ordinary height at a greater distance than this, on account of the reflection from the clouds of the strong beams. When the lantern is installed in service the electric generating plant will be in duplicate throughout, to avoid any possibility of an accident. It is curious to note that the constructors of this apparatus seem to prefer clockwork for its rotation. With the alternating current supplied for the arc, there seems to be no reason whatever why the rotation of the lens should not be accomplished by means of an alternating motor, a far simpler and more reliable device than the elaborate and complicated clockwork now connected with it. The lens was set up, and the tests are now being conducted, under the supervision of Lieut.-Col. D. P. Heap, Corps of Engineers, U.S.A., Engineer of the Third Lighthouse District, who is ably assisted by Mr. Lamy, Assistant Superintendent.

THE UTILISATION OF BLAST FURNACE GASES FOR ELECTRICAL POWER TRANSMISSION.

By W. H. BOOTH.

A REFERENCE appeared in these columns some little time ago to the tests made by the writer upon the electric light plant laid down at the Wishaw Iron Works of the Glasgow Steel and Iron Company for the purpose of proving the value of the Thwaite-Gardner system of utilising the waste gases from blast furnaces for producing power. At Wishaw the power generated is distributed over the works for the purpose of lighting up the furnaces, the residuals plant and the offices, arc and incandescent lamps being used. The gases which leave a blast furnace do so at a comparatively low temperature, usually not far from 500° F., more or less, or not so hot as the waste gases from many boiler furnaces. Possibly it is because of this, and because the waste gases are partially employed to heat the hot blast, that it is so often claimed that the blast furnace is an economical "machine." True as regards the total heat generated, which may be considered as represented by the maximum temperature at the zone of fusion, the proportion of heat utilised may seem great, but in stating this the true facts are ignored. There are only three products from a blast furnace. One of these, at present considered the primary product, is iron. This is run from the furnace at a temperature of, say, 2,800° F. As the specific heat of iron is only about 0·113, or, say, one-ninth that of water, the heat carried away by a ton of iron is only equivalent to that carried off by a ton of water at about 311° F. Assuming 25 cwt. of fuel at a calorific value of 15,000 B.T.U. per pound, the heat waste per ton of pig is only represented by about 46 lbs. of fuel, or 1½ per cent. of the total fuel.

A further amount of nearly 3 per cent. of the fuel disappears in the 80 lbs. of carbon which enters into combination with the iron. Probably another 3 per cent. disappears in the slag, which is also run out at a high temperature, and, if worth the expense of apparatus, could be made to give back this heat in heating the blast. Altogether about 7½ per cent. of the fuel energy appears at the tapping holes, and certain other heat disappears in chemical changes, in setting free CO_2 from its combination with the ore or flux. Then probably there are 15,000 lb. of gases per ton of iron with a specific heat of 0·25 at 500°. This represents the heat of 125 lbs. of fuel, or about 4½ per cent. of the fuel. This heat is more or less recoverable in heating the blast. It is thus perfectly clear that the waste gases must contain

TABLE I.

	Blast furnace gas. Wishaw.	Blast furnace gas. Frodingham.	A gas producer.
Carbonic acid	5·75	6·0	6·6
Carbonic oxide	24·75	27·3	19·6
Hydrogen	2·33	1·5	6·4
Marsh gas	0·75	...	1·3
Nitrogen	66·42	65·2	66·1
	100·0	100·0	100·0
Heat units per cubic foot ...	97·8	96·7	98·0
Calculated cubic feet per I.H.P.	79·44	80·34	79·27
Percentage combustible ...	27·83	28·8	27·3

not much less than 88 per cent. of the total heat capacity of the fuel. As this is not visible as temperature, it must be visible in some other form, and it is so visible as the calorific capacity of carbon monoxide, of which gas the effluent gases of a blast furnace contain about 28 per cent.

In two samples of gas, No. 1 from Wishaw where, as usual in Scotch furnaces, coal is the fuel employed, and No. 2 from Frodingham, where coke will be used and where a Thwaite plant is also at work, these percentages are seen to hold good.

Blast furnace gas is thus fully equal to gas from a producer. A producer is recognised as yielding a gas capable of working in a gas engine. Yet the blast furnace gas of equal quality has required considerable demonstration to convince people of what an analysis ought to have been sufficient to indicate to them.

Approximately about three-tenths to one-third of the waste gases are combustible, the remainder being diluents, and calculated on this basis from the analysis of the gas, a full half of the original calorific value of the fuel remains, apart from the sensible heat, the difference between the 50 or 60 per cent. remaining, and the above 88 per cent. being accounted for in the latent heat absorption of the wet materials and the gasefying of locked up CO_2 of the ore and flux as well as in loss by radiation and connection through the furnace walls, and by a margin of safety.

If we base our calculations on the low assumption of one-half the fuel being available for power, and we know that a liberal allowance for a horse-power-hour in a gas engine is 1 lb. of fuel, we may calculate the horse-power of a blast furnace as being 1,120 H.P. per ton of fuel used per hour, or 1 H.P.-hour per 2 lbs. of fuel, of which 1 lb. is given over to the purposes of the furnace and 1 lb. remains for power purposes. These figures which are calculated on liberal assumptions are more than borne out in practice. At the time of the writer's tests, the furnaces were delivering a poor quality of gas, yet on the assumption of only 180,000 cubic feet per ton of fuel fed to the furnaces, the measurement of the current generated by the dynamo, and of the gas drawn from the holder meter in runs of five minutes, only showed a fuel consumption of 1·656 lbs. per electrical horse-power, which is to say, that for each 1·656 lbs. of fuel used one horse-power of electrical energy could be delivered at the dynamo terminals. If, as seemed probable, the furnaces were producing 200,000 cubic feet of gas per ton of fuel, the fuel per electrical horse-power would only be 1·49 lb. or with an efficiency of 75 per cent. between terminals and cylinder, about 1·12 lb. per I.H.P. The works manager obtained better results than these, but not more than would be accounted for by known variations in the quality of the gas, which may vary its proportion of constituent combustible between 28 and 38 per cent. As there is considerable divergence among different authorities as to the number of cubic feet of gases produced for each ton of fuel consumed, I have prepared Table II. for the purpose of showing in the particular analysis given of the gas at Wishaw how much is really produced, observing that this particular analysis is of a more than ordinary poor gas, the volume of diluent nitrogen being very great—over 66 per cent. of the volume.

From this table it appears that 100 cubic feet of gas weighs close upon 8 lbs., so that the average specific gravity in pounds per cubic foot is 0·079 as might be expected from the large percentage of nitrogen and of carbonic oxide, both which have the same specific weight of 0·0784. The heavier carbon dioxide brings up the average slightly.

From the table it appears that of the total weight of gas, 1·0503 consist of carbon, the bulk of which is derived from the fuel: it is evident that 1 lb. of carbon represents, therefore, 7·525 lbs. of gases. An ordinary blast furnace practice allows 12 cwt. of limestone flux to each 20 cwt. of coke. Basing some further figures on this ratio, 6 : 10, we may, for a coke furnace, make the following equation:—

$$\text{Carbon in 10 cwt. of coke} = 10 \qquad = 10$$

$$\text{,,} \quad 6 \quad \text{,,} \quad \text{flux} = 6 \times \frac{C}{Ca\,CO_3} = 0{\cdot}72$$

$$\text{Total} \quad \ldots \overline{10{\cdot}72}$$

The fuel carbon thus represents $\frac{10}{10{\cdot}72} = 98$ per cent. of the whole, and we may, therefore, say that each pound of carbon in the fuel will represent 98 cubic feet of gas, so that one ton of fuel will yield 217,000 feet of gas.

These figures are not absolute for the particular analysis, because it cannot be accurately known how much of the hydrogen of the bituminous coal used in this furnace, as usual in Scotch practice, is converted into steam and cannot appear in an analysis of permanent gases, but they are sufficient to indicate that the figure of 180,000 feet per ton of fuel will not be far wrong for a coal burning furnace when using a less amount of air. From 80 to 100 feet of gas may be therefore assumed correct per pound of fuel used, and as it is very easy to test the volume of gas consumed by an engine, the power output per pound of fuel is readily found.

The calculations of Table I. are of course based on the customary temperature of 0° Centigrade. Any test figures as to consumption of gas by an engine will show 10 to 12 per cent. more consumption than if measured at the base temperature, the gas in the holder during my own tests being about 550° F. absolute temperature. It need not really concern us how much heat disappears in volatilising the carbonic acid and oxygen locked up as solids in the flux and in the ore. The only items required are the total carbon which enters the furnace and the weight of carbon in the gases. Knowing these two quantities it is easy to calculate the amount of combustible gas produced by a ton of fuel so long as we have the proportions of CO and CO_2 into which the carbon is more or less oxidised. The complicated conversions and reconversions, and general chemical reactions between the tuyeres and the furnace top need not concern us at all. It is of course a point with metallurgists to obtain as much CO_2 as possible

TABLE II.

Gas.	Per cent. Volumes.	Weight per cubic foot.	Weight per 100 cubic feet of mixed gas.	Ratio of constituents.	Actual weights of elements per 100 cubic feet of gas.			
					C.	O.	H.	N.
Carbonic oxide = CO	24·75	0·0784	1·9404	3 : 4	0·8316	1·1088	...	...
Hydrogen = H	2·33	0·0056	0·0130	...	...	...	0·0130	...
Marsh gas = CH_4	0·75	0·0448	0·0336	3 : 1	0·0252	...	0·0084	...
Nitrogen = N	66 42	0 0784	5·2073	...	...	...	...	5 2073
Carbonic acid = CO_2	5 75	0·1234	0 7095	3 : 8	0·1935	0 5160	...	...
Cubic feet =	100 00	0·079038	7 9038	Total	1 0303	1 6248	0 0214	5·2073

7 9038

as an indication of fuel economy, but Lowthian Bell has shown there is a limit below which the ratio of CO must not fall, and, with power an important product, the straining after a high percentage of CO_2 would be unnecessary and undesirable. The power system thus frees the blast furnace management of considerable anxiety, rendering fuel waste impossible—indeed, desirable as furnishing a better gas, for with all the gas used as power, there would be no object in making any more carbon dioxide than could possibly be helped. The estimate of 1 horse-power from each 2 lbs. of fuel is thus well within the mark.

(To be continued.)

"FREE" AND "EASY" PAYMENT SYSTEMS OF HOUSE WIRING.

By V. ZINGLER, A.I.E.E.

THE above title must not be taken literally, or as the heading of a scheme whereby it is sought to show that the debtor of a wiring company is under no further moral obligation to pay his bill to them than he is to his tailor; it is merely a summary of the names of two systems, whereby the distribution of the electric light is to be made more universal, to the mutual advantage of the public and the wiring firms or electric light companies, the corporations being after all the public also.

With the free wiring system—improperly so called—we are all more or less familiar, although there are points in connection with its application which have no doubt not been fully considered. But with the easy payment system the public has not been made familiar, for the simple reason that no financial or wiring firm would be able to get their shareholders to put their money into a concern which would have to spend any amount of money with only the chance of getting a small interest in return, and on no further security than that of the consumer's word, with the alternative of a lot of installations thrown back on their hands, only partly paid for, and situated in property belonging to other parties.

If, however, some solid security for the payment of this class of work could be obtained, the matter would have a different aspect; and in a recent report to the Electricity Committee of the Plymouth Corporation, Mr. John H. Rider, the borough electrical engineer, sets forth a scheme of some boldness, with which it is our intention to deal in comparison with the alternative scheme of the National Electric Free Wiring Company.

After reciting some of the aims and methods of the scheme now in use by the latter company, Mr. Rider proceeds to point out that the system of paying an extra sum per unit—this excess being interest on the capital sunk in the house-wiring, &c.—is very unfair to the consumer, because the percentage will rise as the price per unit is reduced. That is to say, at 8d. per unit an extra charge of 1d. is 12½ per cent., whereas at 4d. it would be 25 per cent. He also points out that under this system the more electricity is used the more the customer has to pay for fittings, and he classes this as unfair also. But is not this itself an unfair way of looking at the matter? It may be assumed that the average consumer will use about as much electricity whether he pays 4d. or 8d. per unit for it—that is to say, the class of consumer for whom the schemes cater. He has a fixed number of lamps in his villa, or shop, and he uses just those lights which he wants. Therefore, he is not likely to use much more electricity at the lower rate than he uses at the higher rate; and as there is nothing to prevent a supply company from putting down its rate per unit, any proportional reduction of the excess for wiring would mean a diminution of income to the wiring company unless it could be proved that the consumption of electricity increases in inverse proportion to the rate per unit.

As regards the amount of electricity that a consumer uses, is it certainly not fairer that he should pay in a certain proportion to the actual use he gets out of the wiring and fittings rather than for the length of time these goods are in his house? If a man hires a piano, he has to pay an exorbitant interest on the value of the same, irrespective of the fact that he may hardly use it at all; whereas, if he had to pay a certain rate for the number of horse-power-hours which he put into the piano, or in default of not using it at all, a certain minimum sum representing the value of depreciation plus a moderate interest, it would be much fairer to all concerned. This is the method which the Free Wiring Company have adopted. The Board of Trade units used are proportional to the amount of benefit that the consumer gets out of his wiring and fittings, and there is no reason why he should not pay for it at an equal rate, no matter what the cost per unit of electricity, as the two things are perfectly distinct. It may, on the other hand, be urged that just as it is found profitable to give the customer a rebate on the cost of electricity after a certain consumption per diem, so it would most likely also be advantageous to all parties concerned to give him a similar rebate on the excess sum per unit for wiring and fittings, the point at which this rebate should come into operation being determined by the sum representing fair interest of capital sunk required from him.

Proceeding, Mr. Rider says that the average consumption is about 18 units per 8 C.P. lamp per annum, and he therefore complains that an excess charge of 1d. per unit for fittings, &c., is equivalent to 7½ per cent. per annum, assuming that the cost of fitting up a house comes to £1 per lamp. Now it is a fair question to ask Mr. Rider whether he approves of wiring and fittings being put up for this price, even for a large installation. As a borough engineer, he will know that good work cannot be done for this price; how much less then will it be possible to instal, say, 10 to 20 lights, the size of installation catered for by this system, for £1 per light, including main switch, fuseboard, and making good. Even assuming 7½ per cent. as being the interest paid, is it excessive, when considering that the installation is guaranteed for six months, that the consumer has no liability as to the time he shall use the installation for, and that the company has to take the risk in this 7½ per cent. of fire, default, and depreciation of a neighbourhood, in which cases they are put to the expense of loss of interest or capital, or of taking down the fittings.

The report then goes on to suggest a scheme for spreading the payment over a long time so as to avoid the heavy initial cost; such a scheme could not be operated by private wiring firms, as we all know that in these days of keen competition they are more anxious to receive long credit than to give it. Mr. Rider also points out that this might be done by the Corporation, but that experience has proved that it is unwise for Corporations to undertake wiring work. This is certainly the result of the experiment at Liverpool, where the monopoly held by the Corporation for wiring became so intolerable that there was not—up to a year or two ago—a single good wiring firm in the town. The Corporation looked with jealous eyes on any wiring work obtained by outside firms, and the latter had no cause to complain that the Electricity Department did not enforce their regulations. However, this is a digression.

Mr. Rider's scheme now begins to develop itself in detail. He argues: Wiring firms can wire but not give credit; Corporations must not wire but can give credit; *ergo*, let the wiring contractor do the work, and the Corporation give the credit!

Let us give the scheme in his own words:—

"The wiring contractor would canvass for orders in the usual way, and could carry out work for any customer on his own terms without reference to the Corporation. But when a person wished to avail himself of the easy payment system, he would have to proceed in the following manner.

The quotation to such customer would be made out upon a special form, binding the contractor to carry out the work to the satisfaction and under the supervision of the Corporation, and naming such a price for the work as would permit him to allow a discount of 5 per cent. for cash.

If the customer agreed to this price, he and the contractor would notify the acceptance in writing upon a form of application to the Corporation. This form would set forth the terms of the proposed agreement, which would be somewhat on the following lines, viz.:—

(*a*) That the contractor will carry out the work in accordance with the conditions, regulations, and other requirements of the Corporation, and to the entire satisfaction of the borough electrical engineer.

(*b*) That the contractor will allow to the Corporation a discount of 5 per cent. from the quoted price, for payment within one month of the date of the work being completed and connected to the mains.

(*c*) That the customer will pay to the Corporation the quoted price in full by means of eight equal instalments, the first being sent with the application in the form of a deposit, and will pay a similar amount every three months from and after the completion of the work, until the whole be paid.

(*d*) That the work will remain the sole property of the Corporation, until the full amount be paid.

(*e*) That the customer will be responsible for any damage to the work (reasonable wear and tear excepted) while it remains the property of the Corporation.

(*f*) That all lamp and fuse renewals will be carried out by and at the cost of the customer.

(*g*) That in the event of a customer's payments being more than three months overdue, the supply of current will be liable to be cut off without notice, and proceedings taken for the recovery of the whole amount due.

(*h*) That (if required by the Corporation) the customer to provide two securities for his due fulfilment of the contract.

If the customer, contractor, and price appeared satisfactory to the Corporation, instructions would be given by the Corporation to the contractor to proceed with the work, and upon the proper completion of the same the Corporation would pay him the quoted sum, less 5 per cent."

(To be continued.)

A PORTABLE ELECTRIC RAILWAY.

THE great success of electric street railways has given rise to many attempts to apply electric traction to portable or field railways. In the earlier attempts the style of construction that had been worked out for street railways was applied with little change to the field railways, no regard being paid to the special requirements in the latter case.

A system, which is designed to meet these special requirements, has recently been worked out at the Field Railway Works of Arthur Koppel. From a description of this system in the *Zeitschrift für Elektrotechnik*, February 13th, 1898, we give the following summary:—

As in other railways, the track consists of easily transportable rail frames, made up of two rails of the usual field railway profile 65 to 70 mm. in height, connected together by, say, five crossbars (fig. 1). The overhead conductor is

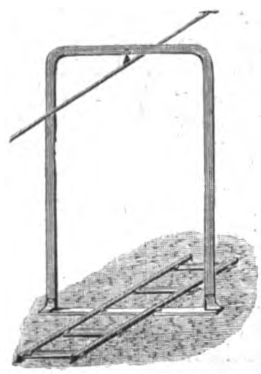


FIG. 1.

supported by a ∩-shaped yoke which is bolted to extensions of the middle crossbar of a rail frame. These yokes are placed about 25 m. apart along the track. The overhead conductor is supported at the middle of the upper horizontal part of the yoke. The weight of such a yoke is about 50 kg. more than that of the ordinary rail frame.

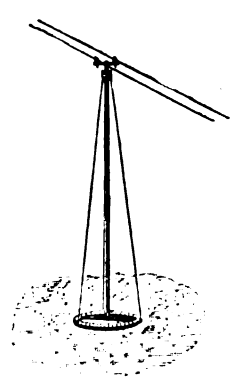


FIG. 2.

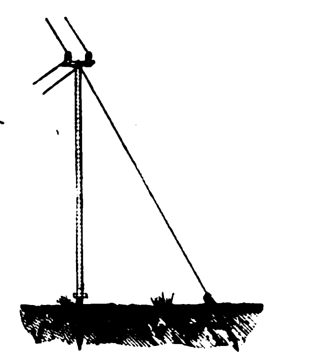


FIG. 3.

These yokes are placed closer together at curves, and at the sharpest curves it may be necessary to fit every rail frame with a yoke in order to keep the overhead conductor sufficiently near the centre of the track.

The generating station is fitted in the usual way with a dynamo which may be driven by a steam engine, gas engine, or turbine, according to circumstances. Two feeders are led from the station to one end of the track, one being connected to the end of the overhead conductor and the other to the rails. The feeders are fitted with safety fuses. The feeders are supported on poles, which may be fixed or transportable, according to the nature of the line. In the former case they are driven into the ground; and, in the latter case, portable stands, fig. 2, with disc pedestals are used when the line is straight, and pointed poles with tension wires, fig. 3, at corners. Where one of the feeders is connected to the trolley wire, it is fastened to one of these anchored poles.

A special truck, fig. 4, has been devised for running the

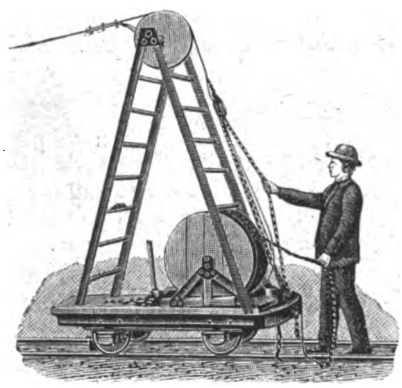


Fig. 4.

trolley wire. On this truck is fitted a reel containing the copper wire, and a pair of ladders supporting a guide pulley at the top. A sufficient length of copper wire is pulled off the reel, passed over the guide pulley and the free end is fastened to the end of the feeder connected to the anchored pole at the end of the track. The fitters' truck is anchored to the rails and the wire is stretched by a block and tackle and fastened to the insulator on the yoke. The truck is now moved along the track till another yoke is passed, when the same operation is repeated. The ladders, reel, and undercarriage of the fitters' truck is made of dry wood saturated with some insulating substance, so that current could not pass from the trolley wire through the truck to the rails.

This precaution is necessary because the end of the trolley wire is left attached to the truck when the position of the track is liable soon to be changed. When the track is to be permanent for a considerable time the end of the trolley wire is fixed to an anchored pole.

The solidly constructed motor car, fig. 5, has, as a rule, a

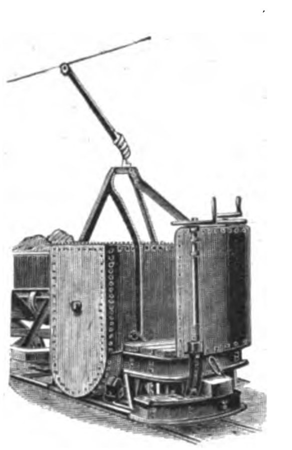


Fig. 5.

motor mounted on the frame of the undercarriage, and geared to the driving wheel axes by toothed gearing and two pitch chains. The frame of the undercarriage is furnished with spring bearings, spring buffers, and coupling arrangements. On the driver's platform is a brake and a switch handle. By means of the latter more or less resistance can be put into circuit, and the speed thereby varied within wide limits.

If the gauge of the rails is 500 mm. or more, the motors can be fixed inside the under-frame of the cars and be connected directly to the axes of the driving wheels by a spring coupling. This construction has the advantage of getting rid of the dead weight of a special motor locomotive, which is of great importance when steep gradients have to be ascended. The electric motor has the advantage over most other kinds of traction in the great range of its output.

These portable railways may be used with great advantage in connection with factories having spare steam power; or having an electric lighting installation. They may be employed for the transmission of goods during the day, and thereby furnish a useful day load to a lighting installation which otherwise would have occasionally to stand idle.

ALUMINIUM WIRES FOR OVERHEAD LINES.

By STUART A. RUSSELL.

The paper on "Aluminium as a Rival of Copper and Brass for Electrical Conductors," reprinted in the Electrical Review (March 11th and April 1st), details very ably all the points in which aluminium may show itself a formidable competitor of copper as an electrical conductor; and the author, Mr. A. E. Hunt, whilst allowing that for insulated conductors aluminium is heavily handicapped by the extra cost of insulation, claims that there is an ample field for the employment of aluminium wire for bare transmission lines, especially for high potential long distance work and for long distance telephone lines. Mr. Hunt quotes figures showing that as the weight of copper is three and a third times that of an equal volume of aluminium, and as the conductivity of the latter is 63 per cent. of that of pure copper (Matthiessen's standard), and further as aluminium wire is now offered for sale at a specially low rate, the prices of an aluminium and a copper wire of the same length and conductor resistance are equal. A comparison is then made between a soft copper wire having a tensile strength of 32,000 lbs. per square inch, and an aluminium wire having the same tensile strength per square inch and a conductivity of 63 per cent. of that of the copper wire, in which it is shown that for equal conductor resistance the sectional area, and therefore also the breaking strain of the aluminium wire will be 60 per cent. greater than that of the copper wire, whilst the weight of the former will only be 48 per cent. of that of the latter.

Mr. Hunt therefore concludes that the aluminium conductor could be used in much longer spans than the copper, and that the number of expensive poles and insulators could be materially diminished. It appears, however, that the effect of wind pressure on the larger aluminium wire has been altogether left out of account in coming to this conclusion, and the writer therefore proposes to give one or two examples to show how this statement must be modified when the effect of wind pressure is taken into account.

Let us assume a wind pressure of 20 lbs. per square foot, which is approximately the figure adopted by the Post Office, and that the ratio of the effective pressure on a cylindrical surface to that on a plane surface is 0·6, then the pressure, P, in pounds per foot run of wire will be numerically equal to the diameter in inches of the wire, and if W = the weight per foot run of wire, the resultant pressure, w, per foot run of wire = $\sqrt{W^2 + P^2}$. Taking as an example the copper wire ·100 inch diameter, and its equivalent in aluminium, of which particulars are quoted by Mr. Hunt, we find for the copper wire—

W = ·0304 lbs.
P = ·100 „
w = ·1045 „
t = safe working strain with a factor of safety of 4 = 63 lbs.,

and for the equivalent aluminium wire, which will be ·126 inch diameter—

W = ·0145 lbs.
P = ·126 „
w = ·1268 „
t = 100 „

To compare these two wires we may find the span, which will give the same dip, say, 5 feet for each, using the equation,

$$a = \sqrt{\frac{8\,d\,t}{w}};$$

from which we get a span of 155 feet for the copper wire, and of 162 feet for the aluminium one, which shows a slight difference in favour of aluminium. This will not, however, permit of any saving in poles, as the side strain on the poles due to wind pressure on the wires will actually be 25 per cent. greater with the aluminium than with the copper wires, and therefore heavier poles would have to be used.

In such small wires the effect of wind pressure is greater than with wires of larger sectional area, as the surface exposed to the wind does not increase so rapidly as the sectional area; and we shall, therefore, find a greater difference in the length of span if we take as an example a copper wire of ·300 inch diameter and compare it with its equivalent aluminium wire, the diameter of which will be ·378 inch. For the copper wire we have—

$$\begin{aligned} W &= \cdot 2736 \text{ lb.} \\ P &= \cdot 300 \text{ ,,} \\ w &= \cdot 406 \text{ ,,} \\ t &= 567 \text{ lbs.} \\ a &= 236 \text{ feet,} \end{aligned}$$

whilst for the aluminium wire we have—

$$\begin{aligned} W &= \cdot 1304 \text{ lb.} \\ P &= \cdot 378 \text{ ,,} \\ w &= \cdot 400 \text{ ,,} \\ t &= 900 \text{ lbs.} \\ a &= 300 \text{ feet.} \end{aligned}$$

The aluminium line would, therefore, need only four poles where the copper line would require five, but part of this advantage would be neutralised by the fact that, as the side strain on the poles due to wind pressure on the line would be 50 per cent. greater for the aluminium line than for the copper one, the poles for the former would have to be of larger diameter.

So far we have followed Mr. Hunt in comparing aluminium with soft copper, but if we compare the wires in the last example with an equivalent hard drawn copper wire of, say, 97 per cent. of the conductivity of the soft copper wire, and with a breaking strain of about 64,000 lbs. per square inch, we get the following figures :—

$$\begin{aligned} \text{diameter} &= \cdot 305 \text{ inch} \\ W &= \cdot 2827 \text{ lb.} \\ P &= \cdot 305 \text{ ,,} \\ w &= \cdot 416 \text{ ,,} \\ t &= 1{,}160 \text{ lbs.} \\ a &= 334 \text{ feet,} \end{aligned}$$

showing that the advantage as to number of poles and also as to side strain on the poles lies with the hard drawn copper wire.

Mr. Hunt says in his paper that experiments are now being made with an alloy of aluminium having an increased breaking strain, and that although these experiments are not yet completed, it can safely be predicted that a wire of aluminium alloy can be furnished with a breaking strain per square inch equal to that of hard drawn copper, and a conductivity of not less than 50 per cent. of Matthiessen's standard. Such a wire would have a diameter about 40 per cent. greater than that of the hard drawn copper wire of equal conductor resistance, and if we suppose that its specific gravity and price per pound remains the same as for aluminium, it would cost from 10 to 15 per cent. more than the equivalent copper wire.

There is another point which should be taken into consideration, and that is, that the coefficient of expansion per degree rise of temperature is nearly 20 per cent. greater for aluminium than for copper, so that if the two wires are to have the same maximum dip in summer, the aluminium wire will have a smaller dip than the copper wire in winter, and will be subjected to a greater strain unless allowance has been made for this by taking a lower working tension in calculating the span from the maximum dip.

A SIMPLIFICATION OF THE MARCONI RECEIVER.

DR. H. RUPP, of Stuttgart, has made an important simplification in the Marconi receiving apparatus, which he describes in the *Elektrotechnische Zeitschrift*, April 14th, p. 237. To restore the resistance of the coherer, Marconi, as is well known, employs an electric tapper, working like the hammer of an electric bell. This taps the coherer tube, loosens the filings and stops the current. This contrivance has been found to be somewhat uncertain in its action, and when a Morse instrument was used the dots and dashes were often not sufficiently separated.

Dr. Rupp dispenses altogether with the electric tapper in his arrangement, and decoheres the filings by causing the tube to rotate on its axis. The rotation of the tube is produced very simply by means of the paper ribbon of the Morse instrument. The leading-in wires of the coherer are mounted in bearings, and a small vulcanite pulley, with flanges, is fixed on one end of the tube. The tube is put in circuit by two small copper springs, which rub on the rotating axes. The paper strip of the Morse instrument passes round the pulley between the flanges.

Fig. 1 shows this coherer partly in section.

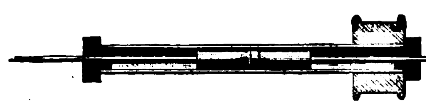


FIG. 1.

The paper spool of the Morse instrument is slightly braked by a brass spring, in order to produce a uniform tension on the paper ribbon, and thereby a uniform rotation in the coherer tube. The arrangement of such a receiving station is shown diagrammatically in fig. 2.

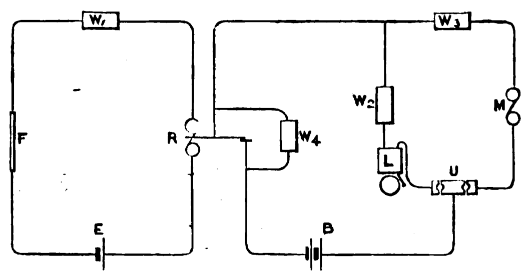


FIG. 2.

In the circuit of the coherer tube, F, there are, in addition to the battery, E, the resistance, W, and the relay, R. By means of the switch, U, either the calling up bell, L, or the Morse apparatus, M, with their respective resistances, W_2 or W_3, and the battery, B, can be thrown into the local circuit; W_4 is a resistance arranged in shunt to prevent sparking at the relay.

Such a station is called up when the tube is at rest, and the bell continues to sound until the Morse instrument is plugged into circuit, and the paper ribbon set in motion.

The diameter of the coherer tube to be employed in this way must not be too small, and the quantity of filings between the silver electrodes must be small enough to roll round the glass wall of the tube. When all the dimensions are properly chosen the dots and dashes stop at the right moment, and the signals are very distinct—certainly much better than with the old arrangement.

Search Lights and Defence.—A committee of naval and military officers at Portsmouth was engaged on Monday night testing the position of the electric search lights distributed among the forts and batteries of the Solent, and to determine whether it was possible for an enemy's torpedo craft to steal into Spithead and effect unperceived an entrance into Portsmouth Harbour under cover of the night.

ELECTRICAL ALLOYS.

By ROLLO APPLEYARD.

Ten years ago German metallurgists began to study the problem of mechanical and electrical permanence of the cheaper alloys used for resistance coils. They appealed to the Reichsanstalt. Metal founders submitted specimens for analysis and criticism, elaborate tests were made, and the results led to the favour and adoption of "manganin" and "constantan." There is still some doubt as to the durability of these alloys, but the evidence shows that, with proper precautions, manganin and constantan may be protected against all ordinary sources of deterioration. The history of that investigation deserves to be told in full, as an object-lesson upon the benefits conferred by a National Laboratory. It is all written in *Band II.* of the *Wissenschaftliche Abhandlungen der Physikalisch-Technischen Reichsanstalt*; parts of it have from time to time been quoted in the Electrical Review and other journals, but several important details have been omitted; it is therefore proposed here to give a summary of the investigation more or less as it appears in the original volume.

I. Metallic Alloys for Standard Resistances.

The first step was to investigate the electrical resistance of most of the familiar alloys, with the intention of elucidating the question of the variation of their specific resistances, for it is these variations that most disturb precise measurements. German silver was next examined, samples being taken from that made by Messrs. Siemens & Halske for standard resistances; also nickel wire from Obermaier, of Nürnburg, and platinum-silver and platinum-iridium from Messrs. Heräus, of Hanau. Of these alloys, the particular quality of platinum-silver examined was found to be too inhomogeneous and too brittle; it had, therefore, to be excluded from the final research.

Platinum-iridium, on account of its high price and great temperature coefficient, was discarded, as it was considered to be only of secondary importance for practical purposes. In the course of the experiments, the nickel used for coins in the Imperial Mint, and manufactured by Messrs. Basse and Selve in Altena, under the trade name of "Patent nickel," was carefully tested.

In order to characterise the materials as nearly as possible, analyses of the various samples were made in the Chemical Laboratory of the Reichsanstalt, with the following results:—

TABLE I.

—	German silver (1 mm.) Messrs. Siemens and Halske.	Nickel. (1 mm.) Messrs. Obermaier.	Patent nickel.
Copper	60·16	61·63	74·71
Zinc	25·37	19·67	0·52
Nickel	14·03	18·46	24·14
Cobalt	Trace	0·19	Trace.
Iron	0·30	0·24	0·70
Manganese ...	Trace	0·18	0·17
Tin	...	...	Trace.
Sp. resistance ...	30·0	33·2	32·8
Temp. coefficient	0·00036	0·00030	0·00021
Thermo-electric power against Cu.	14·4	18·1	29·1

For reference, three physical constants are added to the table:—(1) The *specific resistance* in microhm-centimetres; (2) the *thermo-electric power against copper* in micro-volts per 1° C., temperature difference; and (3) the temperature coefficient.

In the next case, the effect of rolling the wire was investigated at various adjustments of the rollers. Copper pieces were hard soldered to the ends of the wire under test, and the resistance was measured; then, avoiding tensile strain so far as possible, the wire was rolled, and finally its resistance was again determined at the same temperature.

All wires in Table II. show an increase of resistance after rolling, varying from 0·04 per cent. to about 0·87 per cent. Patent nickel varies least, German silver the most. If the diameter of the roller is 40 times that of the wire, only a very small increase in the resistance of the patent nickel wire is observed; with German silver the increase is about four times greater. If rollers of 10 times the diameter of the wire are used, both of these alloys show a change of resistance of about four times the above increment. The cause of this increase of resistance by rolling is partly due to stretch, and partly to mechanical hardening, the result of bending and twisting.

TABLE II.

Specimen of wire.		Diameter of rollers.	Resistance in ohms. Before rolling.	After rolling.	Increase per cent.
1. Standard German silver (Siemens and Halske)	1 mm.	20 mm.	2·2403	2·2575	0·77
		10 "	2·2460	2·2594	0·60
		10 "	2·2470	2·2666	0·87
		40 "	2·2425	2·2457	0·14
		40 "	2·2468	2·2561	0·41
		40 "	2·2440	2·2500	0·27
		10 "	1·9603	1·9698	0·48
2. Nickelin (Obermaier)	1 "	40 "	1·9977	2·0000	0·12
" "	1 "	10 "	2·0008	2·0024	0·08
" "	0·3 "	3 "	2·0099	2·0198	0·49
3. Platinum-silver (Heraus)	0·3 "	4 "	2·0205	2·0217	0·06
4. Platinum-iridium ...	0·3 "	3 "	2·01405	2·0190	0·25
5. Patent nickel ...	1 "	40 "	2·8687	2·8704	0·06
" ...	1 "	10 "	1·1031	1·0035	0·04
" ...	0·6 "	24 "	6·0106	6·0149	0·07
" ...	0·6 "	6 "	2·9936	3·0054	0·23
" ...	0·3 "	12 "	15·0748	15·0837	0·06
" ...	0·3 "	3 "	5·0583	5·0973	0·77

Variations due to bending may be prevented very easily and effectively in standard resistances, by attaching the wires permanently to metal with a strong coating of shellac.

The quasi-permanent resistance-changes due to heating of the material are much more serious. In order to investigate them, bobbins of the foregoing metals were heated for several hours in a dry oven at 40° C., 100° C., and 150° C., and then again at 100° C., measuring the resistance before and after every heating. Table III., column 6, shows the alteration of resistance, corresponding to the various temperature ranges.

TABLE III.

Specimen of wire.	Duration.	Temperature.	Resistance before the heating.	after the heating.	Variation.
1	2	3	4	5	6
	Hours.	Degs. C.	Ohms.	Ohms.	Per cent.
1. German silver (Siemens and Halske). 1 mm	7	40	1·9698	1·9706	+ 0·04
	3	150	1·9706	1·9875	+ 0·85
	5	100	1·9875	1·9878	+ 0·02
2. Nickelin (Obermaier). 1 mm.	7	40	2·0000	2·0007	+ 0·04
	3	150	2·0007	2·0146	+ 0·69
	5	100	2·0146	2·0147	+ 0·01
3. Patent nickel. 1 mm.	8	40	2·8704	2·8692	− 0·04
	2	150	2·8692	2·8575	− 0·41
	2	100	2·8575	2·8576	+ 0·00$_8$
	8	100	2·8576	2·8577	+ 0·00$_4$
4. Patent nickel. 0·6 mm.	5	100	6·0149	6·0056	− 0·15
	4	100	6·0056	6·0048	− 0·01
	2	150	6·0048	5·9962	− 0·14
	3	100	5·9962	5·9963	+ 0·00$_2$
	14 days.	Room temperature.	5·9963	5·9964	+ 0·00$_2$
5. Patent nickel. 0·3 mm.	8	40	15·0837	15·0779	− 0·04
	2	150	15·0779	15·0067	− 0·47
	3	100	15·0067	15·0071	+ 0·00$_3$
6. Patent nickel. 0·3 mm.	6	40	5·0970	5·0945	− 0·05
	3	100	5·0945	5·0863	− 0·16
	2	150	5·0863	5·0726	− 0·27
	2	100	5·0726	5·0726	0

Patent nickel gives a diminution, German silver and nickelin an increase, of the specific resistance after heating. The first heating, 40° C., produces a slight but definite alteration with all the wires. With the next heatings, 100° C. and 150° C., German silver and nickelin have very nearly the same order of increase, which is approximately double of the diminution exhibited by patent nickel. Heating at 100° C., after previous long continued heating at 150° C., influences German silver and nickelin only very slightly; with patent nickel, as a general rule, there is no difference within the limits of observation. The important results derived from these experiments are: (1) that the specific resistance of German silver and nickelin can be made approximately constant, by prolonged heating at 150° C.; and (2) that the specific resistance of patent nickel becomes, within the limits of observation, perfectly constant under the same treatment, so that it does not undergo any subsequent changes even when heated to 100° C. Secondly, the experiments show that, of the materials investigated, patent nickel is essentially better than German silver and nickelin as a material for standard resistances. The above variations are considered by the Reichsanstalt to be due to the presence of zinc in the German silver and in the nickelin samples.

Resistance Alterations due to other Influences.—Of the other influences that can bring about variations in the resistance of metallic alloys, oxidation has first to be considered. The results show that shellac is effective in preventing oxidation, even with the alloys most liable to be attacked. The thermo-electric force of the above specimens against copper, brings about apparent changes of resistance. These changes are most observable with low resistances used with large currents; but by suitably designing the resistances and apparatus they can be nullified.

Of much more importance are the changes of specific resistance with temperature. There is no means for compensating these changes, they can only be held within limits by careful jacketing in oil baths, meanwhile observing the temperature of the oil. They constitute the principal cause of uncertainty in standard resistance coils, and they form the starting point of the investigations of the Reichsanstalt.

Klemencic studied the properties of platinum-iridium and several other alloys used as standards of electrical resistance. He investigated platinum-iridium, platinum-silver, German silver and nickelin, but without giving analyses of the samples. The Reichsanstalt have since examined some of the nickelin alloys used by him, and they find their composition to be :—

	Copper.	Nickel.	Manganese.
1. Bare wire	75·4	24·6	Trace.
2. Covered wire... ...	75·5	24·5	Trace.

thus corresponding with the patent nickel in Table I.

The different materials were tested with regard to their specific resistance, their temperature coefficients, and their thermo-electric force against copper, also the change of their resistance with time, the influences of mechanical deformation, and of moderate temperatures. As a result of the whole investigation, it is found that German silver is of all the alloys the least suitable material for standards of resistance, since it is the one most influenced by mechanical deformations. In this regard the Reichsanstalt conclusions agree with those of Klemencic. The temperature-changes in Klemencic's experiments, though comparatively small, were quite great enough to produce noticeable acceleration of the resistance variations. He himself says: "It would perhaps be possible to bring newly-constructed resistance coils to a final steady value by submitting them for a considerable time to a fairly high temperature." But he did not pursue this idea very far. In his investigations, platinum-silver, such as was recommended 30 years before by Matthiessen, proved the best; in the Reichsanstalt experiments, however, this material seemed to lack homogeneity. With regard to the use of "nickelin" (patent nickel) of standard resistances, Klemencic says: "it has many good properties, but its high thermo-electric power against copper, and the small degree to which it can withstand chemical actions, must be regarded as unfavourable." This alloy is very generally used in the construction of coils for ordinary resistance boxes.

(*To be continued.*)

American Pigs for the Clyde!—It is stated that a large quantity of American pig iron has been brought into the Clyde at 10s. per ton below the price for which English iron could be obtained in this country, and should it prove equal to specifications, it is said there will be a large importation.

SOME FACTS ABOUT WIRELESS TELEGRAPHY.

There have been many wrong conjectures and misconceptions in this country on the subject of wireless telegraphy. The controversy that broke forth on the question of allocating credit to the originators is no doubt still fresh in the minds of our readers. We are not anxious to revivify the differences that have marked the introduction of this new system of signalling, and to that end we shall, as far as possible, confine our remarks to the experiments that are being conducted in this country by Mr. Marconi. To begin with, however, an error perpetrated by a contemporary which still remains uncorrected ought to be swept away. The postal authorities are not conducting experiments on wireless telegraphy between Bournemouth and the Needles, and never have been. A want of knowledge has attributed to the Post Office what has really been done by the Wireless Telegraph Company, under the supervision of Mr. Marconi.

We have been in touch with the Bournemouth experiments for months past, and last week we had the privilege of taking some part in the transmission of messages between Bournemouth and the Needles by the methods of Mr. Marconi.

It is hardly necessary to say that successful experiments on wireless telegraphy have not been confined to this country. In Italy and Germany indefatigable workers have been able to give very remarkable demonstrations. The most noteworthy are those of Dr. A. Slaby, whose achievements have been often quoted in this country as a means of disparaging Marconi's work. Dr. Slaby himself is more generous, and at the present stage it is interesting to quote the following passages from his recent work :—

"Like many others I have also taken up this study, but never got beyond the limits of our High School. Even with the aid of parabolic reflectors and great capacity I could not attain any further.

"Marconi must have clearly added something new to the knowledge by which distances of a kilometre long were attained. I at once resolved to go to England, where the telegraph authorities were making greater experiments. Introduced through my friend Mr. Gisbert Kapp to Mr. Preece, chief engineer of the English telegraph administration, I was graciously allowed to participate in these. What I saw was something new; Marconi had made a discovery; he worked with means, the full importance of which had not been recognised, and which alone explain the secret of his success.

"I ought to have said this at the commencement of my subject, as later, especially in the English technical press, the novelty of Marconi's process was denied. The production of the Hertz waves, their radiation through space, the sensitiveness of the electric eyes, all are known. Very good; but with these means 50 metres were attained, but no more.

"In the first instance, Marconi has devised for the process an ingenious apparatus which, by the simplest means, attains certain results. He has thus first shown how, by connecting the apparatus with the earth on the one side, and by using long extended vertical wires on the other side, telegraphy was possible. These wires form the main feature of his invention; the term 'wireless telegraphy' is, therefore, really incorrect. It would be more correctly termed spark telegraphy, in contrast to the present telegraphy by the electric current.

"I will first of all discuss the constructive apparatus. The principal part of the apparatus is the electric 'eye.' After many experiments, Marconi considered a metallic powder, or rather a mixture of metallic powders, 96 per cent. hard nickel, and 4 per cent. silver, to be the best. It is produced by filing with clean and dry files. This mixture is sealed in a glass tube between two silver balls, the limited surface of which is slightly amalgamated with mercury. The finer the layer of powder, the more sensitive the 'eye,' *i.e.*, the lower the force of the rays, the better the action.

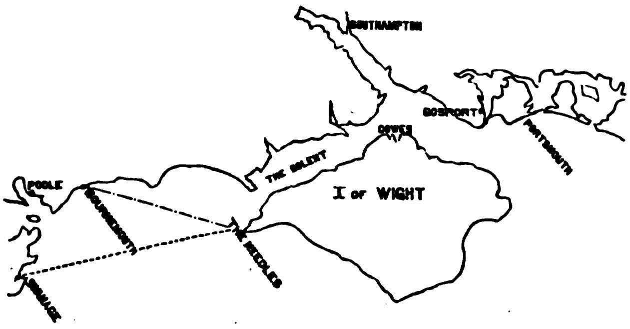
"The layer is only about ½ mm. thick, and only from 20 to 25 metallic grains can be introduced. The exact percentage of silver given is comparatively unimportant; it can only be said that a larger quantity of silver grains make the tube more sensitive, which is of no advantage, as the more silver, the more defective the interruption by concussion after signalling. To effect certain results, which is the main point, I entirely omit the silver, and use only nickel filings. Marconi further recommended the tubes to be exhausted after filling, and hermetically closed. The former is, according to my views, unimportant; the hermetical closing is, however, to be recommended, as it ensures the correct position of the confined silver plungers. The entry is effected by platinum wires, which are welded to the silver plungers. It is, however, of the greatest importance to select with the microscope, metal grains of the most uniform size possible, the sharp edged, jagged and pointed being the most acceptable, and the round grains being the least. Before filling they must be carefully cleaned and dried. In spite of everything one is, however, dependent on chance; some have always to be rejected, partly through having too little or too much sensitiveness, partly on account of an absence of capacity of interruption."

Dr. Slaby, after giving further details of Marconi's apparatus, proceeds to say:—

"Arriving home, I at once commenced to repeat the experiments. I constructed the apparatus in every respect according to Marconi's system. Several simplifications were made subsequently which have proved useful."

The evidence of Dr. Slaby ought to be fairly conclusive that Marconi had made distinct advances on anything previously attempted.

Returning, however, to the experiments at Bournemouth. It is perhaps necessary to say that the Wireless Telegraph Company have had since last November a signalling station at Bournemouth, and one at Alum Bay, on the Needles, Isle of Wight, the position of these places with regard to each other being clearly shown on the section of map. The distance between the two points is 14½ miles, and messages are sent between the two places with facility and accuracy. Swanage is to be very shortly brought into electro-magnetic communication with the Needles.



We have at different times spoken of the apparatus used in Marconi's system,* and at the moment it is scarcely important to refer to the principle in detail, especially as the quotation from Dr. Slaby includes an account of the chief features of Mr. Marconi's system.

A room in one of the houses facing the sea at Bournemouth is fitted up with the necessary apparatus for sending and receiving signals. Even in a locality where masts and flagstaffs are common, the height of the pole facing the signalling station would probably attract attention. It is about 115 feet high, and from the top of this is suspended either an insulated copper wire, or, as on the occasion of our visit, a wire netting some 9 inches in width may be employed. The wire netting is suspended from the pole by means of a long ebonite stick, two coils of wire at this point being employed in order to give an increased capacity. Means are, of course, taken to prevent the netting or the wire coming into contact with the pole. The end of the conductor is carried through a window into the room where the transmitting and receiving apparatus is arranged. Upon entering the room, the scene of such remarkable performances, one is struck with the simplicity, indeed, the sparseness of the apparatus. On a small table near the window is a large 10-inch induction coil, and a Morse key, which forms the sending apparatus, while close by is a metal box some 2½ feet in length, which contains the receiving apparatus, the coherer, a relay and the tapper, while an ordinary Morse printer completes the receiving equipment. A few cells arranged underneath the table completes the apparatus for sending messages across space. After an examination of the instruments, we had various special messages sent by the operator, with a request that they should be repeated; the messages were by no means easy, and, as one was a code message, there was no context to enable the operator at the Isle of Wight end to guess the words. Yet, difficult as it was, the code message came back exactly as it was sent. Altogether we were sending messages backwards and forwards for upwards of an hour, but in no single instance was there any trouble in reading the signals.

As we have already remarked, a 10-inch coil and a Morse key constitute the sending apparatus. The coil at the Bournemouth end is worked by means of a small battery of accumulators. The sparks from the induction coil are made to pass between two small brass balls, about ¾ of an inch in diameter, and placed about an inch apart. In the process of sending a message one sphere of the induction coil would be connected to the end of the vertical wire, while the other would be connected to earth. The operation of the Morse key, by regulating the passage of the current between the battery and the coil, governs the discharge between the spheres, and gives rise to the electro-magnetic waves in the length of vertical wire which affect the apparatus at the receiving station. It is interesting to mention, as showing the tendency to simplify the Marconi apparatus, that in the Penarth experiments it was necessary, for the purpose of transmitting signals over a distance of eight miles, to employ an 18-inch induction coil; but it has been found that perfect signals can now be obtained between Bournemouth and the Needles with a 6-inch coil.

It is necessary, when the sending and receiving instruments are adjacent to one another, to provide a metal screen between them.

Both at Bournemouth and at the Needles the whole of the receiving apparatus, with the exception of the Morse instrument, is contained in a metal box. We need hardly dwell at length upon the receiving apparatus; it consists merely of the coherer, the construction and action of which are well known. The coherer puts into action a one-cell battery, which operates a relay. The relay makes and breaks connection between a 12-cell battery and a Morse instrument, which prints the message. The coherer is about 1½ inches in length and about $\frac{1}{10}$th of an inch in diameter. When receiving a message the end of the vertical wire is connected to the coherer, which then becomes sensitive to electro-magnetic waves. The necessity of decohering exists, and to restore the coherer to its original non-conducting condition, after being affected by the electro-magnetic waves, which go to make a distinct signal, an electrical tapper is provided, which operates automatically and taps the coherer back to its normal state.

After spending a considerable time at Bournemouth dictating messages and having them repeated, we passed over to the Needles to examine the station there. The instruments are arranged in a room in the Needles Hotel, and are practically identical with those in use at Bournemouth. The vertical wire is attached to a mast about 150 feet high, though the entire height of the pole is not utilised. Messages were sent backwards and forwards for some time after we arrived on the island, and at 9 o'clock in the evening of the same day we again witnessed for about an hour and a half the transmission and receipt of messages. Moreover, we availed ourselves of the system to send a telegram to London, the message being sent from the Needles to Bournemouth, and there handed in at the local telegraph office. We had a further opportunity next day of testifying to the facility and accuracy with which signals could be sent and repeated, though it hardly necessitated these various tests to convince us of the successful working of the system. Many of the Morse messages we brought away with us, and a further examination of them demonstrates beyond doubt the clearness and strength of the signals. Admittedly the signals were slow, the average speed in transmission being probably no more than 12 words per minute, but it must be added that no attempts whatever had been made to send fast signals, the aim being rather towards reliability than speed.

The system has now been in use between Bournemouth and the Isle of Wight for some months, and the variations in weather have had practically no marked effect upon the

* A full description of Marconi's apparatus appeared in the Electrical Review for July 16th, 1897.

signals. If there is any difference, it is that foggy and stormy weather is the most favourable for the transmission of signals. The experiments have not been entirely confined to signalling between shore and shore. Quite a large number of successful results have been obtained in signalling between ship and shore in the very worst of weather. In this case a mast, 50 feet high, was erected on a steam tug, and gave excellent signals.

The next move in wireless telegraphy is the erection of a station at Swanage, which is 18 miles from the Isle of Wight; this is in course of construction, and no doubt will soon be in operation. A still more ambitious scheme is in contemplation, and that is telegraphing between the Isle of Wight and Cherbourg, a total distance of 60 miles. We need hardly say we shall follow these experiments with the greatest interest.

Mr. Marconi deserves the congratulations of all scientific men for the singularly able and ingenious manner in which he has brought wireless telegraphy to a practical issue.

Our thanks are due to Mr. Marconi and to Mr. Jameson Davis, the managing director of the Wireless Telegraph Company, for freely giving us information and permitting us to witness practical tests on the system.

INDUCTANCE IN TELEPHONY.

By W. MOON.

(*Concluded from page* 504.)

THIS condition being fulfilled, and E_m being constant, it will be found that the greater the difference between S and R when $R + S =$ constant, that the greater is the current in the secondary circuit. For if the value of "λ" be filled in equation (2) it can be written

$$y = \frac{E_m}{\sqrt{\frac{(S^2 + p^2 n^2)(R^2 + p^2 L^2)}{p^2 M^2} + p^2 M^2 + 2 R S - 2 p^2 L N}} \quad (4)$$

and if $p\,L$, $p\,N$ and $p\,M$ be written as resistances since they are to bear a constant proportion to R and S they may be written $p\,L = n\,R$, $p\,N = n\,S$, $p^2 M^2 = p^2 L\,N\,a = a\,n^2 R\,S$. Filling these values in (4) it reduces to

$$y = \frac{E_m}{\sqrt{R\,S \left\{ \frac{(n^2 + 1)^2}{n^2 a} + n^2 a + 2\,(1 - n)^2 \right\}}}$$

where the quantity in the brackets is a constant, and since the product R S is least at either end of the line, and greatest when $R = S$, it is evident that the nearer the transformer is placed to either end of the line the greater will be the current in the secondary circuit.

Moreover, at a particular point between the centre of the line and "E" the current in the secondary circuit would be equal to that in equation (3) where no transformer is used, and for any position nearer "E" than that point the current in (4) would exceed that in (3) in proportion to the nearness of the transformer to E. And this is the explanation of the use of the induction coil with telephone circuits, where the work done by the battery is much greater, and, consequently, the secondary current is much greater than if the microphone were used on the circuit direct.

The induction coils used with telephones are not of the closed magnetic circuit type. The primary current of a telephone induction coil is undulatory but not alternating, so that the inductances of such coils are single current inductances, and it is necessary to use coils with broken magnetic circuits having but little residual magnetism.

As the presence of a secondary circuit affects the impedance of a primary circuit, it is interesting to note the effect of sheathing such pieces of apparatus as indicators and transformers, as such sheathing acts in every way similar to a short-circuited secondary circuit.

If the value of "ν" be filled in the denominator of equation (1) the impedance of the primary circuit works out as

$$\sqrt{R^2 + p^2 L^2 + \frac{p^2 M^2}{S^2 + p^2 N^2}(2\,R\,S + p^2 M^2 - 2\,p^2 L\,N)},$$

from which it can be seen that the quantity in the brackets is positive when $2\,R\,S + p^2 M^2 > 2\,p^2 L\,N$, is zero when $2\,R\,S + p^2 M^2 = 2\,p^2 L\,N$, and is negative when $2\,R\,S + p^2 M^2 < 2\,p^2 L\,N$, and, therefore, that the current in the primary circuit is increased by the presence of a secondary circuit when $2\,R\,S + p^2 M^2 < 2\,p^2 L\,N$, and reduced when $2\,R\,S + p^2 M^2 > 2\,p^2 L\,N$.

Which of these two cases would result depends on the relative values of the resistances and inductances as well as upon the pitch of the voice. But generally it seems that it is not advisable to sheath telephonic coils with solid metals. And that if indicators are sheathed with iron to give them a magnetic circuit of less resistance that it would be advisable to split the sheathing from end to end to prevent it acting as a secondary circuit.

The inductance of a metal sheathing can be calculated from the measured inductance of a coil of wire occupying the same space and having n turns since the inductance of the sheathing would be $\frac{1}{n^2}$ that of the coil. And the mutual induction between the sheathing and the primary coil would be $\frac{1}{n}$ that of the primary coil and the coil occupying the space of the sheathing.

The cores of electro-magnets act as secondary circuits in the same way as an iron sheathing, and for this reason telephonic induction coils and transformers are provided with cores of iron wires oxidised on the surface. It is doubtful, however, whether the insulation thus procured is all that could be desired. A more efficient core for an induction coil can be made by winding iron foil up in a coil with paper insulation between each turn, as shown in fig. 5, when the straight line represents the iron foil, and the dotted line the paper.

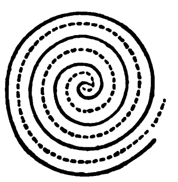


FIG. 5.

A transformer can be similarly made with iron foil in strips with paper insulation, as in fig. 6.

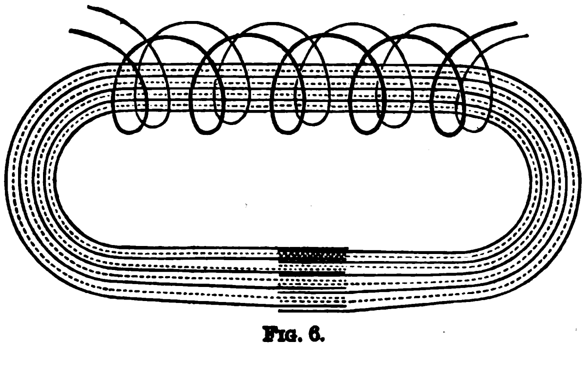


FIG. 6.

The advantage of these methods over the use of wire, is that apart from a better insulation, more iron can be got in the same space.

If, in a transformer in which the inductance of the two coils and the mutual inductance between them is equal, the inductance of the coils be separated from that of the lines by substituting $L_1 + M$ for L and $N_1 + M$ for N in equation (4) this equation reduces to

$$y = \frac{E_m}{\sqrt{\frac{(S^2 + p^2 N_1^2)(R^2 + p^2 L_1^2)}{p^2 M^2} + 2\,\frac{(R^2 + p^2 L_1^2)\,p\,N_1 + (S^2 + p^2 N_1^2)\,p\,L_1}{p\,M} + (R + S)^2 + (L_1 + N_1)^2 p^2}}$$

From which it can be seen that the greater M is made the nearer the current in the secondary circuit approaches

$$y = \frac{E_m}{\sqrt{(R + S)^2 + p^2 (L_1 + N_1)^2}}$$

In a tranformer in which $L N = M^2$ the current can be expressed in the number of turns of wire in the primary and secondary circuits. Let $L = n^2 K$, $N = n_1^2 K$, and $M = n\, n_1 K$. Then if these values of L, N, and M, be filled in equation (4) it reduces to

$$y = \frac{E_m}{\sqrt{\left(\frac{R\ S}{p\, n\, n_1 K}\right)^2 + \left(R \frac{n_1}{n} + S \frac{n}{n_1}\right)^2}}$$

where "K" is a constant depending on the form and size of the transformer, and R and S are the resistances of the primary and secondary circuits which are free from inductance except in the transformer itself.

The mean E.M.F. of a generator can be measured by comparing the deflection produced in a galvanometer by half a revolution of the armature, with the deflection produced by the discharge of a condenser.

If a condenser of capacity "F," and charged with an E.M.F. "e," be discharged through a galvanometer then

$$q_F = F\, e,$$

and the discharge from the generator

$$= q_G = \frac{\Phi\, n_1}{\omega} = \int_0^{\infty} \frac{e_1}{\omega} d\, t,$$

where Φ is the flux of force and n_1 the turns of wire of the armature, and "ω" the total resistance of the circuit. Hence the mean E.M.F. generated when the armature revolves n times per second is

$$E_m = 2\, n\, \Phi\, n_1 = \frac{q_G}{q_F} F\, e\, 2\, n\, \omega.$$

Two generators of which the E.M.Fs. were thus measured gave 16 and 26 volts respectively.

It is found that telephone receivers speak much louder when they contain a permanent magnet, than when they do not. The action of the magnet in the receiver can be thus explained:—

The pull of an element of the diaphragm in the direction of the magnet is $\frac{\beta^2}{8\,\pi} \sin \theta\, d\, s$, where β is the induction and θ the angle the lines of induction make with the diaphragm. Hence the pull on the diaphragm is

$$\frac{1}{8\,\pi} \int \beta^2 \sin \theta\, d\, s.$$

Assume this equal to Φ^2. Then when a current passes through the coil of the telephone the flux would be altered to $\Phi \pm \Phi_1$, and the pull to

$$(\Phi \pm \Phi_1)^2 = \Phi^2 \pm 2\, \Phi\, \Phi_1 + \Phi_1^2,$$

so that the alteration in the pull that determines the motion of the diaphragm would be $\pm 2\, \Phi\, \Phi_1 + \Phi_1^2$. Obviously Φ_1 is much smaller than Φ, so that the loudness of the speech is proportional to the strength of the magnetism of the permanent magnet.

If a soft iron core, instead of a magnet is used, Φ still represents its magnetism, that is, its residual magnetism, and hence the speech is not nearly as loud.

CORRESPONDENCE.

Hoisting Gear for Street Lamps.

With reference to the Davy hoisting gear which you described in a recent issue (p. 469), it would, I fear, be very difficult to carry the steel wire rope round the semi-circle of the carrier on small rollers, as shown in the drawings. To start with, how is one to get the rollers in position in the hole, and supposing that possible, not much space is going to be left for the two cables.

The makers must have early recognised this difficulty, as the sample lamp at Bath, which is referred to in your article, had the steel rope extending from the top of the post to the end of the carrier, just above the contact springs; a sort of short cut, which does not look so neat as when the rope is entirely hidden, but which is effective enough.

In the 84 lamps which the Electric Construction Company, Limited, are now erecting at Bath, the steel wire rope is simply allowed to slide on the inside of the tube of the carrier, and the cables are kept from fouling it by means of a sheet-iron partition, which is slipped into the carrier before it is wired; the two electric cables resting side by side on this partition.

The writer thoroughly tested the first lamp-post and gear for Bath, and found this arrangement satisfactory, the extra friction due to the steel rope rubbing on the tube being apparently very small in comparison with the total weight requiring to be hoisted. A test was also made to see what the life of a $\frac{3}{16}$-inch diameter steel rope would be under these conditions, and it was found that the wear after 10 years of service might fairly be assumed to be inappreciable. The diameter of the rope is really governed by the question of how large a winch can be got into the space at disposal inside the post. A $\frac{1}{4}$-inch diameter steel rope and a 3-inch diameter winch seem about right.

There are several minor improvements in these lamps for Bath, thus two pawls working at half tooth are employed instead of one, and merely pushing the raising and lowering handle home lifts the pawls out of gear by means of a cone. The handle is fixed to an aluminium hand-wheel, so that in lowering the attendant may use his hand as a brake against the rim of the wheel. The contact is slightly different to the one you described, and it was found advisable to introduce a ball and socket joint immediately above it to allow for slight swaying in a high wind.

There can be no doubt that this raising and lowering gear has come to stay, and great credit is due to Messrs. Davy and Davies for introducing it. The fact that when the lamp is lowered it is automatically cut off from the circuit acts as an additional safeguard, besides the double loop of cable which was required. With the old-fashioned type of lowering gear was an additional expense, very liable to foul and kink, and the cause of an extra drop in voltage.

Corner brackets are a bit troublesome to fit with the gear, especially when there is a shop-door or window immediately below; but for tramway poles (especially centre poles), which also carry arc lamps, the lowering gear will be very useful, because trimming lamps with an ordinary ladder is a trifle dangerous, on account of the vibration and the live trolley wires close by, whilst, on the other hand, the traffic generally prevents a truck ladder being wheeled into position.

Ernest Kilburn Scott.

Jerry Wiring.

I had hoped the day of jerry wiring was over. Unfortunately, it is not. The specimen sent herewith is a sample of wire which I yesterday took out of an installation. This wire, you will see, is fair outside bell wire. I might mention that a large portion of this wire had been run under the floors without any casing, in holes bored in the joists. When will fire insurance companies learn that it is advisable, from their point of view, to safeguard their interests?

In justice to South Shields, I must mention that the work was not done by a South Shields firm.

Jos. A. Jeckell.

Blasting.

The communication from Mr. Barnes, in yours of the 8th, is very interesting. The points he mentions to help guard against a repetition of the serious accident which arose while testing detonators are useful, but it suggests to my mind a farther consideration. Is it not a mistake to allow unskilled persons to test at all? The sensitive bridge of a low tension fuse is easily broken, and thus the fuse is spoilt; hence the necessity for constant testing. But with good, reliable, properly constructed "*high tension*" fuses this is never so—once made good always good. I think the lesson to be learnt is: Use a good high tension fuse which needs no testing. I speak in their favour with a wide experience of 25 years.

Frank Brain, A.M.I.C.E.

Referring to the testing of electric detonators, your correspondent of the 8th inst. is in order in stating that, had the operator not tried to test the high tension electric detonator fuses with the magneto, all would have been well; but it is useful to those concerned that some of the points should be more directly referred to.

It cannot be too widely known that high tension electric detonator fuses cannot be tested for continuity *at all* without almost certain explosion, as will be realised by the sectional sketch in page 9 of Nobel's explanatory pamphlet, "Electric Shot Firing" (of which copy is enclosed).

Low tension electric detonator fuses (page 10) are preferably tested for continuity with a single cell and galvanometer, and then at a safe distance, or with the detonators thoroughly shielded.

Electric blasting being a safe method, is becoming very popular, and it is most desirable that all who use high or low tension electric detonator fuses, should obtain from the company who make, or the agent who supplies the goods, some explanatory instructions, such as Nobel's issue to customers, and there need be no danger.

In high tension electric detonator fuses the ends of the wires, touching the fulminating mixture, are about ⅛th of an inch apart; it is, therefore, quite evident that they cannot be tested for continuity without the "arc" so formed firing the flash mixture, which in turn fires the detonating mixture.

In low tension electric detonator fuses the platinum wire bridge is continuous through the flash mixture, so that with a single cell and galvanometer one obtains a deflection of the needle, showing the circuit complete. As the electromotive force and current are so moderate, the platinum wire is not heated sufficiently to fire the composition.

In all matters pertaining to high explosives, the principal desiderata are a thorough understanding of the details, and the exercise of a little thought and ordinary care.

Nearly every mishap or accident is due to an omission or a commission of some kind on the part of the manipulator.

John Mackenzie,
Electrical Engineer.

The Welsbach Incandescent Electric Lamp.

It would, I think, have increased the definite information on this subject if Mr. Gibson in his very able article had given the claims of Dr. Auer von Welsbach's patent which has been laid open for public inspection, and the subjoined translation of same, though possibly not literally accurate, will probably be of service :—

Claim 1.—**Filaments for incandescent lamps, consisting of—**

(*a*) Osmium, or;

(*b*) Osmium with a percentage of other platinum metals, such as platinum, iridium, ruthenium, or;

(*c*) A core of osmium with a coating of thorium oxide, or;

(*d*) A core formed from an alloy of osmium with the platinum metals mentioned under 1 (*b*), or of these metals or alloys of same and coated with thorium oxide.

Claim 2.—A process for the production of the filaments described in 1 (*a*) and (*b*), wherein,

(*a*) Osmium or osmium compounds are metallically deposited on a thin metal wire (core) by the reduction of a volatile osmium compound such as the tetroxide in reducing gases, and this core afterwards volatilised by incandescence, or;

(*b*) Osmium or osmium compounds are repeatedly spread in thin layers on to thin metal wires (cores) using a cementing material if desired, and the metal wire (core) then volatilised by incandescence, or;

(*c*) Osmium or osmium compounds are electolytically deposited on to a metal wire (core) and this core afterwards volatilised by incandescence.

(*d*) Osmium or osmium compounds in pasty form are repeatedly spread in thin layers on a vegetable or animal fibre (using a cementing material if desired), and converted into osmium by incandescence.

(*e*) Osmium or osmium compounds are made into an emulsion with collodion, denitrated and incandesced.

Claim 3.—A process for the production of the filaments described in 1 (*a*), (*b*), (*c*), (*d*), for electric lamps wherein thin layers of thorium oxide are successively and repeatedly spread on to the filaments mentioned and incandesced after each coating and the process repeated until a dense casing of thorium oxide has been formed on the filament.

In regard to these claims, as far back as 1878 (No. 5,306), Edison patented a filament made of platinum, platinum-iridium alloy, or other metal, which fuses at a high temperature, and is pyro-insulated by being coated with a metallic oxide, such as lime or magnesia, cerium or zirconium, which is not injured by a high degree of heat, and in a subsequent patent (1879, No. 2,402), he mentions the use of wire so coated in a vacuum, whilst in 1888 (No. 2,438) Mr. Langhans described thorium oxide as a filament for an incandescent lamp, and the coating of wires electrolytically with this material is also described by him in No. 23,137 of 1895.

The impregnation of carbon filaments with salts of the platinum group of metals is frequently the subject matter of patents between the years 1878 and 1892.

H. E. Moul.

Rubber Cables.

In connection with the late scare and damaging statements made concerning the behaviour of rubber-insulated cables at Burton-on-Trent, it would no doubt interest your readers to know that, according to the abstract of accounts for that undertaking published in one of your contemporaries in 1896, the cost of repairs and renewals of mains was only £15, and in 1897 on a capital expenditure on mains of £14,335, the cost of repairs and renewals for the year was only £16.

Wm. E. Gray,
Electric Light Department, Silvertown.

"Note on Condenser Shunts."

Owing to my own omission of certain words in my rough manuscript, the final paragraph in the "Note on Condenser Shunts" in the last issue of the Electrical Review is ambiguous. May I be allowed to supply the words omitted by me?

"The above diagram shows how an ordinary quadrant pole-reverser may be used either for Gott or for Thomson mixing connections. For the latter the sliding contact is direct to earth, and G with make-and-break key inserted between either of the capacity quadrants and earth, 1 and 2 being plugged for charge, and 3 for mixing."

E. Raymond-Barker.

April 15th, 1898.

MUNICIPAL ELECTRIC LIGHTING.

An interesting and instructive paper on "Municipal Electric Lighting" was read by Mr. W. C. C. Hawtayne, consulting engineer, at the Bishopsgate Ward Club recently. There was a large and influential attendance of members, including the chairman of the Watford Electric Lighting Committee, Mr. A. E. Pridmore, Mr. H. H. Richardson (solicitor to the Watford Ratepayers' Association), and many others.

Mr. Hawtayne's paper struck at the root of the whole question in the first paragraph, "who are the proper persons to undertake the work, local authorities or private companies?"

Beginning with a short history of the introduction of the dynamo, arc lamps and incandescent lamps, giving the several dates on which they made their advent, Mr. Hawtayne passed on to the time, only a few years ago, when the business men put their heads together and the voice of the promoter was heard in the land. To awaken interest in the new industry, the 1881-82 exhibition at the Crystal Palace was held, and many for the first time were able to see for themselves what could be done, and the great possibilities of the electric lighting in the future, and no difficulty was experienced, when batches of companies were floated, in obtaining money, for, to use the words of the author of the paper, "the general public went electricity mad."

Many companies immediately obtained provisional orders from the Board of Trade to supply electricity in the larger towns, and a table is given, which we reproduce below, of the provisional orders granted in 1883.

—	Granted.	Revoked.	Still in force.	
			Companies.	Local authorities.
1883	69	62	...	7
1884	4	4	...	...
1885	...	...	...	...
1886	1	...	1	...
1887	...	...	...	...
1888	...	...	...	...

In 1888, a new Act of Parliament which eliminated most of the drawbacks of the Act passed in 1882, had the effect of resuscitating the business of town lighting in 1889, when it was in the hands of the true friends of electricity supply, and the progress which has taken place since then is apparent on every side of us.

In 1889, nine companies obtained provisional orders and only one local authority; last year 42 local authorities and only eight companies, and only one of the companies' orders were for a new undertaking. These figures are at last convincing of the soundness of the business of electricity supply.

In 1890 the total number of 8-candle-power lamps supplied from central stations was under 200,000 in London, and in the provinces *nil*. In 1897 London had no less than 1,831,000, and the provinces 2,130,000. In London companies supply nearly 1,700,000 and the local authorities less than 150,000, whereas in the provinces companies only supply 600,000 and the local authorities 1,600,000.

These figures speak for themselves. It is not to be expected that local authorities will exploit a new industry; this must be done by companies interested in that particular industry. When it is demonstrated that the business is sound and contains no element of risk, then is the time that local authorities step in, and this is what has happpened. London is no doubt suffering, especially in the City, through what may be called their throwing away of a chance in allowing companies to secure the orders, but we think, for the reason given above, it was absolutely necessary for companies to exploit the new industry, and where could this be done better than in London? Moreover, a great many orders secured by companies were orders obtained simply by manufacturers of electrical machinery, whose members were also members of the various companies. This served a double purpose, namely, provided a market for their electrical wares and demonstrated the utility and sound commercial nature of the industry. Manufacturers have benefited by the change in the enormous amount of business done, and perhaps the only individual who has suffered by the action of the local authorities is the company promoter, and who cares for him?

Mr. Hawtayne gives a long list of reasons for municipalisation, many of which were advanced by the Town Clerk of Douglas, Isle of Man, in a report compiled by him some time ago. They are so strong and clearly stated that we venture to reproduce them here:—

"1. It is generally admitted that a municipal authority can borrow the necessary capital for the initial outlay under more favourable circumstances than can be done by any private company.

"2. By municipalisation the capital applied to the purpose would not be increased by promotion expenses, or by the result of early failures, as is the case with so many companies.

"3. Electric light can be supplied by a corporation at a price so as to be profitable; less than that which would be charged by a company, because the latter must charge a price sufficient, after payment of all working expenses, to provide a good dividend for its shareholders.

"4. By municipalisation the corporation would simply require to make a sufficient profit to pay the interest on the amount of borrowed capital.

"5. Where the installation is carried out by the corporation, it is not necessary to increase working expenses by payments to directors for administration, and consequently municipalities can manage more economically than companies.

"6. If the business which would accrue should be so profitable as to be greater than the interest required for money borrowed, this additional profit might not only be applied with advantage to the reduction of the rates, but also towards the very large expense which would be incurred in lighting the public streets and thoroughfares.

"7. In the event of the corporation deciding to allow a company to undertake the installation, the first step of the company—assuming that the conditions imposed by the Imperial Parliament would apply locally—would be to select a compulsory area, limited in extent, but which would certainly comprise the choicest portion of the town, from an electric lighting point of view. Ratepayers within the limits of this compulsory area would be able by the use of the electric light to make their places of business more attractive, to the detriment probably of the ratepayers outside, who could not demand a supply for two years, and could then only obtain it under onerous conditions of guarantee, &c.

"8. Where installations are in the hands of companies, the progress and growth of the undertaking is necessarily slow. Shareholders naturally believe in quick returns, and insist upon immediate and good dividends as the precursor to any contemplated enlargement of the capital account. From the beginning business is cramped and really obstructed for want of capital, with the inevitable consequence that the unfortunate ratepayers in the outside area are left out in the cold.

"9. A corporation can afford to take broader views than a company, and in the event of the business being sound as a commercial concern justifying extensions, the object of the corporation would be to develop it on an extended basis as expeditiously as possible. The municipality could afford to provide capital extensions without the necessity of waiting for a 5 per cent. or 6 per cent. dividend upon the work in the compulsory area, the principal aim, with due regard to permanent profitable results, being for a corporate body to extend the benefits of electricity supply throughout the whole of the borough.

"10. The corporation would be in itself a good customer in the direction of public lighting. The drawback to the electricity supply industry is that arising from the fact that the demand ceases almost entirely at bedtime, and economical working is greatly increased if the load can be continued far into the night.

"11. Municipal authorities—Esau-like—in numerous instances, have sold their birthright by sacrificing the monopoly in gas and water, and the same blunder, it is contended with reason, would be perpetrated by sanctioning the creation of a similar monopoly in the hands of a company providing an installation of electric light.

"12. Experience demonstrates that ratepayers as a body will support an undertaking in which, as ratepayers, they are personally interested as predominant partners more readily and more extensively than a concern which they naturally look upon as a private monopoly worked for private gain only.

"13. The most important reason, however, which is urged is that by retaining the manufacture and supply of electrical energy in its own hands, the corporation retains for itself the entire control of the whole of the industry, while it at the same time applies to the use of the ratepayers a system of sanitation as beneficial to the public as the system of water supply or that of drainage.

"14. Because with increased demand the cost of production will become infinitely less while the price charged to the consumer can remain the same if desirable.

"15. That with reduced charges the demand is bound to increase. At present electricity has been supplied for little else than lighting, but great advances are being made in electric cooking and heating, and, of course, in motive power work, and I might safely say that within a few years' time every tramway in the kingdom will be driven by electricity. Now the most serious bar to a reduction in the price of supply lies in the fact that with an ordinary lighting load the plant is only working at its maximum load, that is its highest efficiency for about two hours per diem, during the remainder of the day the standing charges are going on and the sales are infinitesimal. Think what a difference there will be when electric cooking and heating are in favour and tramways are working for 15 hours a day.

The traction load will in most of the large towns be larger than the lighting load, and many tramway companies have already arranged with local authorities or supply companies to take their supply of electricity from the lighting station, in some cases the price to be charged not to exceed 1½d. per unit.

"16. That the municipalisation can do their public lighting at cost price. Some local authorities say that they will light the streets at cost price, neglecting all depreciation and management expenses because they say we are making a profit out of our private customers. 'The works are there to supply them whether we supply the public lamps or not, so we will only charge the ratepayers for public lighting, the extra cost involved by keeping the plant running a little longer and for the extra fuel, &c., consumed and the upkeep of the lamps."

Mr. Hawtayne's paper should be read by every member of the councils in the different towns and cities where the question of electric lighting is being considered. Unfortunately sufficient thought is not always given by those gentlemen when considering this momentous question, perhaps on account of the lack of such useful information as the paper under consideration affords, and which is presented in a light and, in language free from technicalities, easily understood.

The question of electric traction for tramways is engaging the minds of local authorities who have established their stations, and this fact, combined with the lighting question, should awaken double interest in the minds of those who have the deciding for and against allowing companies to step in and secure orders which have the effect of keeping up the price and depriving the poor man of his light, for, undoubtedly, the electric light is the poor man's light, and we confidently think electric traction the poor man's brougham.

BUSINESS NOTICES, &c

Agency Notice.—We understand that Messrs. Gudgeon and Co., of 85, Finsbury Pavement, E.C., are the newly-appointed agents for Messrs. Flather & Son, electrical engineers, of Leeds.

Announcement.—Mr. G. Stegmann, of Clapham Junction, has taken larger premises at 45, St. John's Hill, Clapham Junction, where he intends opening electric light showrooms.

Catalogues.—Mr. James White, of Cambridge Street, Glasgow, has brought out a new price list of Lord Kelvin's electrical instruments, also other apparatus for central station and laboratory use. The list is bound in brown cardboard covers, is well printed, and a good enamelled paper is used, showing off the excellent illustrations to best advantage. Among the many instruments of which detailed descriptions are given, we observe the Kelvin standard direct-reading electric balances, standard watt balances, special standard ditto, Kelvin's standard electrostatic voltmeters of various types, dial central station voltmeters, recording ditto for direct currents, astatic recording ditto for alternating currents, Kelvin's ampere gauges, engine room wattmeter, testing set, Kelvin's electricity supply meter, Kelvin's continuous rheostats for current regulation, galvanometers, resistance coils, and Wheatstone's bridges, electrometers, &c. In the engineering and general apparatus section is Amsler's planemeter for determining the mean pressure in an indicator diagram, Thompson's indicator, tachometers and speed indicators, and pyrometers. The conditions and fees for Board of Trade instrument tests are given at the end of the catalogue.

Messrs. Fuller & Co., of 28, Bush Lane, Cannon Street, E.C., have issued new catalogues dealing respectively with telephones and fittings. The telephone list gives numerous illustrations, weights, prices, and code words of various telephonic apparatus and accessories. Portable telephones, wall and desk apparatus, extension bells, intercommunication boards, exchange switchboards, lightning arresters, safety fuses for protecting telephones from high tension currents, also diagrams of connections for systems of various dimensions are given in this list. The electric light fittings catalogue shows a variety of plain and ornamental brackets, some very neat designs in electroliers, standards, pendants, shop lighting fittings, ships' fittings, arc lamp-posts, and various accessories.

Electrical Wares Exported.

Week Ending April 19th, 1897	£	s.
Adelaide	68	0
" Teleg. mat. ...	36	0
Baltimore. Teleg. mat.	19	0
Beira	37	0
Bombay	12	0
" Teleg. mat.	16	0
Buenos Ayres	175	0
" Teleg. mat.	97	0
Calcutta	324	0
Cape Town	288	0
East London	601	0
Gibraltar	15	0
Hamburg	328	0
Melbourne. Teleg. mat.	25	0
Monte Video	114	0
Otago	215	0
Passages	280	0
Port Elizabeth	292	0
Rosario	628	0
St. Lucia. Teleg. mat.	100	0
Sanda Ram	36	0
Singapore	12	0
Trinidad. Teleg. mat.	13	0
Total ...	£3,731	0

Week Ending April 19th, 1898.	£	s.
Albany	80	0
Alexandria. Teleph. mat.	34	0
Amsterdam	120	0
" Teleg. wire	30	0
Auckland	29	0
Bangkok	122	0
Barcelona	41	0
Batoum. Teleg. mat....	180	0
Beira. Teleg. mat. ...	1,155	0
Bombay. Teleg. mat....	50	0
Boulogne	139	0
Buenos Ayres	220	0
" Teleg. mat.	350	0
Calcutta	337	0
Cape Town	2,160	0
Colombo	308	0
Copenhagen. " "	55	0
Delagoa Bay	500	0
Durban	423	0
East London	255	0
Genoa	70	0
Geraldton	80	0
Hamburg	110	0
Hong Kong	28	0
Madras	331	0
Melbourne	169	0
New York	150	0
Ostend	30	0
Port Elizabeth... ...	1,723	0
Rockhampton	9	0
Rotterdam. Teleg. cable	16	0
Santander	28	0
Shanghai	1,000	0
Singapore	150	0
" Teleg. mat.	25	0
St. Petersburg	250	0
Stockholm	255	0
Sydney	150	0
Tientsin...	11	0
Townsville	67	0
Valparaiso	167	0
Wellington	326	0
" Teleg. mat.	2,847	0
Yokohama	437	0
Total ...	£15,607	0

Foreign Goods Transhipped.

	£	s.
Yokohama	240	0

Electric Lifts.—The City and South London Railway Company has placed the order for the whole of the electric lifts required on their new Islington extension in the hands of the United Ordnance and Engineering Company, Limited, of London and Erith, with whom Easton, Anderson & Goolden, Limited, are now incorporated. Each lift will be fitted with their patent gear, and will be capable of carrying about 70 passengers, and the average stroke will be 72 feet. The current required for working will be supplied from the generating station of the railway company. This firm has recently adapted one of the hydraulic lifts on the Stockwell section of this line so that it is now worked by electricity. The United Ordnance and Engineering Company, amongst other work of this class, has in progress five electric lifts for the new Brighton Tower, three of them serving to the 80 feet level, and two to the top of the structure, which is over 500 feet high, the speed of the latter lifts being 300 feet a minute, and each carrying 30 passengers. They are also supplying to the Royal Agricultural Hall a large electric platform lift to raise two tons.

Electric Organ Blowing.—The new organ which is being put down at Lincoln Cathedral is being supplied with electric blowing apparatus by Messrs. Bergtheil & Young.

Extension Granted of the Parsons Patent.—Before the Judicial Committee of the Privy Council (present—Lord Watson, Lord Macnaghten, Lord Davey, and Sir Richard Couch) a petition was heard on 19th inst. for the extension of the term of letters patent dated April 23rd, 1884, granted to the Hon. Charles Algernon Parsons for an invention of "Improvements in rotary motors actuated by elastic fluid pressure and applicable also as pumps." Mr. Moulton, Q.C., and Mr. A. J. Walter were counsel for the petitioner; the Attorney-General and Mr. Sutton for the Crown. It was stated, says the *Times* report, that the invention related to machines known as steam turbines. Prior to the date of the petitioner's letters patent no steam turbine was, so far as the petitioner was aware, in practical use within the realm. Many persons had endeavoured to employ the velocity of steam generated in a boiler for the purpose of causing constant revolution in one direction of moving parts without the use of the reciprocating apparatus commonly in use in engines actuated by steam, but, so far as was known to the petitioner, no practical machine had, at the date of his patent, been devised which would enable steam to be used in this way. At the time when the petitioner first devoted his attention to the subject of steam turbines no one had worked out the conditions essential to the manufacture of a practical turbine which would be capable of working with an efficiency in any way comparable to the efficiency of steam in engines of the reciprocating type. The petitioner, after many experiments and long and exhaustive research, was enabled to produce a practical steam turbine, and to lay down the conditions essential to the successful working of such a turbine. In order to do this the petitioner had to practically and theoretically work out the proper relations between the velocity of the moving parts and the velocity of the issuing steam acting upon them, and by a system of alternate rows of fixed and moving blades he was the first to devise a working machine and to proportion the parts of the machine so as to produce a practical working turbine. The high speed at which, in order to obtain the best results, it was necessary to run the moving parts rendered it essential that bearings of a novel description should be invented, the bearings being provided with a certain amount of elasticity, so that the moving parts would rotate around their centre of gravity, or principal axis, instead of around their geometrical centre or axis, so as to prevent vibration and shaking. The petitioner had also been able to eliminate one of the great difficulties attaching to steam turbines known as the thrust. In introducing the invention, the greatest opposition was encountered from engineers, engine builders, and others, and so little was known of the practical value of steam turbines at that time, that it was generally believed, in the engineering world, that no steam turbine could be constructed whose efficiency would approach the efficiency of the ordinary reciprocating engine. Many turbines constructed upon the principle of the invention were, however, now in use for the purpose of driving electric lighting and other machinery, and the public appeared now to have recognised the merits of the invention. Evidence was given as to the great merit of the invention. Machines made in accordance with the invention were now being largely adopted, and were being bought all over the country. One of the machines had been fitted to a vessel 100 feet long, which attained a speed of 34½ knots, a speed which it was believed would be increased if the machines were fitted to larger vessels.—Lord Kelvin was called as a witness in support of the petition, and said there was no practical steam turbine before the petitioner's. The petitioner's invention gave, for the first time, a practical steam turbine. There was a great future for steam turbines. The petitioner's invention had given very good results, and for many purposes it was going to supersede the reciprocating engine, and its application to ships was a very great step indeed.—Lord Watson said their Lordships would humbly recommend her Majesty to grant an extension of the patent for a term of five years, and they would state their reasons for coming to that conclusion on a later day.

Langdale, Hallett & Co. v. Russell & Lennard.—Before his Honour Judge Lumley Smith, Q.C., in the Westminster County Court on Wednesday, the plaintiffs, builders, of 122, Brompton Road, S.W., sued defendants, formerly in partnership as electrical engineers at 135, Victoria Street, Westminster, for £24 5s. 10d. for work done at 41, Bedford Square in connection with making good the walls there after cutting them for defendants to put in electric fittings, they having the contract for the installation. Judgment was given for the plaintiffs.

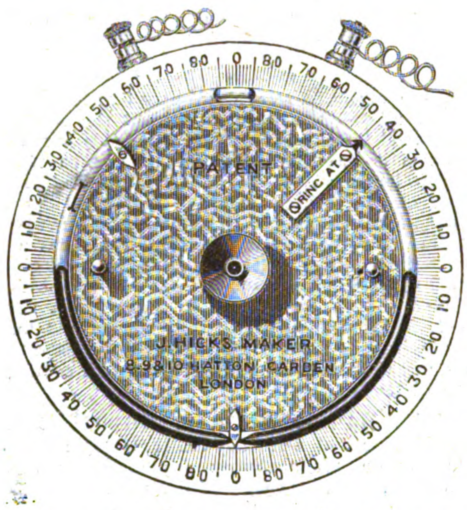
Liquidation Notice.—A meeting of the Electric Traffic Syndicate is to be held at 6, Old Jewry, E.C., on May 23rd, at 2 o'clock, to receive an account of the winding-up operations from Mr. Maurice Jenks, the liquidator.

Melbourne Working Men's College.—We have received a copy of the 1898 prospectus of this College, giving full particulars regarding the different subjects in which instruction is given, and photographs of some of the workshops and class rooms. Mr. W. N. Kernot is the instructor in the electricity department, and Mr. L. S. Daniel is instructor in telegraphy.

Police Electric Lamps.—A sub-committee of the Cardiff Watch Committee has instructed the head constable to report on the subject of electric lamps for the police.

The Shannon Electric Power Scheme.—So many erroneous impressions prevail with regard to this project, that Mr. W. T. Fuller, engineer to the syndicate, writes to a Dublin paper, giving a brief description of the scheme. Originally the desire was to utilise the various lakes of the Shannon River as storage reservoirs which should ensure a sufficiency of water for the power required during the summer; in short, it was desired to use these natural reservoirs to equalise the variable flow of the stream to a certain extent, ensuring a fixed summer quantity, greater than the normal, between Lough Derg and Limerick. In this scheme of storage Lough Allen was included; a certain volume of water would have been retained there to supplement the flow into Lough Derg when the quantity required from that lake exceeded the supply entering it at the upper end. This procedure was said to spell ruin to the fishing industry, and rather than force it Mr. Fuller advised the directors to revert to the use of steam during periods of drought, and to leave the summer flow untouched. Various objections have been raised to the company's proposals. The intention to develop a certain amount of power, with its necessary abstraction of a small share of the river, is considered to be generally objectionable. Side by side with that statement, however, "we are told," says Mr. Fuller, "that were we to take four or five times the amount of water, and develop four or five times the amount of power at once, we should deserve support; and, although the original proposal was to develop 5,000 H.P. only all the year round, and although the present intention is to develop 5,000 H.P. all the year round, and in addition another 5,000 H.P. during wet periods, it has been publicly stated that the capacity of the works has been decreased. These things must speak for themselves. I shall content myself with pointing out that even 10,000 H.P. is a very considerable factor in the industrial life of a community, and that the argument that no one should erect a water mill unless it takes the whole power of the river concerned, is a novel one. The intake and outlet of the power canal are separated by about a mile of river, containing fisheries. Down that river flows a volume of water, varying from one and a quarter millions of cubic feet per minute to one considerably smaller. The height of the flood water at Castle Connell frequently prevents good sport. Of that flood, it is proposed to divert a comparatively trifling amount and return it to the stream lower down. When the water is there, part of it will flow night and day, *viâ* the canal; when it isn't there, the generators will be steam driven."

Ships' Clinometer.—We illustrate below Hicks's new patent ships' clinometer, which has been designed to register the exact roll of a vessel at sea, or when listing to port or starboard. The clinometer shown is made entirely of metal, and the acting part consists of a circular tube containing mercury, with a contraction in the lower part to avoid undue oscillation, and is fitted with electric connections so as to record any particular roll of the ship in the captain's cabin or other place. For instance, if the captain desired to be warned should his vessel roll as much as 45°, he would place the small metal pointer marked "ring at," with arrow attached, opposite that point, as shown in the illustration. This is done by slightly releasing the milled screw head in the centre by giving it a few turns to the left



and then turning the pointer gently by the aid of the brass pins until the plate "ring at" is opposite the 45° or other desired point, clamping the disc again by turning the milled head to the right. Should the vessel ever roll sufficiently to cause the mercury to reach this point, contact is instantly made, and a loud warning bell would be rung. The bell can be placed at any desired distance away from the clinometer. This instrument has also an index to record the greatest roll. To re-set the index, release the milled headed screw and turn the disc round as described above, but it must be turned sufficiently to cause the mercury to pass round the tube and drive the index back. If it is desired not to cause the bell to ring when the index is being set, contact is broken by removing one electric wire from the terminal, replacing it after the index has been pushed round. The small quantity of fluid shown on top of the mercury is creosote, which is placed there for the purpose of always keeping the mercury pure and bright.

ELECTRIC LIGHTING NOTES.

Aberdeen.—The Beach Bathing Station is to be lighted by electricity at a cost of £170.

Ayr.—On the proposal of Mr. A. J. Fuller, the electrical engineer, 23 additional arc lamps are to be used for street lighting.

Bedford.—The Electric Lighting Committee proposes inviting tenders for a new sub-station, also a new engine room at the electricity works, and for a 10-ton overhead travelling crane; and further, for a 30 unit dynamo. Application is to be made to the Local Government Board for sanction to borrow a further sum of £5,400 for electric lighting purposes.

Belfast.—The Electric Committee have under consideration the public lighting of some of the principal thoroughfares, to be carried out when the new station is working, and have instructed the engineer to prepare a statement of the comparative cost of gas and electric light. The report for the first quarters' working of this year shows that the output is 55 per cent. greater than for the corresponding quarter of last year. The statement of accounts for the year ending December 31st, 1897, also shows the department to be in a prosperous condition, the lamps connected being equivalent to 21,000 8-C.P's., whilst the average price obtained per unit is 6·035d., with a total of 201,832 units sold.

Bromley.—Mr. Ernest Newton is to design the central station buildings for the Bromley Electric Light Company, the site chosen being approached from West Street. It is stated that £7,000 out of the £20,000 required has been subscribed, and that a gentleman has offered to subscribe the remainder provided he receives a seat on the board of directors, but the offer has been declined.

Camberwell.—The Vestry has adopted the recommendation of the General Purposes Committee mentioned in our last issue, and will not proceed with the proposed purchase of the undertaking of the County of London and Brush Company.

Cheltenham.—A new "set" has been erected at the generating station, and a preliminary run was made the other day with the arc lighting load before putting it on the actual service of the town. It stood the trial to the entire satisfaction of the engineers, and in the evening took up the greater part of the street and private lighting without mishap of any kind. The new set consists of a Belliss engine direct coupled to a Siemens alternator, and has a capacity of about 250 kilowatts. It is the sixth set, so far, laid down. Three were in running when the works were opened nearly three years ago, viz., two with a capacity of 33 kilowatts each, and one of 110 kilowatts. Since then two other sets have been added, each of 110 kilowatts, and the one now erected has a capacity exceeding these two combined. Another of a capacity equal to it is now on order, and will be delivered in time to meet next winter's load. The committee already has authority to order another set of 400 kilowatts capacity, when occasion requires. All the sets have the Siemens alternator, but while the first three are driven by Willans engines, those since erected are engined by Belliss, under contract with Messrs. Siemens. The new set should have been in place before Christmas, but delivery has been delayed until now by the engineers' strike.

Colwyn Bay.—At the last District Council meeting the surveyor produced plans and specifications for the contract for lighting the promenade with electricity. He had every reason to believe that if tenders were advertised for at once the scheme might be completed by August 1st. Mr. W. Davies was inclined to believe that the town stood in as much need of electric lighting as the promenade. It was agreed to advertise for tenders forthwith.

Mr. Clirehugh has approved of the Ivy Street site.

Dewsbury.—We hear that for the post of borough electrical engineer there were about 60 applicants.

Dublin.—The Town Clerk asked the Corporation for instructions regarding the recommendations set forth in the report of the committee of the whole house relative to the proposed new electrical station at the Pigeon House Fort. The Corporation, after considering the matter, passed a resolution referring to a committee of the whole house to consider the entire question of the new station, the question of site, and also submitting the question of the station and scheme to the best electrical experts for advice; to suggest methods of raising the necessary money for erection and equipment of a station to supply current for lighting the entire city; to advertise for tenders for carrying out the work, and report thereon.

Dumfries.—The Provost's Committee of the Town Council is considering the question of electric lighting.

Ealing.—The Clerk has reported that now, at the end of the first three years of the Council's working of the electric lighting undertaking, 15,209 lamps had been applied for, and of these, 14,495 had actually been connected. The original estimate was for 5,000 lamps within the first three years.

Edinburgh.—The Lighting Commiteee has again considered its previous recommendation regarding the lighting of a number of additional streets—which recommendation was not approved by the Council—and has resolved to adhere to its proposal with a slight modification.

Hackney.—There is much dissatisfaction expressed locally at the unreasonable way the Vestry has been playing with the electric lighting question during the past few years, and ratepayers are beginning to feel that the Vestry is unable to settle matters satisfactorily by itself. Therefore the ratepayers requisitioned for a special meeting of the inhabitants, and this was held on Monday, the chairman of the Vestry presiding. The meeting passed, by 500 votes to 3, a resolution to the effect that the Vestry should keep the provisional order in its own hands. Mr. Henry Hulland, the chairman of the Electric Lighting Committee, argued that the Vestry could re-purchase the order at the end of 12 years as a going concern, and that if the proposed scheme was carried out the company would collect the house refuse to be consumed at the generating station and save the parish £5,000 a year. The prices to be charged by the company in Hackney would be considerably lower than in other London districts.

The Vestry met on Wednesday to receive the report of the Electric Lighting Committee, which recommended the transference to a company. In the heated speeches various charges of "treating" and corruption were made, and the matter was adjourned until after the next elections.

Holborn.—The Clerk of the Board of Works reports that, for the purposes of electric lighting, it is proposed by the Board of Trade to divide the district, one company to have the part south of Holborn, and the other the north part. A resolution was passed that the Board of Trade be informed that the Board of Works is still of opinion that both companies, who were now applying for permission, should be allowed to come into the district.

(*Continued on page* 549.)

ELECTRIC LIGHTING AND INSURANCE.

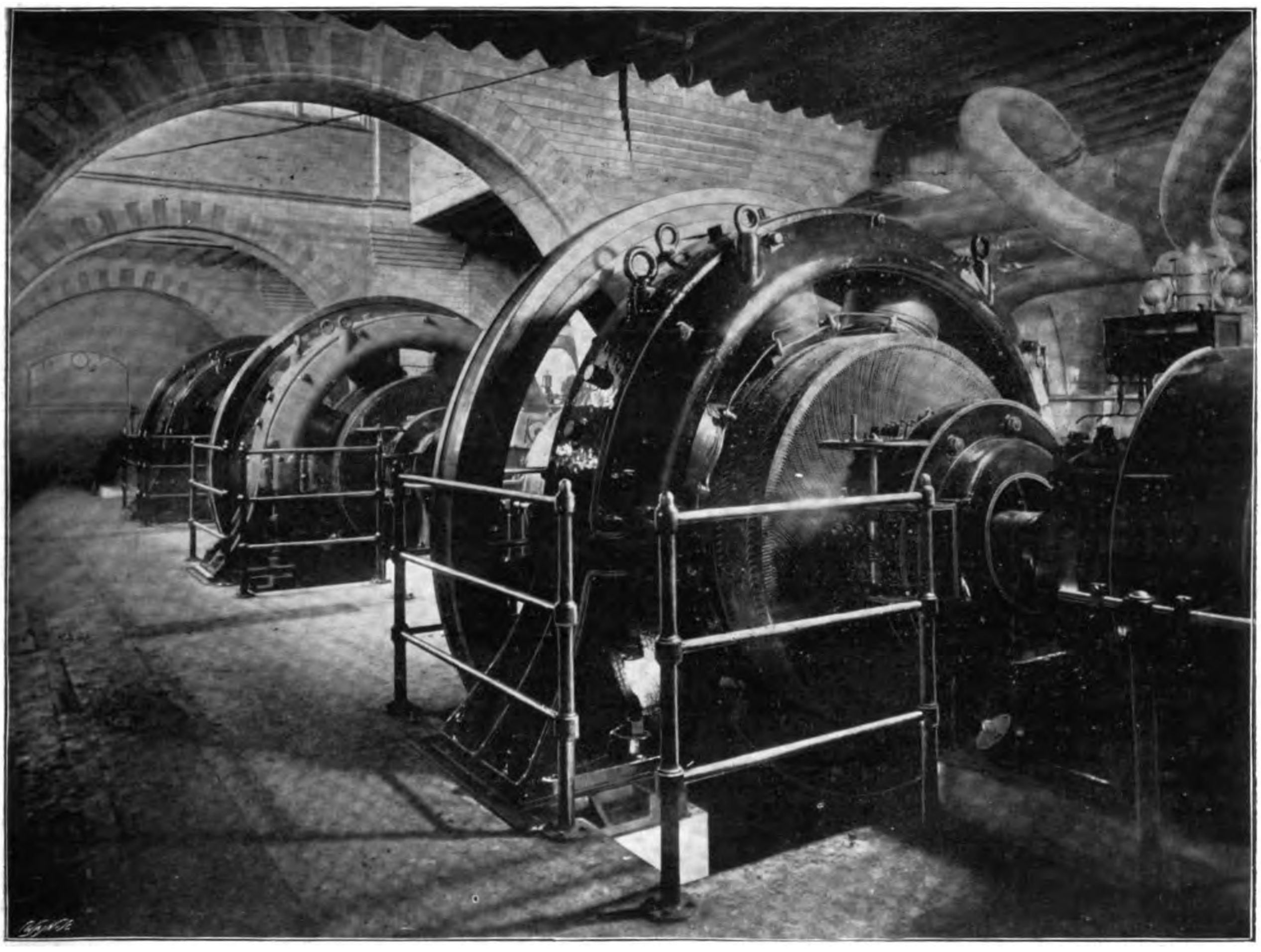
PROBABLY one of the most important, if not the largest private electrical installation in the country, is one that has been recently completed at the offices of the Prudential Assurance Company by Messrs. Drake & Gorham, with Mr. J. Landon in charge of the works. Some idea of the magnitude of the plant will be gained from the illustrations and the following description.

The Prudential Assurance Company have, during the last few years, been extending their premises to a great extent; whole streets are being pulled down to make room for these extensions, which seem to be never ending. One is almost sorry to see such famous localities as Furnival's Inn rapidly disappearing, but the demands of life insurance seem to be inexorable.

and Gorham, who have now completed the plant, have adopted slow speed dynamos, running direct between two horizontal coupled engines.

Each set consists of one dynamo and two single cylinder engines, weighing 60 tons, the weight on the main bearings being 22 tons. The dynamos have eight poles, the magnets being bolted to a steel ring 10 feet 5½ inches in diameter; the armature itself is 6 feet in diameter; the commutator has 360 segments, and is 3 feet in diameter, the revolutions being 85 per minute. A special pit is arranged beneath the commutator to enable the attendant to adjust the brushes. The weight of the armature and crankshaft is 15 tons, and there is a fly-wheel 12 feet in diameter, to ensure steadiness in running. There are three sets of this description, each of 184 kilowatts, and two smaller ones for light load.

The brush gear of the large dynamos is in some respects similar to that of the electric lighting dynamos employed by



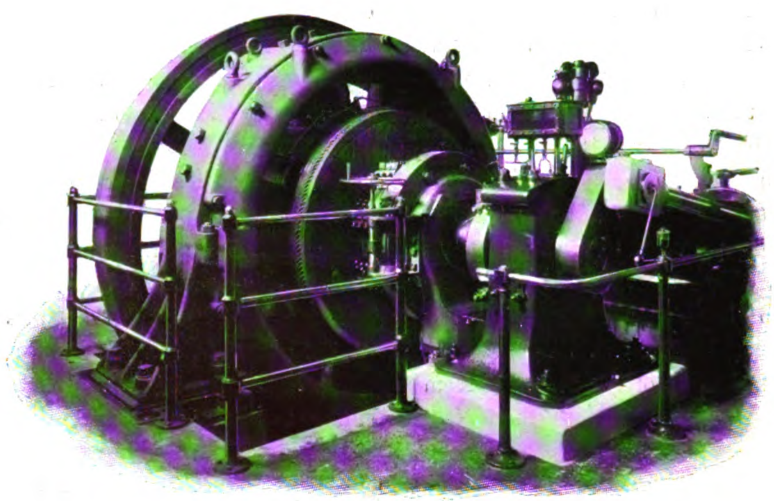
GENERAL VIEW OF DYNAMOS AT THE PRUDENTIAL COMPANY'S OFFICES.

The growth of the Prudential Assurance Company is probably one of the most remarkable features in the history of life insurance, and the alterations in the methods of lighting afford a faint indication of the increase in the business of this company.

It has been necessary to entirely re-model the electric light installation which Messrs. Drake & Gorham originally designed, the old plant having worked without intermission for 10 years. The policy which has been found so successful in central station work of turning out less efficient machinery and replacing it with modern plant of higher efficiency has been adopted in the present instance; in fact, the whole of the apparatus is new from beginning to end. Messrs. Drake

the Great Eastern Railway Company for lighting Liverpool Street and adjoining stations. There are 24 brushes arranged in eight groups of three brushes, the groups being alternatively positive and negative. The positive and negative groups are connected to copper rings carried in the main bearing of the armature. A hand-wheel and gear enables the position of the brushes to be readily altered as required, and gives a wide range of adjustment. Connection between the dynamos and the switchboard is made by means of rubber cables carried in earthenware pipes laid underground.

In accordance with the above proposal, engines to work up to 350 B.H.P. were specially constructed by Messrs. Marshall, Sons & Co. They are of the well-known coupled high pressure type, with 18 inches cylinders × 36 inches stroke. The steam admission gear is of the Proell type, and the exhaust gear of the Corliss type. A central governor controls the automatic gear for each pair of engines. The smaller engines are of the vertical type, one having cylinder of 16 inches × 16 inches stroke, the other 12 inches cylinder × 14 inches stroke. The portions of the dynamo were obtained from Messrs. Crompton & Co., and erected by Messrs. Drake and Gorham *in situ*. This particular size and arrangement has proved so satisfactory, that similar steam dynamo plants have since been constructed. The steam is supplied by five Cornish multitubular boilers, 24 feet long and 7 feet 7 inches in diameter, supplied by Messrs. Marshall, Sons & Co.; they work at a pressure of 100 lbs. through a duplex 11-inch wrought-iron steam main. The exhaust steam is utilised for heating purposes in the building.



One of the Large Machines at the Prudential Company's Offices.

The original design of main conductors for the distribution of the current has proved to be so successful that it has been extended. This consists of bare copper strips suspended from insulators on the walls of the building outside the area. There are many tons of mains on the walls. In most cases they simply run from bottom to top, entering the building at each floor, so that the appearance is extremely neat. The main distributing board is fitted with Messrs. Drake and Gorham's patent spring contact switches and Kelvin measuring instruments.

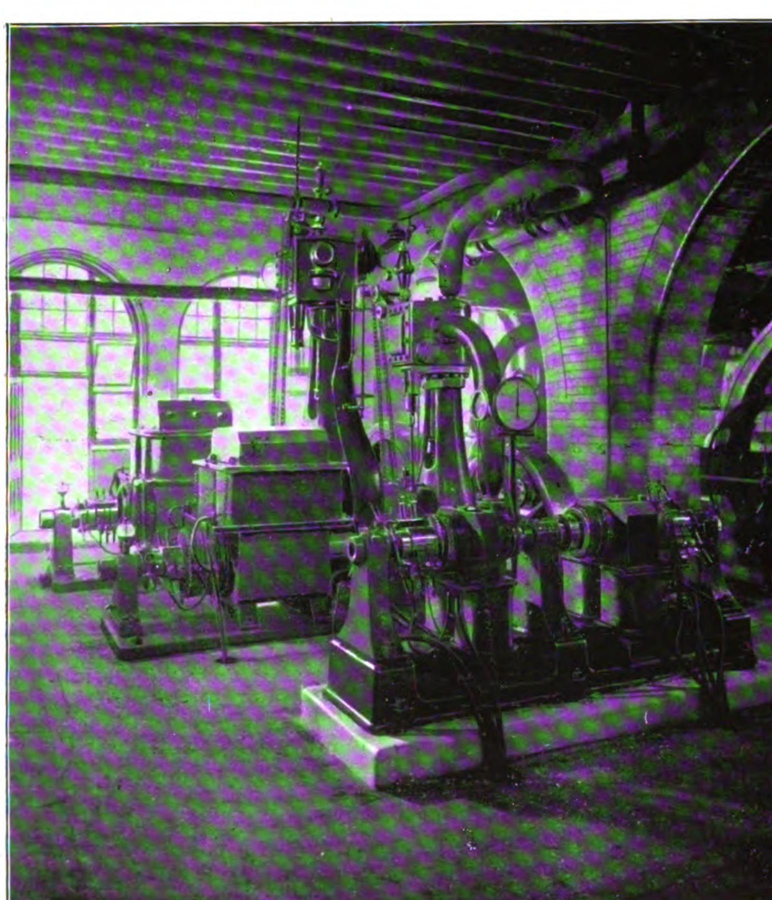
Practically the board is divided into two, positive and negative. On the positive board are three main switches for the three large dynamos, with fuses and ammeters connected to the main omnibus bar. In addition, are 14 switches and fuses which control the circuits into which the system is divided.

The negative board contains the negative fuses of the 14 distributing circuits and the main negative fuses of the large machines. The ammeters, switches, and fuses of the two small dynamos are also on this board, as well as the discharge switch of the battery.

We have already mentioned that the distribution is effected by means of 14 circuits, each of which is arranged to carry 300 amperes or practically 500 lights. Tappings from the main conductors are made on each floor, and at this point a sub-distribution board is arranged which is provided with a double pole switch and double pole fuses.

In spite of the work of the Prudential Company being chiefly confined to the daytime, it is necessary to provide a supply for the complete 24 hours. The light load demand during working hours is met by the smaller machines, but the all night supply is furnished by a large battery of accumulators.

The accumulators manufactured by the D.P. Battery Company are of the new central station type, and have several novel features, one being that the active surfaces of the positive plates are arranged facing one another on the inside of the plate, thus exposing a very large surface to the negative. Although these plates are cast in one piece, they may be described as being built up of a number of narrow plates facing one another, with ample space for acid and electrolytic action between the whole, forming one plate. Now, in an ordinary plate for every inch in width there would be 9 inches exposed, this being the height of the plate, but here we have in the width of 1 inch three strips, each 1 inch deep, having, therefore, six times the surface exposed, or 54 square inches. This plate, patented by Messrs. Drake and Gorham, has been thoroughly tried by the D.P. Battery Company for the past two years, and machines are now being put down to deal with the large demand that has already arisen.



The Light Load Plant at the Prudential Company's Offices.

In order to enable the machines to be wound for 100 volts instead of 130, and to permit of the battery being charged from the omnibus bars, a booster has been erected which raises the charging current to the necessary charging volts. The switchboard specially set apart for the accumulators and the motor generators is furnished with double pole switches for charging the battery, *i.e.*, on the generator side of the booster, and on the motor side, in addition is a 500-ampere charge and discharge regulator. This board is, of course, only used for charging, the discharge circuit being broken by a switch on the negative board.

The plant, with one set in reserve, is capable of dealing with 6,500 lights of 16-C.P. (equivalent to 13,000 8-C.P. lamps), a portion of which are fixed, and the remainder are being put in as the building proceeds.

The Boilers at the Prudential Company's Offices.

Owing to the steam being used for a pneumatic arrangement for sending messages from one part of the building to the other, for pumping, heating, and other purposes, it has been impossible to determine the actual figures as regards working cost, but the rough tests made have shown the result to be very satisfactory in every way.

The whole of the above work has been supervised on behalf of the Prudential Assurance Company by Mr. G. Bailey, of the Surveyors' Department.

Looking back upon the time when the Werdermann or Joel semi-incandescent lamp was first tried in the Prudential Offices, the present installation enables one to fully realise the progress which has been made during recent years in electric lighting, and Messrs. Drake & Gorham may be congratulated upon having erected a plant which for proportions and perfection cannot be surpassed in private supply. To Mr. Richardson, secretary to the company, high praise is also due for his indefatigable efforts to secure the best and most up-to-date arrangements for the colossal enterprise with which he has so long been associated, and with which he must feel eminently satisfied.

THE ELECTROLYTIC REFINING OF LEAD.

By SHERARD COWPER-COLES, M.I.E.E., A.M.I.C.E.

Lead, when recovered from its ores by smelting, is obtained as a crude metal, the so-called work lead, which has to go through a refining process in order to obtain soft or market lead. Work lead is obtained either by roasting reactions, by reduction, by roasting and reduction, or by the precipitation process. Refining is effected either by oxidation after fusion, or by electrolysis. Lead is never obtained pure when smelted from the ore. It is almost always alloyed with all the other metals contained in the ore itself. Apart from the fact that the useful properties of the metal are affected by these other metals, it is, of course, advisable for economic reasons to recover the precious metals present, such as silver One of the first processes worked on a commercial scale for the electrolytic refining of lead by electrolysis was that of Keith. In this process the crude or work lead is melted at the lowest possible temperature in iron kettles, from which it is tapped into moulds. The anodes thus produced are fastened to metal rods by suitable clamps, and enclosed in close-fitting bags of coarse muslin. The electrolysing cells are made of wood or iron; the cathodes are thin metal plates attached to rods in a similar manner to the cathodes. The electrolyte is composed of lead sulphate dissolved in an aqueous solution of acetate of sodium; it is made by electrolysing with lead anodes a mixture of 1½ lbs. of acetate of sodium, 2¾ ounces of sulphuric acid, and 1 gallon of water, and is heated to 38° C. The sulphuric acid attacks and the acetate dissolves the lead, zinc, and iron of the anodes. The zinc and iron, being electro-positive to lead in the liquid, are less easily reduced to metal and accumulate in the solution, and when dissolved in considerable quantity are, to some extent, deposited as oxide on the cathode, the current density employed being about 1·86 amperes per square foot. The lead which is deposited on the cathode is crystalline in form and separates continually from the plates, a space being left in the cells for its accumulation. When the anodes have been dissolved, the bags suspended from their supporting rods are carried to a reservoir and the residual solid matter from the plates is washed and returned to the melting kettles. The slimes suspended from the wash water are allowed to settle, the water is drained off, and the residue filtered. The slimes usually contain antimony, arsenic, silver, copper, gold, and iron. A process that has been recently tried on a commercial scale is that of Tommasi. In this case, the electrolyte is the double acetate of lead and potassium (or sodium) the anodes are crude argantiferous lead, and two of these are opposed to a copper or aluminium alloy cathode, which is in the form of a disc rotating at the rate of from one to two revolutions per minute. These discs are about 10 feet in diameter and three-quarters of an inch thick and are half immersed in the

The Switchboard at the Prudential Company's Offices.

liquid. At the upper part are scrapers which serve to detach the small spongy crystals of lead which form during electrolysis. The crystals when removed fall into channels which convey them to a sieve of wire gauze where they are drained and washed, the wash water being concentrated by evaporation to 20 Baume (sp. gr. 1·256) and used again in the electrolyte. The lead is then compressed and mixed with 2 or 3 per cent. of charcoal powder and fused. The silver, with most of the arsenic and antimony, is separated at the anode, and is collected in trays to be fused subsequently with sodium nitrate and a little borax, by which the silver is separated from the arsenic and antimony.* The cost is estimated by the inventor at from 8 to 10 francs per ton of lead when steam power is used. When lead acetate is used as an electrolyte, the resistance is found to be lowered, which is probably due to the prevention of lead peroxide deposits upon the anodes, which must be at the expense of the organic substance itself, which becomes slowly and surely oxidised. The products of the oxidation of acetic acid are carbonic acid gas and water, which are of no intrinsic value. This being the case the acetic acid becomes an expensive electrolyte as it has to be constantly renewed. The lead peroxide formed at the anode is reduced by a portion of the organic acid to oxide, which then dissolves in the acid and becomes finally reduced to metallic lead at the cathode. The impurities present in the crude metal and the oxides on the face of the anodes are usually bad conductors of electricity, and, if they do not become detached from the anodes, they form an insulating coat over a large portion of the anode surface. The natural consequence of this is, that the current passes mainly through those parts of the plate that remain freely exposed, and so the current density becomes greatly increased at those portions, with the result that the anode is rapidly riddled with holes. The addition of fluid carbonic acid when mixed gradually with sulphuric acid and digested for some time at a temperature of from 50 to 100° C. easily converts it into cresole sulphuric acid, which is soluble in water, and is capable of forming soluble salts with lead. These salts have been successfully used for the deposition of lead.

Maxwell Lyte has suggested converting the lead into chloride and electrolysing it in the molten condition. Crude lead is fused and oxidised by a blast of air in a converter, the oxide is then stirred with hydrochloric acid in earthenware vessels until it is converted into chloride. Any silver compound associated with the lead, salt, or oxide treated, is chlorodised and is extracted from the mass by the application of strong hydrochloric acid or brine.

MEASUREMENT OF THE EFFICIENCY OF CONTINUOUS CURRENT ELECTRIC MACHINES OF ALL POWERS.†

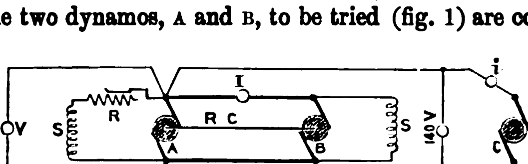
By P. DUPUY.

We know what difficulty is experienced in the workshops where electrical machines are constructed, in determining accurately the efficiency of these machines.

The brake methods are no longer employed, on account of their want of accuracy, and the different sources of error arising from their employment. Other well-known methods require mechanical appliances and rheostats, that are not often available when the power of the dynamos to be tried attains a certain importance. The method that we are about to describe has not yet been proposed, we believe, and we think that it may be of some interest to machine constructors.

This method necessitates the use of two similar machines.

The two dynamos, A and B, to be tried (fig. 1) are coupled



I = 1,000 amp.; i, 160 amp.; V, voltmeter; S, shunt; R, exciting rheostat; R C, rigid coupling; V, voltmeter 140 V; C, 3rd machine 200 amp. 140 volts.

in parallel by means of conductors of short length and considerable section, so that we need not take into account losses of energy from this cause. The two dynamos have their armatures coupled rigidly by any system, a Raffard coupling, for instance, and the connections are arranged as shown in fig. 1.

We send into the whole arrangement the current produced by a third dynamo, C, the power of which need not be equal to that of the two first.

We will suppose that we have to try two machines of 140,000 watts, at 140 volts; it will be sufficient, for instance, to have for the third machine a power of 28,000 watts, or 200 amperes, at 140 volts.

The rigid pair of machines to be tried begins to revolve; the excitation of one of them is then lessened, so as to break the electrical equilibrium existing before. Precisely at this moment, we must observe, one of the dynamos becomes a generator and the other a motor. The current resulting from this want of equilibrium is then made to give the normal output, or, in the case under consideration, 1,000 amperes. The two dynamos of 140,000 watts then work at their normal rate of 1,000 amperes at 140 volts, and it is evident that the losses are furnished by the third machine, and we have only to measure the output in amperes and in volts to get the total losses of the two dynamos. The total loss of one of the two dynamos being tested is equal to half the watts furnished by the third machine.

Working thus, we suppose that the efficiencies of the two machines are equal—which is not quite correct, as one of the machines is a generator and one a motor. This error, however, can be disregarded, as practically it only amounts to some thousandths, and, moreover, the hypothesis is used in other methods.

There is also, in this method, another source of error, which we will mention, although it is of scarcely any practical importance, especially in powerful machines.

In short, the watts furnished by the third machine representing the total loss, include the losses by the Joule effect, which should be expressed by $2\,R\,I^2$, and which are by

$$R\,(I - i)^2 + R\,(I + i)^2 = 2\,R\,I^2 + 2\,R\,i^2,$$

or an addition given by the term $2\,R\,i^2$. But we must observe that the resistance, R, is very weak in powerful machines, and that, moreover, this augmentative error is of an opposite nature to the one due to the above-mentioned cause, so that for both these reasons it is practically of no importance.

If we again take, as an example of the application of this method the two machines of 140 kilowatts, quoted above, we get, at the tension of 140 volts:

$$I = 1{,}000 \text{ amperes}$$
$$i = 160 \quad \text{„}$$

which gives a loss of

$$\frac{160}{2} = 80 \text{ amperes}$$

for each machine, or an efficiency of

$$\frac{1{,}000 - 80}{1{,}000} = \cdot 92.$$

As we see, this method is particularly applicable to the practical testing of powerful units; it has the advantage of being quick, and it only requires a very limited apparatus, the various appliances being found in all testing rooms of machine constructors. We think, therefore, that this is a very practical method, and, as such, we have thought it would be worth while to make it known.

Interesting Ceremony.—An interesting gathering took place recently at St. James's Hall, Manchester, at which over 1,100 guests assembled to celebrate the silver wedding and at the same time the coming of age of the eldest son of Mr. and Mrs. Isidore Frankenburg. Mr. J. Furness, on behalf of the employés of the Greengate Rubber and Cable Works, presented a handsome epergne, suitably inscribed, to Mr. and Mrs. Frankenburg, and a dressing bag to Mr. Cherton Frankenburg. Among those present were Alderman Sir W. H. Bailey, Alderman Hall, and the Town Clerk of Salford. Alderman Sir W. H. Bailey added his congratulation in a neat speech. We also may, perhaps, be permitted to join in congratulations, as Mr. Frankenburg has recently entered the electrical field as a manufacturer of insulated cables.

* The arsenic and antimony are oxidised to the maximum and unite with the soda to form scoria.

† *L'Eclairage Electrique.*

ELECTRIC LIGHTING NOTES.

(*Continued from page* 544.)

Horsham.—Warnham Court, Mr. C. J. Lucas's country seat at Horsham, is to be lit with electric light. There will be 300 lights in all, which will be supplied from the farm by a combined system of gas and petroleum engines, the power being also utilised for pumping and driving farm machinery of all kinds. A "D.P." battery of 106 cells of the latest type will be provided. The contract has been entrusted to Messrs. Drake & Gorham.

King's Lynn.—Prof. Robinson's report on the electric lighting question is before the Council, and it has been decided to apply to the Local Government Board for sanction to a loan of £30,000.

Kinning Park.—A Kinning Park (Scotland) Municipal meeting referred back a recommendation to apply for an electric lighting order, and the Committee will obtain further information.

Leyton.—The tenders received for the electric lighting extension plant have been referred to the Electric Lighting Committee. For the dynamos, tenders were submitted as follows:—Electric Construction Company, £854; T. Parker, Limited, £931 10s.; General Electric Company, £647 16s. 6d.; United Ordnance and Engineering Company, £761; India-Rubber and Gutta-Percha Company, £738; Laurence Scott & Co., £771; Laing, Wharton & Down, £732; Brush Electrical Engineering Company, £827 7s.; Johnson and Phillips, £716 15s.; Siemens Bros., Limited, £737; Paterson and Cooper, £736. Contract No. 2:—Crossley Bros., Limited, £1,900; Wells Bros., £1,707 6s.; Bilbie, Hobson & Co., £1,803 2s. For buildings: J. Haydon, £2,643 4s. 9d.; F. J. Coxhead, £2,594 15s. Mr. Coxhead's tender was accepted. For switchboards: J. White, £181 12s. 9d.; Bertram Thomas, £175 15s. 6d.; Laurence Scott and Co., £150; Laing, Wharton & Down, Limited, £157 10s.; Veritys, £153 4s. 9d.; Siemens Bros., £239 5s. Pea-nut anthracite is to be included in the next coal contract, and the grates of the present gas producing plant will be altered to suit the new fuel. From July 1st the charge for current for lighting purposes will be 5d. per unit for the first 1½ hours and 2d. per unit after, Wright's demand indicators being used.

London.—Mr. D. J. Ross, the City engineer, has issued a report on the works and improvements which have been executed in the City during the past year. He says that the number of arc lamps in lighting at the end of the year was 494. The question of lighting the side streets by electricity is still under consideration. The number of defective electric lamps observed during the last 12 months was 1,620. These returns are made to the Commission daily by the police, and the Electric Light Company is fined for each failure. Beneath the City streets now under the control of the Corporation, there exist at the present time about 2,360 yards, or one and a third miles of subway. The lengths of gas, water, and hydraulic mains, telegraph and pneumatic tubes, and electric lighting conduits laid in these subways amount to a total of 7¾ miles. The electric light and telegraph conduits contain about 424 miles of wires and cables.

Lowestoft.—The provisional order has been approved and granted by the Board of Trade.

Ludlow.—The Public Lighting Committee reported that 10 schemes were sent in by engineers, and that of Mr. J. S. Enright, of Kensington, has been awarded the first prize of £20 by the Council.

Mexico.—Further copies of the Mexican papers show that several more failures have arisen in connection with the electricity supply plant. On one occasion recently a number of the public streets were in darkness the whole night, and the Portales, Municipal Palace, and other buildings were in darkness for a considerable time.

Newcastle.—At a meeting of the special committee of the Corporation, held on Monday, it was decided to submit to the Council a proposition in favour of approaching the electric lighting and current companies, with a view to buying up their interest and plant.

Paris.—The Municipality has decided upon having all the principal roadways of the Bois de Boulogne lighted electrically.

Perth.—Mr. Gripper, managing director of Edmundson's Electricity Corporation, Limited, has written to the Perth Electric Lighting Committee stating that as the provisional order would soon be passed, he should be glad to meet the Committee as to the transfer of the electric lighting powers to his company. The meeting resolved that the Committee were not yet ready to take any definite step in this matter.

Port Adelaide (Australia).—Early last month the Mayoress laid the foundation stone of the electricity works which are being put down by the South Australian Electric Light and Motive Power Company. The architect is Mr. W. W. Crawford, who has gone out from England under engagement to the company. The plant will consist of three boilers, a Green's patent fuel economiser, and four Belliss compound engines. These will be coupled to three Johnson & Phillips patent shunt-wound dynamos, each capable of giving an output of 70 amperes, 420 volts, at a speed of 350 revolutions per minute, and two dynamos of the same make, capable of an output of 70 amperes, 210 volts, at a speed of 420 revolutions per minute. There will, in addition, be the usual batteries and switchboards. It is estimated that the whole of the works in going order will cost £9,000. The contract provides for 23 arc lamps of 2,000-C.P. each, and 66 incandescent lamps of 50-C.P. each. The arc lamps will be turned off at midnight, and incandescents kept alight till sunrise. The contract is for 10 years; but at the expiration of five years the Corporation may acquire the lighting plant at a valuation.

Portsmouth.—A contemporary says that the Town Council will shortly consider a report for the lighting of the ordinary street lamps with electricity at precisely the same cost as is now incurred with gas.

Sheffield.—The Town Council held a special meeting the other day, and passed a resolution approving of the Council promoting a local and personal Bill in the present Session of Parliament to confirm the agreement for the purchase of the undertaking of the Sheffield Electric Light and Power Company, and to confer borrowing and other powers on the Corporation.

Shoreditch.—The report made by Messrs. Kincaid, Waller & Manville to the Electric Lighting Committee of the Shoreditch Vestry was discussed at considerable length at the Vestry meeting held on Tuesday evening. The consulting engineers recommended the Vestry to instruct them to prepare detailed plans and specifications for the alteration of the destructor house and the erection of new coal and accumulator house, and for the boilers and requisite steam and feed pipe connections and necessary accessories; and also to furnish a further report on the terms as to which the makers would be prepared to increase the size of the battery. The cost of the work was estimated by the consulting engineers at £13,200, which included a provision of 10 per cent. for contingencies and extras. Having been advised on the matter by the chief engineer (Mr. Russell), the Lighting Committee recommended the Vestry to generally adopt the scheme proposed, and that it should be referred to the Committee to advertise for tenders for the work. An amendment was moved and seconded that pending the making up of the accounts, the report should be referred back to the Committee. Replying to criticisms made upon the report and electric light station, Mr. Kershaw, chairman of the Lighting Committee, stated that during the third quarter the whole scheme of electric lighting had resulted in a profit of £1,700. With regard to the thermal storage plant, that had not yet had a practical test, but if the terms of the specification were not fulfilled the contractors would not be paid. They were, however, now treating at the rate of from 30,000 to 40,000 tons of refuse per annum, and it was believed they would have the lowest works' costs in London, and perhaps less than those of the Leeds works, where coal only cost from 6s. to 7s. per ton. It was proposed to put down five dry back boilers to supply steam to the engines ordered some time ago, and this would enable the present output of 407 kilowatts out of a possible 456 kilowatts to be considerably increased. Only six members voted for the amendment, which was lost, and the original motion was carried. The Vestry authorised the Lighting Committee to order from the Electric Construction Company a 30-kilowatt transformer and four switchboard panels for the arc light system. The Lighting Committee reported having received an inquiry from the Electric Vehicles Syndicate, asking for a supply of current at 1½d. per unit during the day. The Vestry resolved to inform the Syndicate that the offer made was not acceptable, but that they would be prepared to consider a proposal on lines similar to the terms made with the London Electric Cab Company. Fifteen tenders were received for the supply of arc lamps in connection with the extension scheme. These were referred to the Lighting Committee.

Southampton.—At the last meeting of the Town Council the Electric Lighting Committee submitted a report, showing that the number of units metered at the works during March was 19,186, being an increase of 42·5 per cent. over the number for March, 1897. Having considered an application from a corporate committee with respect to lighting the public parks, the Committee had resolved to defer the consideration of the matter until the question of public lighting was somewhat further advanced. The electrical engineer reported to the committee that he had been in communication with several firms upon the matter of electric lanterns for the police, but, having regard to the cost, weight, and other circumstances connected with the samples submitted for his inspection, he could not recommend them to the committee. The committee's report was adopted.

Southport.—At a recent Council meeting, the Gas Committee opposed a proposal made by the Electricity Committee to add 42 arc lamps to the street lighting, and the motion was eventually withdrawn.

Southsea.—A Committee is to consider the desirability of lighting St. Jude's Church, Southsea, with electricity.

Stockport.—The Local Government Board has granted the application of the Council for a loan (£24,600) for electric lighting purposes, and has approved of the land lately occupied by the Millgate gas works as a suitable site for electricity works.

St. Pancras.—At last week's Vestry meeting, Mr. Thornley submitted a special return, showing that a beginning had been made at the destructor in generating electricity from dust. The committee hoped to bring up a more complete return on a future day. They had already generated some hundreds of units.

Sunderland.—The Town Council has adopted a report recently submitted by Mr. Snell, the borough electrical engineer, on the subject of electric lighting extensions. Application will in consequence be made to the Local Government Board to sanction a further loan of £26,000 to carry out the scheme, and subject to such sanction leave has been granted to borrow £10,000 for immediate requirements. Mr. Snell is drawing up specifications, and inviting tenders for two Lancashire or Galloway boilers, and all piping and accessories, one new Weir's pump, one new steam dynamo, complete with piping, &c., and two motor transformers. Mr. Snell has been also authorised to take steps so that the change to the 440-volt system may be effected in the spring of 1899, subject to the approval of the Board of Trade. In the report referred to the figures were given showing the increased demand which had rendered extensions necessary:—

Year ending.	No. of consumers.	8-C.P. lamps fixed.	Increase.	Max. load E.H.P.	Increase.	Capacity of station, E.H.P.	Capacity E.H.P. deducting stand-by.
Dec. 31st, 1896	118	11,289	—	294	—	345	210
Dec. 31st, 1897	170	19,177	7,888	499	205	480	345
Dec. 31st, 1898 (E)	—	23,750	4,573	680	181	715	480

To the present date the number of lamps connected has increased to 20,411, as against 19,177 in December last, or an increase of 1,234 in two months, to which must be added some 800 more applied for. The number of consumers has also increased from 170 to 191. The following table was also given:—

Year.	Electric H.P. required.	Total units estimated to be sold.	Estimated total capital outlay to end of year.	Working and sleeping costs.	Sinking fund and interest.	Total costs.	Revenue.	Net profit for year.
1898-9	680	418,550	£46,300	£3,580	£2,370	£5,950	£6,055	£105
1899 1900	800	529,470	£56,000	£3,860	£3,180	£7,040	£7,800	£760
1900-1	1,000	660,960	£69,000	£4,360	£3,700	£8,060	£9,430	£1,370

The estimate for all requirements to the end of 1901 is £12,728, but for immediate requirements the outlay will be £7,800. The report under the heading of "mains" says:—"The alternating plant is gradually being loaded up, and I expect will be loaded up by the year 1900. Instead then of adding to this plant, I propose to serve that district by direct current, and to lay a feeder (in the existing conduits which convey the high tension cable) to, say, the corner of Belvedere and Stockton Roads, looping up the now isolated pieces of distributing mains; a much more reliable, safer, and more economical system will thus be provided; a 24 hours' supply given with economy to all consumers, residents, and others alike, and the whole supply will be derived from one system instead of two. It must be distinctly understood that I do not propose to do this yet; but I shall require your sanction to this scheme to enable me to pave the way gradually for the change. I am confident, after the most careful and lengthy consideration of the matter, that this will be the best system for Sunderland, both immediately and when considering the future. The alternating plant could still be made use of for pioneering another district, *e.g.*, Roker, until such time as that outside system had grown to such extent as to warrant its transference to the general system. It may be necessary, when effecting this change (unless some arrangement is arrived at between the Corporation and consumers), to change the lamps in most of the consumers' premises, and to effect some minor alterations therein. The cost will not be large, compared with the very great advantages otherwise obtained. I wish to point out that the present mains will carry from three to four times the amount of energy without increase of section by this method, and therefore a very great saving will thus be effected. Estimate:—Extensions of feeders in present district, *required at once*, £675; mains to the workhouse, £2,200; new feeder to residential district, £1,665; three years' ordinary extensions of mains and services, meters, &c., £7,000; allowance for new lamps and alterations to consumers' wiring in certain cases, £1,000; total, £12,540."

Taunton.—The Taunton District Council long ago made itself conspicuous for its debates on electric lighting, and that reputation it has maintained up to the present time. No fair-minded man would wish to prevent legitimate discussion on the electric lighting question in any council chamber, but in some parts of the country there is a tendency among councillors to take every opportunity of finding fault with either the electricity works or the administrators thereof. There has been considerable heckling at Taunton from time to time, and one member in particular has been very much in evidence in the debates. Where the desire to oppose exists it is not unusual that actual facts should be ignored and gross mis-statements made. And it may often happen that these mis-statements will do a considerable amount of harm unless they are publicly contradicted. At Taunton it seems that the mis-statements have been so gross and so often repeated that the Electric Lighting Committee has felt itself compelled to give a quietus to two councillors who have circulated them. That body has, therefore, drawn up and issued to the local public a lengthy explanation, showing on the one side the mis-statements of Messrs. Standfast and Clement Smith, and showing, on the other side, item for item, the actual facts. The document is duly signed by the 10 members of the Electric Lighting Committee. A comparision of the facts and the mis-statements, allowing the necessary grain of salt on either side, is evidence of the extent to which public men can go in trying to prove their case. The matter is not of more than passing interest, though we suppose the issuing of this statement may lead to further protracted discussion both in the local press and in the council chamber, but borough electrical engineers and sometimes electric lighting committees in different parts of the land have to listen to most absurd statements from ignorant councillors, and though in most cases the statements are only worthy of contempt, there is yet such a thing as going too far. Then is the time to meet the matter in the way adopted by the Taunton Committee. It ought to have a healthy effect upon the Council generally.

Councillor Standfast has issued a circular in reply, in which he proves to his own satisfaction the inaccuracy of the Committee's statements.

Wallasey.—A Local Government Board inquiry was held on 14th inst. into the Council's application for a loan of £20,785 for electric lighting extensions. The sum is made up of £17,725 for electric lighting extensions proper, and £3,060 for purposes of street and promenade arc lighting. The amount of £17,725 is required to extend the engine and generating power, and to supply 150 more consumers. The sum of £3,060 is composed of £1,380 intended to be spent on 46 arc lamps and standards for the streets, and £1,680 for 16 arc lamps for the promenade, together with the necessary cables and attachments. The electric light was installed in the district and first used in the month of January, 1897. There were then 2,000 8-C.P. lamps in connection with the supply, but at present the number is between 5,000 and 6,000. The number of consumers is about 100. The profit for the 11 months ending March last was £840. Applications for energy were being received so fast that the committee were unable to comply with them owing to insufficient generating power. Since the system was installed the price had been reduced from 7d. to 6d. per Board of Trade unit, and a reduction had also been made for prolonged consumption. Evidence in support of the application was given by Mr. J. H. Crowther, lighting engineer.

West Ham.—The West Ham Board of Guardians has been considering the question of improved lighting of the Workhouse, and it was thought advisable to consult an engineer *re* laying down electric lighting plant. The Leyton District Council offered to supply current at 3d. per unit. The matter stands adjourned for a fortnight.

In the Corporation Bill power is sought to amend the provisions of the West Ham Electric Lighting Order, 1892, with reference to power to supply and let electric fittings.

Weston-super-Mare.—The Municipal Electric Supply Company, having offered to take over the Council's electric lighting order, the Council has written stating that, if it determines at any future time to dispose of its order, the company's terms shall be considered.

Winchester.—The Winchester Electric Light and Power Company has written to the City Council on the subject of street lighting. The present lighting contract terminates in a few months, and as a special arrangement was made for supply of current for all municipal purposes at 4d. per unit, the company has raised the question. The works are now about ready to supply current. We understand that tenders are being invited for lighting the streets for three or five years.

Wycombe.—The foundation stone of the electricity works was laid by the chairman of the Electric Lighting Committee last Saturday.

Yarmouth.—The new plant referred to last week comprises a 150-kw. steam alternator. Mr. Ranken, in his report recently, stated that the number of lamps connected has during the last two years been increasing at the rate of about 2,500 lamps per annum. Taking this figure as likely to continue during the next 18 months, he estimated that the number of lamps connected will, in September, 1899, be about 14,700, increased to 15,300 if the Council carried out the illumination of the Drive by festoons of coloured glow lamps. Towards the end of the season 65 per cent. of the lamps are in use at one time, so that before the 1899 season it will be necessary to provide enough machinery to supply 10,000 lamps alight simultaneously, with sufficient reserve plant. The new plant will enable the works to supply 12,000 lamps at one time, leaving one 150-kilowatt set in reserve. No addition to the boilers will be required until it was necessary to increase the engine room plant, which, at the present rate of growth, would not be till 1901. It would be advisable to order this plant not later than June next, as most of the manufacturers have so much work in hand, that they will require a year to execute the contract. The Council resolved to apply to the Local Government Board for sanction to a further loan of £4,800, and that Mr. Preece be consulting engineer for the new engine and alternator. The items in the application would be as follows:—Steam engine, 1,500 kw., alternator and steam pipes, £2,800; additional high and low tension mains, £1,600; transformers and transformer stations, £400; total, £4,800. The quarterly electric light statement showed that the receipts totalled £1,203 5s., leaving a margin of £564 2s. 9d. over the cost of production, which is sufficient to pay all capital charges, interest, and sundries. The accounts for the nine months ending December 31st showed that the income had met expenditure, including repayment of capital, within £327. Out of capital repayments during the year of £852, the surplus revenue from the light had paid £525.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Ayr.—There was a brief discussion at last week's Council meeting regarding electric traction, a proposal to put down overhead trolley lines having been submitted by Mr. Bickerdyke, of Montreal.

Bradford.—The deputation which went to the Continent early in March to inspect electric traction systems with reference to the supply of electricity for electric lighting and electric traction purposes from the same plant, has issued its report. The deputation consisted of the Mayor, Councillors Dixon and Shaw, and Mr. Gibbings (borough electrical engineer), and paid visits to Brussels, Hamburg, Berlin, Dresden and Leipzig. After taking into consideration all that the deputation saw they express themselves satisfied that the arrangements already made at the Valley Road electricity works for running the Bolton Road and Great Horton tramways, are as complete as anything seen on the Continent, but the Continental generating stations are very much larger and finer than anything in this country. Instead of making undue haste in the matter of electric traction or lighting the committee says that we are considerably behind the development which has already taken place in each of the towns visited. It appears to be the practice to utilise either the accumulator system or the conduit system for crossing the more important thoroughfares in the centre of the town with electric trams, "thus doing away not only with the unsightliness but possible danger of the overhead wires," and although the initial cost of the conduit system is considerably higher than that of the overhead, it was found to be far preferable in the centre of the cities visited.

Bristol.—Pursuant to the instruction of the Bristol City Council, the Tramway Committee of that body have taken steps to continue, or rather to re-open, negotiations with the Bristol Tramway Company with regard to the extension of their system and the adoption of electric traction. One of the points upon which a deadlock had occurred was as to the period at which the new lines should be purchasable by the city. The committee desired they should be purchasable at the same time as the old horse lines, in other words, about 14 years hence. The company stuck out for the full 21 years allowed by the Tramway Act. An intimation had been since given that the company were prepared to throw their various lines together and to give the city power to purchase the whole in 18 years. The Bristol city engineer has calculated what the period would be on simple mathematical lines and finds it works out to 16 years and 7 months. Thereupon the committee suggested the term should be 16 years 6 months, so that 18 months only separated them from the company upon this point of the negotiations. The company's representatives asked for an interview with a deputation from the committee, and on Monday the Sanitary Committee commissioned their chairman (Alderman Cope Proctor) and vice-chairman (Mr. George Pearson, who happens to be chairman of the civic electrical department) to meet the company's nominees and talk over the whole subject. The citizens, the great majority of whom are anxious electric traction should not be delayed, are now hopeful that terms will still be arrived at.

The Kingswood Council has been informed by the Light Railway Commissioners that they propose issuing the order applied for by the Bristol Tramways Company to authorise the construction of a new line from St. George to Hanham. The Council was asked to make any suggestions thought necessary.

Cable Traction.—It is interesting to note that Messrs. Dick, Kerr & Co., have just secured a contract for the equipment of cable tramways at Edinburgh for the sum of £89,000.

Christchurch and Poole.—The Pokesdown District Council has resolved to grant the representatives of the British Electric Traction Company an interview in order to discuss their new scheme of a light railway from Christchurch to Poole.

City and South London.—An evening paper says that the contract for the construction of the extension of the City and South London Railway from Stockwell to Clapham Common has been placed. This extension is to be completed in 15 months.

Cork.—The electric tramway and lighting plant and undertaking, which was commenced last November, is said to be approaching completion. It is expected that the lighting will be in operation by the end of May, and the tramways before July 1st. Orders are being booked for lighting current. There is a local free wiring company. The chief engineer of the undertaking is Mr. Horace F. Parshall, and Mr. Wright, of Brighton, is stated to be in charge of the lighting arrangements at Cork. Mr. Richard D. Walsh, C.E., of Dublin, is the engineer for the tramway construction, and Mr. Merz and Mr. Beverley Griffin are the resident engineers for the electric works and tramway construction respectively.

Coventry.—The work of extending the electric tramway system is being rapidly carried out in Coventry. The extension is nearly six miles in length, and will open up communication with the outlying districts. The existing line, which has been successfully working for several years, connects Coventry with Bedworth, a distance of about seven miles.

Dublin.—Before the Judicial Committee of the Privy Council, sitting at Dublin Castle last Saturday, application was made by the Dublin United Tramways Company for an order in Council to authorise the construction and extension of several tramways in the County of Dublin, in the Townships of Rathmines and Rathgar, Pembroke, Drumcondra, Clonliffe, and Glasnevin, and Clontarf, in the City of Dublin. The matter was adjourned for four or five weeks. The Dublin Corporation had the previous day passed a resolution approving of the scheme conditionally.

Liverpool.—The Corporation Tramways Committee on Friday last inspected specimens of an American-made, and of a German-made, electric car for the new experimental electric line to the Dingle, and they have decided to order a number of cars of each make.

Leeds.—The Tramways Committee is to purchase 10 additional trailer cars.

New Conduit System.—A model car and tramway on the Munson electric conduit system has been fitted up at the Glasgow Corporation Tramways works, in St. James Street, by the Munson Electric Conduit Company, of Chicago. There was a press inspection on 15th inst. Mr. Wm. Arnot, late electrical engineer to the Corporation, explained the working of the system. The system is described in the Glasgow papers as follows:—"Within the conduit, placed at intervals regulated by the length of the car, are small gun-metal rollers. These rollers are fixed on the end of a plunger, to the other end of which there is attached a tongue, which is in metallic connection with the roller. Opposite the tongue are two contacts connected with the main wire, which is equivalent to the trolley wire on an overhead system. This main wire is laid in solid insulating material, such as hard bitumen. Opposite the roller is a second one connected similarly, and having the main return wire on the other side. The action that takes place while a car is running is that, when the plough which protrudes underneath the car comes between the two rollers it forces them inwards, the tongue on the end of the plunger in both cases going in between the two contacts which are connected with the main cables, and completing the circuit, the motor is actuated in the usual way. Whenever the car leaves these two rollers they are forced out, and then become quite dead—that is to say, no electricity is in them. The plough of the car, before leaving one pair of rollers, makes contact with the pair in front. The great point claimed for the system is, that the entire system is an insulated one on both sides, that the return current is not taken back by the rails, hence there can be no trouble with the electrolysis, and that no bonding of the rails is required."

Paisley.—At a meeting of the Town Council on the 12th inst., it was stated in the minutes of Council that at a recent committee meeting Mr. Emile Garcke, manager of the British Electric Traction Company, Limited, was introduced and heard with reference to the proposed construction of electric tramways in the burgh and as to the probable requirements of the company for supply of motive power from the Corporation works. After a lengthened statement, he asked that the Council should agree to the principle on which the proposals of the company are based, subject to the terms of the provisional order to be obtained by the company, and the system they propose to adopt, being satisfactory. Mr. Garcke having retired, the clerk read letters from the Simplex Electric Tramway Conduit Syndicate, Limited, and from Mr. R. Bickerdyke, vice-president of the Banque d'Hochelaga, Montreal, calling attention to the merits respectively of the "Simplex" and "American Electric Trolley" systems of electric traction. These he was directed to hand to Mr. Teague, and it was agreed to defer consideration of these and of Mr. Garcke's proposals until Mr. Teague has reported in terms of instructions.

The Electric Power Schemes.—The Clerk to the Derbyshire County Council has informed the Blackwell District Council that the General Electrical Power Distributing Company has decided to put certain clauses into its Bill that would meet a good deal of the opposition now directed against it by various public authorities. The introduction of these clauses would practically wipe out the Blackwell opposition.

As there has been so much opposition raised to the scheme of the General Power Distributing Company, the *Derbyshire Times* discusses the advantages of the scheme at some length.

Roumania.—The Helios Company of Ehrenfeld, Cologne, is reported to have secured a contract for the construction of an electric tramway in the town of Braila, Roumania.

Sheffield.—The question of site for the electric tramway power station is occupying attention at the present moment. Various sites have been suggested, and various opinions are held as to their suitability. The Tramways Committee recommended, and the Council approved, of the Kelham Island site, and Mr. H. F. Parshall, of the British Thomson-Houston Company, expressed the opinion that this was in all ways suited for the purpose. Dr. Hopkinson in his report discussed the respective advantages of half-a-dozen sites, and we abstract a few of his remarks:—"Kelham Island is in reality less advantageous in position than would appear at first sight, because it will not be convenient to lead out conductors in the most direct way for the supply of the district to the north-west and west. The conductors for this direction must be brought back to Alma Street, and part of them as far back probably as the Borough Bridge. The station further is actually at a greater distance from the centre of the district than any one of the remaining four. Water for condensation is, of course, readily obtained, but the whole of the coal required would have to be brought in by cart. . . . Johnson Street is favourably situated in regard to the work to be done. Comparing it with Kelham Island, it is a little more central; it is equally advantageous with regard to condensation, and it may be better placed for bringing in coal if the overhead gantry can be carried out. . . . Assuming that the foundations were all good, and not requiring piling, I should on the whole prefer Johnson Street. But the advantage of one over the other is not so great that it would be worth while going into any very large expenditure in purchasing one site rather than another. A perfectly successful result should be obtained with any one. It has further been suggested to me that the tramway generating plant might be placed on a part of the land occupied by the present electric lighting station. The station is well situated in relation to the work to be done, and I understand there is water for condensation. There is also sufficient room in the existing buildings for enough machinery for present requirements. I see no objection to the plant immediately required being placed there, and to leaving the question of where a larger plant shall be fixed to be settled later."

Sunderland.—The Council has decided to send a deputation consisting of the Mayor, Tramways chairman and vice-chairman, borough engineer, and the borough electrical engineer (Mr. J. F. C. Snell) to the Continent, to obtain information respecting electric traction.

West Derbyshire Light Railway.—At a meeting of the Derbyshire County Council last week it was reported that the promoters desired to increase the width of the gauge from 4 feet to 4 feet 8½ inches. The Council decided to raise no objections, on certain conditions, among them being:—That no steam power shall be used on the line; that the length of the trains shall be restricted to two carriages, in addition to the carriage carrying the motor power.

Whitley.—A poll was taken on Saturday of the parochial electors and ratepayers of the urban district of Whitley and Monkseaton, to ascertain the feeling with regard to the proposed introduction of electric tramways. The result of the ballot was: For the tramways, 260; against, 220; majority for, 40.

TELEGRAPH AND TELEPHONE NOTES.

Australian Overland Lines.—It appears, says the *Financial News*, that the South Australian Government has decided upon the desirability of duplicating the overland telegraph by the erection of a second wire to Port Darwin. The subject has claimed attention as a result of the recent interruptions in the existing wire, and the complaints they have entailed. The double wire, when the intended addition is completed, will have a working capacity nearly four times greater than the existing single one, and this will greatly facilitate the transmission of messages and prevent a block on the line. The cable company has two cables to Port Darwin, and, as South Australia has only one wire, the cable has at present an advantage over the land line. There are over 2,000 miles to be traversed, and it is expected that the work will be completed about the end of the year. The total cost is estimated at something over £50,000. The Agent-General in London has been advised of the materials required for the work, and is now only awaiting the receipt of a cablegram to put the order in hand.

The Cuban Crisis.—It is stated that the Minister of the Colonies for Spain has approved of a contract for the laying of a telegraph cable between Cadiz and Havana *viâ* Teneriffe and Vieques, an island near Puerto Rico.

Delays in Australian Telegrams.—We reprint an extract from the *Sydney Morning Herald* of the 12th ult., which shows that the Australian public is perfectly alive to the inconvenience caused by the very frequent interruptions to the Australian landlines. We believe that the South Australian Government propose to remedy this very unsatisfactory state of affairs by putting another wire on the same poles as the present line from Adelaide to Port Darwin is carried upon. It is estimated that this proceeding will cost something over £50,000, but it seems absurd to expect that by putting additional weight on these poles they will stand any better than they do at present. It has been stated in the House of Commons that the Colonies are making no movement in favour of a cable across the Pacific, but it is difficult to understand how the public can do more than protest in the press, and how the Premiers of the Colonies can express themselves more strongly than they have done at the recent Federation Conference, where it was agreed, with regard to the Pacific cable, "That if Great Britain and Canada would contribute each one-third of the cost, the four eastern Colonies, Queensland, New South Wales, Victoria, and Tasmania, would favourably consider the proposal to provide the remaining one-third of the contribution." As regards the official notification of the delays in Australian telegrams, a correspondent in the *Sydney Daily Telegraph* writes concerning the telegraphic department of South Australia, which, he says, "sends to the Sydney office the most misleading information regarding the state of cable business. To go no further back than yesterday, the official notice read as follows:—'London, 8.28 p.m., March 2nd. Received Adelaide 7.7 a.m., March 3rd, equal to 8 7 a.m. Sydney.' Whilst the actual experience of business people was:—'London, 6.50 p.m., March 2nd. Received Sydney Telegraph Office 5.40 p.m., 3rd idem (after business hours)' or a difference of no less than 11 hours 11 minutes between official representation and actual facts, whilst for business purposes the difference was equal to 24 hours."

The extract above referred to from *Sydney Morning Herald* runs as follows (we would merely premise that "Broome" is identical with Roebuck Bay):—

"CABLE COMMUNICATION.

"*A Series of Interruptions. The Record since January.*

"The imperfections of the present means of communication between Australia and Europe have been the cause of increasing dissatisfaction among commercial classes. Local feeling on the subject was expressed on Thursday by the deputation (from the Sydney Chamber of Commerce) that waited on the Postmaster-General; and although it cannot be said that that deputation exhausted the possibilities of the subject, it brought the question into prominence, and gave the movement towards reform an impetus that it much needed. The main object of the deputation was to advocate the claims of the Pacific cable. A more general question, and one in which all sections of the public are directly interested, is that which is concerned with the reasons for the interruptions, their increasing frequency, and the possibility of an improvement in the present state of affairs. That there has been more trouble with the cable service of late than was the case formerly Mr. Cook admitted. As a well-known merchant said to a *Herald* representative yesterday, messages are delayed, and it is impossible for the person who receives them to be certain how long the delay has continued. He is unable to say whether the message was put in half an hour, an hour, or 10 hours ago. To the commercial world a doubt of this kind is often attended with serious consequences. The uncertainty is, in fact, the worst feature of the case.

"Speaking generally, it may be said that the interruptions which have occurred during the past few months have occurred on the overland service. There are practically two overland lines connecting Sydney with Europe. The bulk of the work falls upon the line between Port Darwin and Adelaide. This is the principal medium for transmission of English and Continental intelligence. There is another line which crosses the south of the continent and connects Broome in the west with Port Adelaide in the south. This line serves as a sort of second string for the line running north and south, but it is in an almost chronic state of disrepair. As far as the lines between Adelaide, Melbourne, and Sydney are concerned, there is seldom any difficulty. Occasionally, as happened two or three weeks ago, heavy rains and swollen rivers may delay communication for a day or two. But the question practically narrows itself down to the condition of the line between Adelaide and Port Darwin and that between Adelaide and Broome. It is these two which transmit foreign intelligence to the more central colonies, and it is with their efficiency, or otherwise, that the public are chiefly concerned.

"Probably only those immediately interested are aware how numerous of late have been the interruptions to the overland telegraph service. Occasionally something is heard of a deep-sea cable going wrong, but, taking the period from the present time back to the beginning of the year, it may be said that the difficulty has been entirely with the overland route. In the press, the heading 'Telegraph Interruption' has appeared with monotonous frequency. On Thursday last it was announced that the 'Port Darwin line is unworkable, and cables are being transmitted *viâ* Broome.' On the Tuesday previous, March 8th, the announcement appeared that the Port Darwin line was interrupted between Katherine and Port Darwin. On March 7th the familiar heading was again in evidence, and this time it was the Broome line that was out of order. On March 2nd there was an interruption on the Port Darwin line. On February 26th the *Herald* explained that there was no English news of the previous day, as the Port Darwin circuit was affected. An announcement of February 11th stated that the Port Darwin line was interrupted north of Woodnadatta. On February 9th came the news of another interruption to the same line; and going back to February 2nd there is still another, this time the news being accompanied by the additional intelligence that the line between Perth and Roebuck was working badly. On January 31st over 200 poles were down on the line between Overland Corner and Renmark. On January 24th an expedition had to be sent from Port Darwin to enable communication to be restored. On January 13th European messages were delayed through an interruption to some part of the overland line. In all 13 interruptions—some of them trifling, some were serious—have occurred on the overland line during the beginning of the year. The numbers are taken from announcements made in the columns of the *Sydney Morning Herald*. No official record has been kept locally, and it is possible that no mention has been made of interruptions of the more trifling kind. But enough has been said, however, to show that the representations of Thursday's deputation were well founded.

"As has already been announced, the South Australian Government has undertaken the continuation of a duplicate line between Port Darwin and Adelaide. The line will, however, for the most part be worked upon the same telegraph poles as those which support the present one, and for this reason the scheme is not received with much favour by commercial men in Sydney. Mr. H. C. Mitchell, secretary to the Chamber of Commerce, said yesterday that he was confident that nothing but the construction of the Pacific cable would satisfy local requirements. The convenience would be very great, and the saving would, he thought, be enormous. The Eastern Extension Company, while offering to lay a line from Natal to Port Darwin, made no offer to reduce the cable rates. The proposed Pacific cable would convey messages at a rate cheaper by 1s. 9d. a word than that at present in force. 'In five years' time,' said Mr. Mitchell, 'there will be four million words passing annually between here and Europe. A saving of 1s. 9d. a word means a saving on that of £360,000 a year. If the work is to be done, it should be done by the Government. The overland line may be interrupted, and the proposal of the Eastern Extension Company does not seem satisfactory. The Pacific cable would pass through British territory, and would be the cheapest in the end."

Interruption to Cape Cables.—During the present month two of the cables which form part of the main line from England to the Cape along the West Coast of Africa have been interrupted. The cable which connects Sierra Leone with Accra was interrupted on the 9th and was restored last Tuesday (19th). Another cable, which runs from Mossamedes to Cape Town was interrupted on the 14th and is not yet repaired. Thus, since the 9th of this month we have been depending for communication with the Cape on the cables along the East Coast from Aden; of which only the Mozambique-Zanzibar section is duplicated. The frequency of the interruptions to the Cape cables emphasises the necessity for laying the proposed alternative line *viâ* St. Helena and Ascension. In addition to the above we learn that another cable on the West Coast, *i.e.*, that from Mossamedes to Benguela, broke down on Wednesday.

The Privacy of Telegrams.—In reference to the order recently issued to the staffs at the various Post Offices on this very important subject, a correspondent of the *Standard* asks, What is the use of this order, when the contents of telegrams are telephoned from sub-offices to the Central Telegraph Offices in such a way that anybody in the sub-office can hear the whole contents of the telegram, together with the names of the addressee and sender? The other day he had occasion to send a telegram, and some question arising respecting it, he was catechised across the public office (then full of people) by the clerk in communication with the telegraph room. What made the circumstance the more annoying was that the message was perfectly in order. But at the busiest hour of the day the receipt of telegrams at a "first-class" provincial office was left to the care of one girl.

The Telegraph Wire Export Trade.—Quite an active trade was done in the exports of telegraph wire and apparatus connected therewith during the past month, the total value of the shipments amounting to £135,583, as compared with only £75,276 in February last, and against £139,642 in March, 1897. The total value of the exports for the first three months of the year may be considered satisfactory as it amounts to £246,788 as compared with £245,472 in the same period of last year, and only £188,302 in the first quarter of 1896.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1898 ...	...
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1898 ...	...
Cayenne-Pinheiro ...	March 24th, 1898 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Cable beyond Gurupa ...	April 4th, 1898 ...	
Cyprus-Latakia	Feb. 10th, 1898 ...	...
Sierra Leone-Accra	April 9th, 1898 ...	April 19th, 1898
Bolama-Bissao	" 12th, 1898 ...	...
Cape Town-Mossamedes ...	" 14th, 1898 ...	...
Maranham-Para	" 17th, 1898 ...	...
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Cartagena-Barranquilla ...	July 4th, 1896 ...	...
Majunga-Tananarive ...	April 1st, 1898 ..	April 7th, 1898
Saigon-Bangkok	" 12th, 1898 ...	" 13th, 1898
" "	" 14th, 1898 ...	" 14th, 1898
" "	" 14th, 1898 ...	" 15th, 1898
" "	" 15th, 1898 ...	" 16th, 1898
" "	" 16th, 1898 ...	" 19th, 1898
" "	" 20th, 1898 ...	...

The Telephone Service.—The St. Pancras Vestry, as the road authority for the parish, has refused to give sanction to the National Telephone Company to place their mains, pipes or wires underneath the streets of St. Pancras until the interests of the public in regard to the telephone service are duly secured by statute.

CONTRACTS OPEN AND CLOSED.

OPEN.

Aberdeen—The Council invites tenders for the supply and laying of about 10 miles of ·67 single core feeder cable, 5 miles of ·2 three-core network cable, and 3⅝ miles of arc lamp series cable. The cable is to be armoured and laid in wooden casing. Under another contract the Harbour Commissioners invite tenders for the supply and erection of 62 arc lamps and three leading lights, each consisting of four arc lamps. All lamps to be Brockie-Pell or Crompton-Pochin. Both the contracts will have to be completed by August 31st, and particulars in both cases can be obtained from the Corporation Electricity Works, Cotton Street. See our "Official Notices" this week.

Belgium.—May 31st. The Municipal Authorities of Ixelles, a suburb of Brussels, are inviting tenders until May 31st for the exclusive concession for the supply of electrical energy for lighting and power purposes during a period of 26 years, that is, to September 1st, 1924. Tenders to be sent to the Secretariat de la Commune d'Ixelles, Brussels, from whence particulars may be obtained.

Bootle.—April 25th. The Corporation wants tenders for the supply and erection of arc and incandescent lamps, lamp posts and accessories. Engineer, Mr. T. L. Miller, Liverpool. See our "Official Notices" April 15th.

Dudley and Stourbridge.—The Dudley, Stourbridge, and District (Staffs.) Electric Traction Company is inviting tenders for the erection and completion of a power station (with chimney stack), car shed, walling, &c., on a site near Dudley Road, Hart's Hill, Brierley Hill. Drawings, specification, &c., from Mr. Thomas Robinson, architect and surveyor, Victoria Chambers, Stourbridge, on deposit of £1 1s.

Edinburgh.—April 23rd. The Midlothian and Peebles Lunacy Board is inviting tenders for the installation of electric light in the Asylum at Rosslynlee, near Edinburgh, including (1) generating plant, accumulators, switchboard, &c.; (2) wiring, fittings, &c. Particulars may be obtained on application to Prof. Bailey, Heriot-Watt College, Chambers Street, Edinburgh.

Hyde.—May 5th. A Corporation Committee invites tenders for the supply and fixing of gas engine, dynamo, wires, fittings, &c., for electric lighting at the new technical school and free library. Engineers, Messrs. Lacey, Clirehugh & Sillar, 78, King Street, Manchester. See our "Official Notices" this week for particulars.

London.—May 17th. The Bethnal Green Board of Guardians invites tenders for the supply of plant, and installing the electric light at the new infirmary, Palestine Place. Plans, &c., to be obtained from the architects, Giles, Gough & Trollope, 28, Craven Street, Charing Cross, W.C. See our "Official Notices" this week for particulars.

Roumania.—April 30th. Tenders are being invited until the 30th inst. by the Roumanian Post and Telegraph Authorities in Bucharest, for the supply of 50 tons of galvanised iron wire, 10 tons of galvanised steel wire, and 5 tons of tinned copper wire. Particulars may be obtained from, and tenders to be sent to, La Direction Générale des Postes et Telegraphes, Bucharest, Roumania.

Sunderland.—April 29th. The Corporation is inviting tenders for the supply of a high-speed 225-kw. steam dynamo, and two Lancashire or Galloway boilers. Borough electrical engineer, Mr. J. F. C. Snell. See our "Official Notices" April 15th for particulars.

Switzerland.—April 30th. Plans and estimates are being invited, says the *Contract Recorder*, by the Government authorities of Fribourg, Switzerland, until April 30th next, for a projected electricity generating station to be established at Hauterine. Water-power is to be utilised, and the station will have a capacity of about 6,000 H.P. A premium of £120 will be awarded to the three schemes submitted which are considered to be the best. Plans and estimates are to be sent to the Department des Travaux Publics, Fribourg, Switzerland, from whence full particulars of the competition may be obtained.

The War Office.—April 27th. The Secretary of State for War is prepared to receive offers, competitive designs and specifications for the supply of portable electric search light apparatus. Particulars from the Director of Army Contracts, War Office, Pall Mall, S.W. See our "Official Notices" February 4th.

Victoria.—June 24th. The Council of the city of Hawthorne (Colony of Victoria, Australia) is inviting tenders for the supply and erection of buildings, boilers, engines, dynamos, transformers, mains, meters, arc lamps, poles; also running the plant for three years. See our "Official Notices" March 11th.

Waterloo (Lancs.).—April 26th. Tenders are invited for wiring and fitting the Town Hall for electric lighting. Particulars from Mr. F. S. Yates, surveyor to the District Council.

CLOSED.

Bootle.—The Town Council has accepted the tender of the Chloride Electrical Storage Syndicate for supplying and fixing two storage batteries at the electricity supply works for the sum of £1,079, and for the maintenance of same at £64 per annum.

Dudley and Stourbridge.—An inclusive contract for the electrical equipment of the Dudley and Stourbridge tramways has been placed with the British Thomson-Houston Company, Limited, and work will be commenced immediately.

Portsmouth.—A contract has been given to Messrs. Yates & Thom for the supply of boilers, feed pumps, mechanical stokers, coal conveyor, &c., at a cost of £7,900.

Walsall.—The Council has accepted the tender of Callender's Cable and Construction Company, Limited, for supplying and laying new feeders and relaying old ones for £1,815 odd.

FORTHCOMING EVENTS.

1898.

Friday, April 22nd, 5 p.m.—Physical Society. "On a Method of viewing Newton's Rings," by the Rev. T. C. Porter.

Monday, April 25th, at 8 p.m.—Society of Arts. Second Cantor lecture on "Sources of Commercial India-rubber," by Dr. D. Morris, C.M.G.

Tuesday, April 26th, at 8 p.m.—The Institution of Civil Engineers. Annual general meeting to receive report and to elect council and auditors.

Wednesday, April 27th, at 7.30 p.m.—Institution of Electrical Engineers. Students' meeting. Paper on "The Commercial Development of the Electric Lighting of Small Towns," by C. Milton and H. Bell.

NOTES.

Prevention of Vibration.—*Apropos* of the recently much-advocated felt mat for deadening noise on solidly laid tramways, *Cassier's Magazine* names a case where a noisy engine was completely checked of jar and tremble by bedding it in a shallow pan of hair felt placed between the stone bed and the engine frame, the pan sides preventing the lateral extension of the felt. Noise due to rigid connections may be deadened considerably in this way, vibration or sound waves being probably unable to propagate themselves between diverse materials. Resonance is the best term to employ in respect of many cases where noisy machinery is found. The same applies to the resonance of a rigid rail or tramway which it is hoped to check by the felt mat, which is made from one-third of an inch in thickness and upwards. Such deadness of sound ought, however, not to be thick, or they will yield under passing pressure, and place vehicles in the position of always running uphill, which it is the object of the rigid girder rail to prevent. Mr. Deacon, of Liverpool, professes that an elastic supported rail is productive of great saving, but he does not advance figures to show the difference in traction where a rail is rigidly supported, or has a yielding elastic support.

Some New Galvanic Cells.—Carbon electrodes immersed respectively in concentrated chlorine water and sodium thiosulphate solution, form essential features of a new cell described by H. Pauling in the *Zeitschrift fur Elektrochemie*, No. 5, page 332. The liquids are separated by a porous pot soaked in brine. During action the sulphur separates out from the thiosulphate solution. Pauling has tested this cell, and found that the electromotive force fell on short circuit, from 0·64 volt to 0·47 volt, and then remained constant for five hours, the current passing being 0·7 ampere. In another cell, which is also described by H. Pauling, the electrolyte is a concentrated solution of ferric chloride, and the electrodes are of iron and carbon respectively. The author considers that the following reactions take place in this cell:—

$$\left\{\begin{array}{l}(1)\ 3\,Fe\,Cl_3 = 3\,Fe\,Cl_2 + 3\,Cl.\\(2)\ Fe + Cl = Fe\,Cl_2.\end{array}\right.$$

The chlorine gas reconverts the ferrous chloride into ferric chloride. The principal advantages of this cell are its cheapness and freedom from odour, whilst the electromotive force is only 0·9 volt. Depolarisation is, of course, the chief difficulty, but by means of a simple mode of construction a constant flow of ferric chloride solution is maintained throughout the cell, and this is claimed to be sufficient to ensure complete depolarisation. In the same number of the *Zeitschrift*, page 383, there is a paper by F. W. Kuster on the last-mentioned cell. Kuster considers that the process which takes place in the cell is better represented by the equation

$$2\,Fe''' + Fe = 3\,Fe'',$$

the dashes indicating the number of positive charges of electricity. Since the iron is always contaminated with finely-divided carbon or iron carbide, local galvanic action must occur of the same kind as the main reaction taking place in the cell. That this is the case was proved by an experiment in which the iron plate lost 1·66 grammes in weight, whereas the loss corresponding to the quantity of electricity produced should have been 0·31 gramme. That the iron dissolves as ferrous chloride and not as ferric salt was shown by immersing the iron plate in a solution of sodium chloride and the carbon plate in a solution of ferric chloride. After allowing the current to pass for some time, the solution in the vicinity of the iron plate was found to contain ferrous salt alone without a trace of ferric iron.

Lectures, &c.—A demonstration of the application of electricity to cooking and heating purposes was given on Monday last week before the Edinburgh South Side Merchants' Association by Mr. Hugh Fleming.

On 11th inst., before the Royal Scottish Society of Arts at Edinburgh, Mr. William Shaw, Pleasance, read a paper, in which he gave a detailed description of an electric system of mechanical ventilation which he had invented.

Tramways and the Light Railways Act, 1896.—In reply to an application addressed to the Board of Trade, we have received the following important communication:—"With reference to your letter of 13th inst. on the subject of the above-named Act, I am directed by the Board of Trade to state that they have been advised by their solicitor that there is no reason why an application under the Light Railways Act, 1896, for a light railway entirely within the limits of a borough should not be entertained, provided the order is properly framed."

Appointment Open.—The Government of Lagos, West Africa, want an engineer of Government vessels (£350 per annum). Applicants must be marine engineers with a knowledge of electric lighting plant. Preference will be given to marine engineers who are now in electricity works. See our "Official Notices" this week for conditions of engagement, &c.

The Electrical Work at Newington Baths.—Messrs. Sharp & Piper, in equipping the recently opened Newington Baths with electrical plant, have completed a most interesting installation. The plant consists of a Thwaites-Crichton double 6 inches and 10 inches × 6 inches compound engine developing at 80 lbs. pressure 35 B.H.P. at 470 revolutions. This is coupled to an Easton, Anderson and Goolden dynamo (Fynn's patent), of four-pole shunt-wound type. This machine has an output of 80 amperes at 225 volts, and is fitted with shunt regulating resistance. There are 125 11-plate R type Chloride Electrical Storage Company's cells having a total capacity of 276 ampere-hours, when discharging in six hours. The battery is used mostly for the light loads. The lighting is done by arc and incandescent lamps, there being 16 32-hours 10 amperes Brockie-Pell lamps placed as follows:—Four in series in first class swimming bath, four in series in second class swimming bath, two on pavement on ornamental standards in series with two in ladies' swimming bath, and two in manure yard in series with two on brackets on outside of building. Street standards, fitted with two 32-C.P. each, to turn on after 12 at night. The incandescent lighting is done by 320 incandescent Ediswan lamps, 16 and 8 C.P., having a terminal voltage of 220. The wires and mains through basement and wash-houses, &c., are enclosed in iron armoured insulated conduits, fitted with drawing-in boxes, &c., and we must say, from our observation, that the character of the work done at the Newington Baths is certainly an argument in favour of interior conduits. The wires and mains in the dwelling portions are enclosed in casing thoroughly varnished inside and out with shellac varnish. As we have already indicated, the fittings throughout are specially designed for 220-volt work. The electrical work in the stables is interesting, because it comprises both lighting and electrical driving. There are 32 16-C.P. 220-volt lamps, arranged on special fittings, and the whole of the provender machinery is driven by electric motors. The whole of this part of the contract, including the shafting, motor, chaff cutter, corn mills, friction hoist and elevators, was supplied and fixed by Sharp & Piper, and designed by Mr. J. B. Cumberland, chief of the engineering staff of the above firm. It comprises a 12½-13 H.P. Sharp and Piper motor, 50 amperes, 220 volts, 780 revolutions, shunt-wound, and fitted with patent starting resistance, driving a 2¼ diameter shafting, which runs at 200 revolutions. To this is geared the chaff cutter, fitted with fast and loose pulleys and bell-striking gear, capable of cutting and sifting 25 cwt. of chaff per hour, the power required being seven to eight B.H.P. Then there is the oat mill, fitted with fast and loose pulleys, capable of crushing 25 bushels oats per hour, the power required in this case being four B.H.P. In addition is a bean mill, fitted with fast and loose pulleys, and capable of splitting 25 bushels of beans, peas, or maize per hour, the power required being 1½ B.H.P. There is friction hoist for raising light loads, which can be made to raise, lower, or break by means of one pull on cord running off the shaft. It is perhaps hardly necessary to say that the character of the installation is very complete, and reflects much credit upon the contractors.

Internal Resistance of Galvanic Cells.—Last year, Ernst Haagn, in the *Zeitschrift für Physikalische Chemie*, No. 23, pages 97—122, described a method for the determination of the internal resistance of cells, which is fundamentally similar to the Wheatstone bridge method for the comparison of the capacities of condensers, the known ratio of the capacities giving the ratio of the resistances. The availability of the method for various classes of cells is first proved by comparison of the results obtained with those obtained by other methods. The experiments afterwards show that the internal resistance of cells during electrolysis is quite independent of the current strength or current density. The slight variations which were found to occur are traceable to alterations in the concentration of the solutions. In the case of accumulators during discharge, the resistance at first slowly increases, the rate of increase being more rapid towards the end, whilst during the charging of the cell the reverse changes occur, the resistance at first diminishing rapidly, and afterwards more slowly. The cause of this variation is partly the change in concentration of the sulphuric acid, and partly alteration of the surface of the lead plates. Haagn has continued his researches, and has more recently turned his attention to the determination of the resistance of galvanic cells with small polarisation capacity. If the resistances in the arms of a Wheatstone bridge are R_1, R_2, R_3, and R_4 (R_3 and R_4 referring to the halves of the bridge wire), and the arms 1 and 2 contain in addition capacities, C_1 and C_2, balance is obtained when $R_1 / R_2 = R_3 / R_4$, and $R_3 / R_4 = C_2 / C_1$ simultaneously. The present method is based on this. The cell, of which the resistance (R_1 say) is to be measured, has a capacity, C_1. The measurements are made by the telephone method, and in order to get a good minimum, the arm of the bridge containing the comparison resistance, R_2, must also contain a condenser of capacity, C_2, fulfilling the requirements of the above equation. A suitable condenser may be made by immersing two aluminium plates in sulphuric acid of maximum conductivity; a current is then passed between them with an E.M.F. of about 10 volts for a minute, when the aluminium plates become polarised, so that a smaller E.M.F. than 10 volts causes no current to pass in the same direction, and this condition is retained for a considerable period. The capacity of the condenser is varied by varying the depth to which the plates are immersed in the acid. In order to prevent direct current from the cell passing through the telephone circuit, an air condenser is included in it. The measurement is made by first adjusting the bridge contact to an approximate minimum of sound in the telephone; a nearer approximation is obtained by adjusting the depth of immersion of the aluminium plates, and then the final adjustment of the bridge contact is made. The method is applicable, whether current is flowing through the cell or not.

Manchester Electric Lighting.—The Manchester Electricity Committee's estimates for the year ending March 31st, 1899, set down the estimated expenditure on revenue account at £53,829; estimated income, £66,000; balance, £12,171; out of which it is expected that £12,000 will be devoted to the relief of the rates. The capital expenditure is put down at £143,900. Last year the surplus was £14,080.

Personal.—As we go to press we hear that Mr. George White, managing director of the Bristol Tramways and Carriage Company, was yesterday (Thursday) elected president of the Bristol Stock Exchange.

Earl Russell Studying for the Bar.—It is stated in the daily papers that Earl Russell has entered his name for the Bar.

NEW COMPANIES REGISTERED.

Mansfield Motor Car Company, Limited (56,901).—Registered April 9th, with capital £5,000 in £10 shares, to carry on the business of automotor and cycle manufacturers, pneumatic tyre manufacturers, electrical, gas, and mechanical engineers, cycle manufacturers, ship and boat builders, machinists, fitters, &c. The subscribers (with 10 shares each) are:—W. J. Chadburn, Grove House, Mansfield, brewer; G. A. Fish, Nottingham Road, Mansfield, ironfounder; F. Hameyer, Nottingham Road, Mansfield, ironmonger; C. Manners, Edenbank, Mansfield, printer; F. A. Robinson, The Park, Mansfield, ironfounder; R. F. Vallance, The Ridge, Mansfield, architect; J. J. Ward, The Park, Mansfield, manufacturer. The number of directors is not to be less than three nor more than seven; the first are W. J. Chadburn, G. A. Fish, F. Hameyer, F. A. Robinson, R. F. Vallance, and J. J. Ward; qualification, £100; remuneration as fixed by the company. Registered by Jordan & Sons, Limited, 120, Chancery Lane, W.C. Registered office, Leeming Street, Mansfield.

Mexico Electric Tramways, Limited (56,932).—Registered April 13th, with capital £500,000 in £1 shares, to adopt an agreement with Wernher, Beit & Co., and to construct or purchase, equip, maintain and work any tramways, railways, telephone or telegraph lines, electric lighting and other works, &c. The subscribers (with one share each) are:—W. Martin, Avondale Road, Manor Road, Richmond, gentleman; R. W. Brown, 79, High Street, Beckenham, journalist; A. J. Swan, 124, Peckham Rye, S.E., gentleman; E. T. Rouse, 1, Avenue Gardens, Mill Hill Park, W., accountant; G. F. Barnett, 12, Weston Park, Crouch End, N., clerk; C. Field, 27, St. Margaret's Road, Brockley, S.E., clerk; A. W. Rogers, 8, Denning Road, Hampstead, N.W., clerk. The number of directors is not to be less than three nor more than nine; the subscribers are to appoint the first. Qualification, £500; remuneration, £500 per annum divisible. Registered by Ashurst & Co., 17, Throgmorton Avenue, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Eastern Telegraph Company, Limited (6,338).—This company's return, made up to February 3rd, was filed on March 9th. The capital is £4,700,000 in £10 shares, of which 469,989 have been taken up. The full amount has been called and paid.

Pontypool Electric Light and Power Company, Limited (36,109).—This company's return was filed on March 25th, when 1,143 shares were taken up out of a capital of £10,000 in £5 shares. £5 per share has been called on 669, and £4 per share on 474, and £5,241 has been paid.

Birmingham Electric Supply Company, Limited (30,296).—This company's annual return was filed on March 28th, when the capital of £200,000 in £5 shares was fully taken up. £5 per share has been called, and £199,926 10s. has been paid, leaving £73 10s. in arrears.

Peru Telephone Company, Limited (56,290).—This company's return, made up to January 14th, was filed on March 8th. 7 shares have been taken up out of a capital of £100,000 in £5 shares, but no calls have been made.

Westminster Electric Supply Corporation, Limited (27,061).—This company's annual return was filed on March 10th, when the whole capital of £399,500 in £5 shares was taken up and paid for in full.

Cuba Submarine Telegraph Company, Limited (4,710).—This company's return was filed on March 9th, when the whole capital of £220,000 in £10 shares was taken up and paid for in full.

Anglo-American Telegraph Company, Limited (2,891).—This company's return was filed on March 23rd, when the whole capital of £7,000,000 stock was fully paid up.

Charing Cross and Strand Electricity Supply Corporation, Limited (29,122).—This company's return was filed on March 24th, when 49,999 shares were taken up out of a capital of £250,000 in £5 shares. £5 per share has been called, and £249,996 paid. £1 has been paid on a forfeited share.

St. James's and Pall Mall Electric Light Company, Limited (26,015).—This company's return was filed on March 15th. The capital is £300,000 in 100 founders' shares of £1 each, and 39,980 ordinary and 20,000 preference shares of £5 each. 100 founders', 31,980 ordinary and 20,000 preference have been taken up, the full amount called, and £260,000 paid.

National Telephone Company, Limited (15,066).—This company's return was filed on April 6th. The capital is £4,000,000 in 150,000 first preference shares of £10, 150,000 second preference shares of £10, 250,000 third preference shares of £5, and 490,000 ordinary shares of £5 each. All these shares, except 5,403 ordinary have been taken up, and 28,284 third preference and 44,413 ordinary are considered as paid. The full amount has been called on the others, and £3,609,500 has been paid.

Scarborough Electric Supply Company, Limited (37,569).—This company's return was filed on March 10th. 4,000 shares have been taken up out of a capital of £50,000 in £10 shares, and £9 per share has been called. £35,967 has been paid, and £33 is in arrears.

G. R. Blot & Co., Limited (54,459).—This company's statutory return was filed on February 24th. 30,693 shares have been taken up out of a capital of £75,000 in £1 shares, of which 14,400 are considered as paid. The full amount has been called, and £16,293 received on the rest.

CITY NOTES.

The Oriental Telephone and Electric Company, Limited.

The report of the directors for the year ended December 31st, 1897, to be presented at the fourth ordinary general meeting of the company, to be held at the Cannon Street Hotel, London, on Wednesday, April 27th, 1898, at one o'clock p.m., states that the revenue account shows a balance to credit of £10,909 18s., transferred to profit and loss, and including £829 14s. 3d. brought forward from 1896, and after deduction of £2,858 8s., representing the interim dividend of 4d. per share paid on October 30th last, there remains £8,681 4s. 3d. to be dealt with. The directors recommend the appropriation of this sum as follows:—£5,716 16s. in payment of a final dividend of 8d. per share, free of income-tax, making 5 per cent. for the year; £1,000 to extinguish the balance at debit of Colombo Exchange "suspense account"; £1,000 to reserve fund; and to carry forward £964 8s. 3d. The revenues of the Indian companies continue satisfactory. The Bombay Company has paid a dividend of 6 per cent., as against 5 per cent. for 1896, and has reserved from profits of the year a further sum of Rs. 30,000, which has been deemed desirable, in consequence of the continuance of the plague in that city and the unsatisfactory outlook in connection therewith. The Telephone Company of Egypt has declared, as hitherto, a dividend of 6 per cent. on its preferred shares, and the business still continues to develop. The China and Japan Telephone Company has paid its debenture interest, and makes fair progress both at Shanghai and Hong Kong. The electric lighting branch of the Company's business, carried on at several of its stations, has paid its way for the past year, and the current year opened with a fair amount of business in hand. In accordance with the articles of association, Mr. Lloyd and Mr. Frost retire at this meeting. Mr. Lloyd offers himself for re-election; Mr. Frost does not do so. The auditors, Messrs. Deloitte, Dever, Griffiths & Co., also retire, and offer themselves for re-election.

The Great Northern Telegraph Company of Copenhagen.

The working accounts for the year 1897 states that the net receipts during 1897, including the balance brought forward from 1896, amount to £332,474 11s. 2d., exclusive of interest on the investment of the reserve and renewal fund, which has been credited direct to this fund. Deducting £39,361 2s. 3d. for interest and authorisation of debentures, and £75,000 for interim dividends (already paid), there remains a balance of £218,113 8s. 11d., which the board proposes to distribute as follows:—Extra dividend (making the total dividend for the year 10 per cent.), £75,000; reserve and renewal fund, £77,777 15s. 6d.; pension fund of the staff, £2,777 15s. 7d.; directors' remuneration, £1,500; balance to be carried forward, £61,057 17s. 10d.

Indo-European Telegraph Company.

The ordinary general meeting of this company was held on Wednesday at Winchester House, Mr. J. Herbert Tritton presiding.

The Chairman, in moving the adoption of the report, expressed regret at the death of Mr. Earle. He said Mr. T. W. Andrews had been elected to the board in Captain Earle's place. The business compared very favourably with that of last year. The revenue had increased by £7,000. They had made last year certain concessions, and as a result they had not sustained any loss. It was probable there would be an increase in expenditure during the coming year—for instance, they were going to put down another wire between Warsaw and Odessa, permission having been granted by the Russian Government. They were also making some alterations in Persia. They had adopted the automatic Wheatstone apparatus with satisfactory results. The line had been working for 30 years, and there had been great improvements, but more were possible, especially in the wild country of the Caucasus. Mr. T. W. Andrews had been all over the line, and was satisfied with its condition. Replying to a question as to what would happen in the event of a war between England and Russia, the chairman said that he could not say what might happen to them, but it was agreed that their line was neutralised.

The report was adopted.

Calcutta Tramways Company, Limited.

At the ordinary general meeting held on Tuesday at the offices, 11, Abchurch Lane, Mr. E. C. Morgan, in moving the adoption of the report, said that the negotiations proceeding with the Calcutta Corporation last year for the use of mechanical traction had not, he was sorry to say, been brought to a satisfactory conclusion. In December last a proposal was received from the Corporation, but it was of such a nature as to render its acceptance impossible. A reply had been forwarded by the directors in which they stated that if the Corporation were prepared to agree that electric traction by the overhead trolley system should be applied to the Calcutta tramways, and any extension of the present system, and to give every necessary and reasonable facility for its introduction and use, the board would be prepared to recommend the shareholders to sanction an agreement by the company with the Corporation to the following effect:—(1) That the perpetual rights of the company to the tramways under the existing concession, unless purchased by the Corporation at 140 per cent. on the capital invested, be surrendered, and that, in lieu thereof, (2) the Corporation should have the right, on giving six months' previous notice in writing to purchase the tramways at the end of 42 years from January 1st, 1901, or at the end of any 10 years thereafter, on paying the company in cash 25 years' purchase of the average profits of the undertaking during the last three years of the term; (3) that the company would take at its own charge the necessary steps for applying electric traction to the tramways without asking the Corporation for any other concession or alteration of the existing concession, and would provide all the means necessary for that purpose, and pay Rs.30,000 annually by way of track rent throughout the term of the concession. This reply of the directors had been referred by the Corporation to a committee, which, so far as the board knew, had not yet met. If the Corporation continued to let the matter drag on, the directors proposed to represent to the Lieutenant-Governor of Bengal the actual state of affairs, and ask him to bring some pressure to bear on the municipal authorities, because it was impossible for the board to keep their offer open indefinitely. In the meantime their traffic had so far improved that they would be able to go on working the line satisfactorily with horses.

Submarine Cables Trust.

The report of the trustees for the year to 15th inst., to be submitted to the annual meeting of the certificate holders to be held in London on 27th inst., states that the revenue for that period, including the balance of £159 brought from the previous accounts, amounted to £23,156. During the past year the following coupons have been met:—Due April 15th, 1897, paid 10s. balance July 15th, 1897; due October 15th, 1897, paid £3 in full on due date; due April 15th, 1898, paid £3 in full on due date. The expenses of the trust amounted to £1,150, and the payments on account of the coupons to £21,976, together £23,136, leaving a balance of £20 to be carried forward. The trustees, in accordance with reasons given in last year's report, have sold the balance of their holding (£69,200) in Anglo-American Telegraph Company, Limited, deferred stock, and by a unanimous resolution of the trustees passed at a meeting called with express notice of the object, at which all the trustees were present in person, decided to invest the proceeds of such sale in the purchase of other securities of the character mentioned in the deed of trust. The certificate holders will be asked, in accordance with the provisions of the deed of trust, to confirm the resolution of the trustees and sanction such investments.

Apostoloff Automatic Telephone Parent Syndicate.—Mr. J. W. Cohen, of 13 and 14, Abchurch Lane, E.C., the liquidator of this syndicate, has declared a first dividend at the rate of 10s. in the £ upon the amounts of the respective debts of the creditors of the company whose debts have been admitted and proved. The liquidator states that there will be more than sufficient to pay creditors 20s. in the £, which payment he hopes to complete shortly.

Rand Central Electric Works, Limited.—This company announces that warrants for the dividend at the rate of 6 per cent. per annum for the period ended December 31st last have been posted to the shareholders registered in the books of the company as on March 31st.

Stock Exchange Notices.—The Committee has been requested to allow Chelsea Electricity Supply Company, Limited—Further issue of 8,000 ordinary shares, Nos. 32,501 to 40,500, to be quoted in the Official List.

TRAFFIC RECEIPTS.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending April 15th, 1898, were £3,278 4s. 4d.; corresponding period, 1897, £2,219 7s. 7d.; increase, £1,058 16s. 9d.

The City and South London Railway Company.—The receipts for the week ending April 17th, 1898, were £945; week ending April 18th, 1897, £845; increase, £100; total receipts for half-year, 1898, £16,771; corresponding period, 1897, £16,684; increase, £87.

The Cuba Submarine Telegraph Company.—The receipts for the month of December were £4,595, as compared with £3,818 in the corresponding month of last year.

The Dover Corporation Electric Tramways.—The receipts for the week ending April 16th, 1898, £180 7s.; total receipts to April 16th, 1898, £1,695 4s. 2d.

The Dublin United Tramways Company.—The receipts for week ending Friday, April 15th, 1898, were £3,338 9s. 2d.; corresponding week last year, £2,640 9s. 9d.; increase, £697 19s. 5d.; passengers carried, 588,181; corresponding week last year, 456,784; aggregate to date, £40,629 4s. 7d.; aggregate to date last year, £37,726 4s. 7d.; increase to date, £2,903; mileage open, 34 miles.

The Liverpool Overhead Railway Company.—The receipts for the week ending April 17th, 1898, amounted to £1,736; corresponding week last year, £1,478; increase, £258. 1898, includes Easter Monday. 1897, includes Good Friday and Easter Sunday.

The Western and Brazilian Telegraph Company, Limited.—The receipts for the week ending April 15th, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company Limited, were £2,030.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, April 18th.	Closing Quotation, April 20th	Business done during week ended April 20th, 1898. Highest.	Lowest
137,400*l*	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	...	...	100 104	100 —104	...	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	7 — 8	7 — 8	...	...
125,000	Do. do. 5% Debs. Red.	100	...	...	...	93 — 96	93 — 96	...	...
923,960*l*	Anglo-American Teleg., Ltd.	Stock	£2 9s	£2 13s.	3 %	61 64	59 — 62xd	61	...
3,038,020*l*	Do. do. 6 % Pref.	Stock	£4 18s.	£5 6s.	6 %	111½ 112½	109½ 110½xd	111	109½
3,038,020*l*	Do. do. Defd.	Stock	...	...	...	12¾— 13½	12 — 12½	12⅝	12⅜
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	7 %	7 %	16½ — 17	16 — 16½	16½	...
75,000*l*	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	...	...	112 —116	112 116	...	...
44,000	Chili Teleg., Ltd., Nos. 1 to 44,000	5	4 %	4 %	...	3 — 3½	3 — 3½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	8 %	...	185 —190	175 —185	...	...
918,297*l*	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	104 —106	104 —106	105½	105
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	2 %	...	1/16 — 3/16	1/16 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	7 %	6½— 7½	6½— 7½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	14½— 15½	14½ - 15½	15½	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 11	10 — 11	...	...
30,000*l*	Do. do. 4½ % Debs. Nos. 1 to 6,000 ..	50	4½%	4½%	4½ %	103 —106 %	103 —106%	...	...
60,710	Direct United States Cable, Ltd.	20	2½%	2½%	...	10⅞ — 11¼	10½ 10⅞xd	11 1/16	10⅞
120,000	Direct West India Cable 4½% Reg. Deb	100	...	...	...	99 —102	99 —102	..	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000 .. .	10	6½%	6½%	...	17⅞ 18¼	17¾ 17⅞xd	17¾	17½
70,000	Do. 6 % Cum. Pref.	10	6	6%	...	18½ 19½	18 - 19 xd	18½	1[illegible]
89,900*l*	Do. 5 % Debs., repay. August, 1899	100	5 %	5%	..	100 103	100 —103	...	..
1,302,615*l*	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4%	...	128 —131	127 130	...	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	...	18⅞— 19¼	18¼ — 18⅞	19	18⅞
25,200*l*	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5%	...	99 — 103	99 103	...	...
100,500*l*	Do. do. Bearer, 1,050—3,975 and 4,327—5,400	100	5 %	5%	...	100 — 103	100 —103	...	...
320,000*l*	Do. 4 % Deb. Stock	Stock	4 %	4%	...	128 —131	127 - 130	...	...
35,100*l*	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5%	...	99 - 103	99 —103	...	...
46,500*l*	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5%	...	100 — 103	100 —103	...	...
300,000*l*	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1900	100	4 %	4%	...	102 —105	102 —105	102	...
200,000*l*	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4%	...	107 —110 %	107 —110%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	...	11⅝ - 12¼	11½ - 12	11⅝	...
180,042	Do. do. 6 % Pref.	10	6 %	6%	...	17½ - 18	17½ - 17⅞	17⅞	17½
150,000	Great Northern Teleg. Company of Copenhagen	10	10 %	10%	10 %	29½ - 30½	29½ - 30½	...	...
160,000*l*	Do. do. do 5 % Debs.	100	5 %	5 %	5 %	100 —103	100 - 103	...	...
97,000	Halifax and Bermuda Cable Co., Ltd., 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	95 —100	95 —100	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10%	...	52 — 55	52 — 55	...	...
100,000*l*	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6%	...	106 -109	106 —109	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	4 %	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5½%	5½%	6 %	5½ 6	5½— 6	5 11/16	5½
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 18	16 — 18	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5½ 6	5½ — 6	5½	...
1,329,471*l*	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½ %	100 —105	100 —105	102½	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	⅝— ¾	⅝ ¾	9/16	...
100,000*l*	Pacific and European Tel., Ltd., 4 % Guar Debs, 1 to 1,000	100	4 %	4 %	...	105 108	105 108	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	8 — 9	8 9	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	140 - 145	136 141xd	139	..
58,000	United River Plate Teleph., Ltd.	5	4 %	5 %	...	4 — 4½	4 — 4½	...	...
146,733*l*	Do. do. 5 % Debs.	Stock	5 %	...	...	105 —108	105 —108	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	*nil*	...	3½ — 4½	3½ 4½	...	...
213,400*l*	Do. do. do. 5 % Debs.	100	5 %	5 %	...	99 102	99 -102	...	...
64,269	Western and Brazilian Teleg., Ltd.	15	3 %	2 %	...	12 — 12½	11⅞ — 12¼	12 3/16	12
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	...	7⅞ — 8¼	7½ - 8	7½	...
33,129	Do. do. do. Def. Ord ..	7½	1 %	*nil*	...	4½ — 5	4½ — 4⅞	...	...
389,521	Do. do. do. 4 % Deb. Stock Red....	Stock	...	...	...	106 —109	106 —109	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅞%	1 %	...	½ — ¾	½— ¾	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	7½ — 8	7½ — 7¾	7 7/16	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	5 — 7	5 — 7	...	...
80,000*l*	Do. do. 5 % Debs. No. 1 to 1,600 ...	100	5 %	5 %	...	105 — 108	105 —108	...	...
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7%	...	105 —110	105 —110	...	...
160,100*l*	Do do 6 % Ster. Bonds. ...	100	6 %	6%	...	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	1895.	1896.	1897.	Closing Quotation, April 18th.	Closing Quotation, April 20th	Highest.	Lowest
30,000	Charing Cross and Strand Electy. Supply	5	5 %	6 %	7 %	13½ - 14½	13½ — 14½	...	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	...	...
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	6 %	10¼ - 10¾	10 — 11	10 7/16	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	4½%	4½%	4½%	115 —117	115 —117	...	...
50,000	City of London Elec.Lightg. Co., Ltd., Ord. 40,001—90,000	10	5 %	7 %	10 %	26 — 27	26 — 27	26¾	26¼
10,000	Do. do. Prov. Certs. Nos. 90,001 to 100,000 £5.	10	...	...	...	19 — 20	19 — 20	...	...
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17½— 18½	17½ - 18½	18	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	129 —134	129 —134	...	...
30,000	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—30,000	10	*nil*	*nil*	*nil*	14¾— 15¼	14½ - 15	14¾	...
20,000	Do. do. do. 6% Pref., 40,001—60,000 ...	10	6 %	6 %	6 %	15½— 16	15½— 16	16	15½
17,400	Edmundsons Elec. Corp., Ltd., ord. shares 1—17,400 ...	3	...	...	...	3¼— 3¾	3¼— 3¾	...	...
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5			4 %	10½— 11½	10 — 11	10⅞	10⅝
10,000	Do. do. 7 % Cum. Pref. ...	5	7 %	7 %	7 %	11½— 12	11 — 12	...	...
62,400	*Metropolitan Electric Supply, Ltd., 101 to 62,500 ...	10	4 %	5 %	6 %	19½ - 20½	18 — 19	19⅜	18⅜
220,000*l*	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½ %	117 —121	117 — 121	117	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	2 %	4 %	6 %	20 — 21	19½— 20½	20⅜	20
31,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord.	5	7½%	10½%	14½ %	17½— 18½	17½ — 18½	18⅜	...
20,000	Do. do. 7 % Pref., 20,001 to 40,000	5	7 %	7 %	7 %	10 — 11	10 — 11	...	..
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	4 %	107 —110	107 —110	...	..
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2½— 2¾	2½— 2¾	2⅝	2 9/16
79,900	Westminster Electric Supply Corp., Ord., 101 to 80,000 ...	5	7 %	9 %	12 %	16½ — 17½	16½— 17½	17⅜	16¾

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation April 18th.	Closing Quotation, April 20th.	Business done during week ended April 20th, 1898 Highest	Lowest
30,000	British Electric Traction	10		...	...	16 — 16½	15½ — 16½	16½	...
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	2½%	*nil*	*nil*	1¾ 2	1⅝ 1⅞	1¾	1⅝
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	*nil*	4 %	2¼— 2½	2¼ 2½	2¼	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	..	...	...	110 114	110 - 114	...	...
50,000	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	102 —105	102 —105	103½	102½
19,894	Central London Railway, Ord. Shares	10	...	...	...	10¼— 10¾	10¼ — 10¾	10¾	10½
129,179	Do. do. do. £6 paid	10	...	...	...	6¼— 6¾	6¼ — 6¾	6½	...
59,254	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1½— 2	1½— 2	...	...
67,680	Do. do. Def. do. £5 pd. ...	...	...	...	...	4⅝— 4⅞	4⅝— 4⅞	...	...
690,000*l*	City and South London Railway	Stock	1 1/16%	1 9/16%	1⅞%	68 — 70	68 — 70	69⅞	68½
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	nil	...	...	2 — 2½	2 — 2½	...	...
99,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 99,261	5	5 %	5½%	...	2¼ - 2¾	2¼ 2¾	...	...
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5½%	...	4 — 5	4 — 5	...	...
194,023	Do. do. do. 4% Deb. stock Red. ...	100	.	...	...	103 —105	103 —105	...	...
119,980	Electric Construction, Ltd., 1 to 119,980	2	5 %	6 %	...	2⅝ - 2⅞	2⅝ - 2⅞	2 13/16	2¾
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 ..	2	7 %	7 %	...	3⅛ 3⅜	3⅛ - 3⅜	3 3/16	...
111,100	Do. do. 4% Perpetual 1st Mort. Deb. Stock	Stock	...	...	...	106 —108	106 —108	...	...
91,196	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	.	...	...	½ - ¾	½ - ¾	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	.	...	...	⅜ - ⅝	⅜ - ⅝	...	...
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	10½%	7 %	7 %	9 — 11	9 — 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	8 %	10 %	12 %	22 — 23	21½— 22½	22¾	21½
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½ - 19½	18½ — 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½%	110 - 115	110 —115	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	21 — 22	21 — 22	21 9/16	21¼
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	..	...	...	102 —106	102 —106	...	...
87,500	†Liverpool Overhead Railway, Ord.	10	2⅞%	2⅞%	3¼ %	10 1/16 10 3/16	10 1/16 10 3/16	...	...
18,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15¾— 16¼	15¾ — 16¼	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	15 %	15 %	35 — 38	35 — 38	36½	36
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	...	...	135 —138	135 —138	137	136¾

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

* Birmingham Electric Supply Company, Ordinary £5 (fully paid) 10¾.

House-to-House Company, 4½% Debentures of £100, 106—108.

Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 16½—17; 1st Preference Cumulative 6 %, £5 (fully paid), 8—8½. Debentures, 105—107. Dividend, 1897, on Ordinary Shares 10 %.

* From Birmingham Share List.

London Electric Supply Corporation, £5 Ordinary, 3½—4.

* T. Parker, Ltd., £10 (fully paid), 15½.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8—8½. Dividend for 1896—6 %.

Bank rate of discount 4 per cent. (April 7th, 1898).

SOME RECENT IMPROVEMENTS IN ACCUMULATORS AND THEIR APPLICATION TO TRACTION ON COMMON ROADS.*

By J. T. NIBLETT.

(*Concluded from page* 522.)

Probably no individual type of secondary cell will be found to answer for the very varied and ever-increasing purposes to which this class of apparatus is now being applied, and it follows that some form of specialisation must occur.

For central electric light stations, or for such work as levelling up the loads on electric tramways, where moderately constant work is required, a battery whose weight is large, or whose bulk is great, may be safely used. For self-contained electric light installations, weight and space occupied by the battery is of some moment; and where intermittent charging only is resorted to, absence of local action is desirable. The battery, under these circumstances, may have to stand idle for considerable periods, and it would not do for it to lose its charge while thus waiting. For traction purposes, where charging each day, or even several times per day, may be practised, local action is not such an objection, and the loss sustained thereby may be neglected. For some forms of vehicles, such as broughams, dog-carts, tricyles, and the like, which may be only occasionally required, and may have considerable waits between the periods of use—waits which may extend over days and even weeks—the absence of local action is essential. A fifth class of apparatus in which storage batteries are now playing a most important part is that of self-contained portable electric lamps, so largely used for medical and other purposes. In this case absence of local action, lightness, and compactness, together with great mechanical strength, is absolutely essential. In many cases such lamps are required to hold their current for many months, and this can only be obtained where there is little or no local action. Again, as the plates used in these small batteries are of small dimensions, the form of construction may be such as is not permissible in any other class of apparatus.

"Local action," it may be explained, is the term given by electricians to that frittering away of energy which frequently occurs while a cell is at rest. This wasting is experienced in nearly all forms of primary cells, and in many types of secondary cells. In the case of secondary cells it is due to the establishment of voltaic couples between the metal support and molecules of lead salt when in the presence of sulphuric acid and water. This troublesome complaint leads to the destruction of the peroxide and the formation of sulphate of lead, and it not only reduces the capacity of the cell, but it frequently leads to its ruin. In the Planté cell, with its large metal surface and thin layer of active material, local action is far more prevalent than in the Faure, with its comparatively smooth and small metal surface and thick masses of lead oxide.

To accurately test a storage cell is no easy matter, and unless great care is exercised very fictitious results may be obtained. A laboratory test as a preliminary may be very well, but for practical results such tests should not be relied upon. Testing under actual working conditions, and for an extended period, is the only reliable means of ascertaining the capabilities of cells intended for traction work.

To obtain a capacity test by discharging through a constant resistance, noting the fall of current and potential, is quite easy of manipulation, and is much used when comparative tests only are required. A more reliable method, however, is to discharge at a constant current, stopping when a prescribed fall of potential occurs. For traction work, where a uniform output for a given number of hours is required, it is very much the best plan to take the capacity of the cell in terms of watt-hours. Under these circumstances the discharging rate in watts must be kept constant. Testing for local action, noting the effect of high rates of charge and discharge, are more serious matters, and require careful manipulation.

The internal resistance of a cell depends upon the total active surface area of the opposing plates, the nature of the electrolyte and its condition and temperature, and the distance between the plates.

There are many methods for determining the internal resistance of batteries. If the cells be as nearly as possible of the same dimensions, capacity, and state of charge, then two cells may be placed in opposition (poles of like polarity joined together) and their joint resistance may be measured by the ordinary Wheatstone bridge method. If the cells be exactly similar, then one-half the resistance indicated will represent the resistance of each cell.

A far more reliable and accurate means of ascertaining the internal resistance of cells is the differential method, as expressed by the following formula:—

* Abstract of paper read before the Self-Propelled Traffic Association, Liverpool Centre, on March 29th.

$$r = \frac{D - D'}{D} R$$

where r is the resistance required, D and D′ are the values of deflections obtained on a high-resistance sensitive galvanometer, and R expresses the value of a small but known resistance, used as a shunt.

When making tests by this method, a high-resistance potential galvanometer should be used, and one whose scale readings are either of uniform value, or whose tangents are strictly proportional to the angle of the deflections. To determine r we have to obtain a deflection, D, when the cell is on open circuit, and then obtain another reading, D′, when the cell is shunted by R, then by the formula given the internal resistance may be ascertained. The shunt resistance, R, should be small in comparison with the galvanometer coils. Good results may be obtained if the resistance of the galvanometer is, say, 5,000 ohms, and the shunt not more than 1 to 5 ohms.

The total current, or energy capacity, of a storage cell is the maximum amount of current or electrical energy which it is capable of storing, without reference to any loss that may occur by it being allowed to remain idle, nor does it take into account the rate or manner of its discharge.

The working current, or energy capacity, is that amount of current, or electrical energy, which can be obtained from the cell at any specified rate of discharge. When estimating this, the discharge is always stopped as soon as the cell ceases to do useful work. The working capacity of storage cells may vary between very wide limits.

The absolute current, or energy efficiency, of an accumulator cell is the ratio between that amount of current or energy put into it and that obtained by a total discharge, without reference either to its rate of charge or discharge, or to the time allowed to elapse between these operations.

The working current, or energy efficiency, of a storage cell is the ratio between the value of the current or energy expended in the charging operation, and that obtained when the cell is discharged at any specified rate.

In a lead storage cell, if the surface and quantity of active material be accurately proportioned, and if the discharge be commenced immediately after the termination of the charge, then a current efficiency of as much as 98 per cent. may be obtained, provided the rate of discharge is low and well regulated. In practice it is found that low rates of discharge are not economical, and as the current efficiency always decreases as the discharge rate increases, it is found that the normal current efficiency seldom exceeds 90 per cent., and averages about 85 per cent.

As the normal discharging electromotive force of a lead secondary cell never exceeds 2 volts, and as an electromotive force of from 2·4 to 2·5 volts is required at its poles to overcome both its opposing electromotive force and its internal resistance, there is clearly an initial loss of 20 per cent. between the energy required to charge it, and that given out during its discharge. The normal discharging potential seldom exceeds 2 volts, and as this pressure is continually being reduced as the rate of discharge increases, it follows that an energy efficiency of 80 per cent. can never be realised. As a matter of fact, a maximum of 75, and a mean of 60 per cent., is the usual energy efficiency of lead-sulphuric-acid storage cells.

What the ordinary commercial man will be most interested in are tests which give him reliable information at to the cost of the up-keep and life of the battery; also data as to the initial cost, and as to the mode of it doing its work. Such information cannot be obtained in a laboratory, and has to be obtained by actual trials.

We have already shown that no one type of cell is capable of doing all the very varied kinds of work accumulators are now called upon to do. Before building up a battery, it is, therefore, wise to ascertain definitely the class of work it is intended to do, and construct accordingly.

Perhaps a short description of one or two of the present applications of secondary batteries for propelling motor cars will best serve to show the usual method of practically dealing with them.

In this country, the vehicles put upon the London roads by the London Electrical Cab Company may be looked upon as a pioneer enterprise, and its development will be watched with the closest interest by all those concerned.

The battery used is a special Faure-King type, and is supplied and maintained under contract by the E.P.S. Company. The plates used are thin, and to prevent the active material being "washed" out, the surfaces are covered with a layer of silicated asbestos held in position by thin sheets of perforated vulcanite. The whole of the cells are mounted in a tray, which is slung underneath the cab by four suspending links. These links are supported by springs under compression, and, as an extra safeguard against vibration, the ordinary carriage springs again support the battery tray. The total weight of the battery is 14 cwt. The total weight of the complete vehicle, including driver and its full complement of passengers, is approximately 30 cwt.

The battery consists of 40 cells, and, as previously stated, it weighs complete about 14 cwt. The capacity of each cell is 170 ampere-hours at a normal discharging rate of 30 amperes. The electrical pressure at the battery terminals is 80 volts. Thus the battery has a storage capacity of 13,600 watt-hours at a discharging rate of 2,400 watts, or about 3¼ electrical H.P. When fully charged the battery is said to be able to run the cab a distance of 50 miles over the ordinary London streets. The mean current drawn from the battery when on a level road is 30 amperes, on rougher road from 40 to 45 amperes is required, while climbing steep gradients the cells are called upon to give as much as 120 amperes. The motor, although constructed to give a normal output of 3 H.P., is capable of a maximum of 4 H.P. without unduly heating, so that a margin of 25 per cent. is obtained for eventualities.

In New York some electric hansom cabs have recently been put on the roads. The cabs are made by the Electric Carriage and Waggon Company. In some respects they resemble our London hansoms, but the vehicles are fitted with four wheels instead of two. The back wheels are used for steering and the front for driving. The chief feature of this cab is that two motors are used, one for each of the driving wheels. By employing two motors, various variations of speed can, of course, be obtained by running them in parallel or series; and by having each wheel under separate control, quicker turning power of the vehicle can probably be obtained. This is doubtless the object the designers of the New York hansoms had in view, although it is very problematic if any very real advantage is gained by such an arrangement, unless it be used in heavy vehicles such as coal lorries.

The New York cabs are said to weigh 3,000 lbs. Each motor develops 1½ H.P. with 75 volts, and at a speed of 800 revolutions per minute. This represents a speed of 8 miles per hour for the vehicle. The battery used consists of 44 cells placed in trays containing 11 cells in each. The four sections are placed in a receptacle in the rear of the vehicle. No loose terminals are used, contact between the sections and other parts being established by means of plates and contact springs. Each cell contains three plates of the chloride form, and they have a useful capacity of 100 ampere-hours when discharged at 21 amperes—the normal rate. The whole battery weighs 900 lbs. Speeds varying from 4 to 15 miles per hour can, it is said, be obtained with varying battery discharges of from 12½ to 40 amperes.

L'Electrique Société Anonyme of Brussels have recently introduced an electrically propelled dog-cart. In this vehicle, and according to the usual practice, the battery cells are placed underneath the seats. 48 cells of the Planté type, having a capacity of about 75 amperes, are used. The total weight of the battery is 850 lbs. The motor is wound with the coils of the fields and armature in series, and it weighs about 260 lbs. A speed of 1,750 revolutions per minute is attained with a battery discharge of 21 amperes. The motor is connected to the driving wheels by reducing gear and chain bands, while differential movements of the driving wheels are obtained by the use of an intermediate clutch.

The dog-cart has four wheels, and is made to seat four passengers, including the driver. The carriage, including batteries, motor, and gearing, weighs, complete, about 2,500 lbs. The maximum speed is 10 miles per hour, and at this rate it is stated a distance of from 40 to 50 miles can be travelled with one charge of the battery.

As a means of regulating speed in a self-contained motor car, actuated by batteries, two methods are at present in vogue. The first is by splitting up the battery into sections by a suitable commutating arrangement, thereby putting the sections either in series or parallel, as required. The objection that may be raised to this plan is that the cells may be unequally discharged. A more practical method, and one adopted on the London cabs as explained, is using the battery as a complete unit, and obtaining the various speeds by commutating the coils in the fields and armatures of the motor. It is possible that some method may be adopted, by which the motor may be run at constant speed, while the speed variations in the car are obtained by suitable gearing. According to present practice the motor, when starting the vehicle, is running slowly, and therefore in its most inefficient condition. If the constant speed idea were utilised, the motor might be of smaller power, and it could also be run at a higher and more uniform efficiency.

For the Paris electric cabs Messrs. De Puydt & Poncin, of Birkenhead, are supplying some special motors, which appear to compare favourably with those used in our London cabs. It is stated that these motors, which weigh only about 170 lbs., will develop 8·5 H.P. for 20 minutes, or 4·5 H.P. for continuous running, without any undue heating or sparking. The normal speed is given as 1,700 revolutions per minute, and a commercial efficiency of 81 per cent. is said to be obtained.

As regards the prevailing method of connecting the motors to the driving wheels by the system of gearing, probably with our present knowledge it is the best that can be done. Some way of dispensing with gear and running direct will probably be devised. If this could be done, not only would it lead to great economy in working, but it would greatly add to the comfort of the passengers. When riding, for instance, in one of the London electric cabs, in addition to the hum of the motor, which is not at all unpleasant, one's ears are assailed by the clanking and rattling of the gearing and chain. If direct running or some more silent method of gearing could be devised, it would be a desirable improvement. Improvements in the wheel tyres will doubtless be made, and such improvements would tend to reduce road friction, and thereby save power or give increased speed. They would also reduce the depreciation in the working parts and give the battery a better chance.

Methods of electric locomotion on common roads present enormous possibilities. Electrically-propelled omnibuses, broughams, dog-carts, and light parcel delivery vans may now be seen running along our thoroughfares. There is no reason why the same plan should not be adopted for driving vehicles for the cartage of goods generally. In the latter case appearance need not be studied to such an extent as in the passenger-carrying conveyances; therefore, in this case the electrical engineer would have a freer hand, and better results might be anticipated.

Methods of recharging will have to be seriously considered. There seems no reason why, in all our large towns, charging centres should not be established. The ordinary cab is stationary a great part of the day, and there seems no valid reason why the charging operation should not be rendered so simple that a cabman of ordinary intelligence could easily perform it. With an "in-and-out" electricity meter placed on the vehicle in a convenient position on the battery circuit, the driver could see at a glance how much energy had been put in and taken out of his battery; therefore, would know when a recharge is required; also, when charging, by reference to the meter, he could see when his battery is satisfied. Such a measuring instrument, with the small range required, need not be an expensive addition. A supply system, worked on the penny-in-the-slot principle, could easily be arranged. The battery, of course, would not be removed, but would be connected up to the source by suitable flexible mains. Under these conditions the driver could buy his supply of electricity much in the same way as a carman can now buy fodder for his horses.

The form of battery required for driving a self-contained motor car over common roads may need to be of a different nature to that required in cars running on a permanent way, where the tractive force remains more nearly constant, and where there is less jolting and vibration. Possibly some form of mechanically solid cell with a Faure type negative and a Planté type positive element will fulfil the requirements.

As to the probabilities of the self-contained electric motor car comparing favourably with horse haulage, this will entirely depend upon its economic aspect. However great the convenience of electric haulage, however great its reliability, ease of manipulation, sanitary aspect, and general convenience, the question as to whether it is best or not has still to be satisfactorily answered. In its present experimental stage trustworthy figures of the daily or weekly cost of up-keep cannot be expected. It is only by taking the average expenses incurred during months or years that anything like an accurate estimate can be arrived at. The initial cost and cost of maintenance of the batteries employed will, we believe, be the controlling factor. Whatever turn the idea of electrically propelled motor cars may take, it must necessarily always involve the use of some apparatus for storing and giving out electrical energy.

The modern secondary battery leaves very much to be desired, but still there are several very good batteries for this purpose obtainable, and these may serve to tide the electric traction man over the period intervening before the advent of the ideal cell which we all wish to see.

ELECTRIC LIGHTING OF MAIL COACHES.

Some interesting particulars have been published concerning the electric lighting of German mail coaches. The *Elektrotechnische Zeitschrift*, which discusses the subject in a recent editorial, states that the 15-volt lamps employed for this purpose are of 12 candle-power and are replaced by others after being in service for 200 hours, notwithstanding the fact that the filaments are still intact. The glass bulbs are tolerably larger in order to delay the blackening of the bulbs as much as possible. As the lamps are arranged in suitable positions before the Post Office officials, a greater illumination of the working places is obtained than with intensive gas burners suspended from the roof behind the sorters.

In the case of the 12-metre mail coaches a battery of 32 cells of the Boese type is used, whilst the coaches 10 metres long are equipped with 16 cells arranged in four boxes. The weight of the 16 cell battery, which has a capacity of 120 ampere-hours, is 184 kilogrammes; but in a newer type with the number of plates reduced from 9 to 7 per cell, the weight has been diminished to 172 kilogrammes.

At the present time the re-charging of the batteries is effected at 18 depôts, and three further charging stations are now being erected. Where the railway administration possesses a charging station of its own, the batteries are connected in series of 16 cells, or from boxes to omnibus bars between which there exists a pressure of 45 volts. If the current is obtained from municipal supply works, the pressure as a general rule ranges from 100 to 110 volts, and in some cases, as at Breslau, it amounts to 220 volts. In these instances a lot of useful energy would be dissipated in resistances unless a larger number of cells were simultaneously charged in series. The batteries delivered at a charging station are, however, not all in the same condition, and for that matter it would be impracticable to select and group them according to their electrical condition. As a result the inconvenience arises that highly exhausted batteries do not receive a sufficient re-charge, whilst those slightly exhausted receive too much; hence the life of the plates is injuriously affected.

In order to overcome this difficulty, Post-Inspector Argrath has suggested a method whereby each battery, where the pressure between the bus bars at a charging station is too high for the purpose, only receives a charge of current at a pressure of about 45 volts, or at that pressure required by the condition of the battery. This object is attained with a current at a pressure of 100 volts by the employment of a middle bus bar between which and the outer bars the batteries are connected in a manner similar to the Edison three-wire system. If the number of batteries on both sides of the middle bar is the same and the batteries are all in the same condition, only about 5 volts has to be absorbed in each charging conductor by the rheostats, which must be used in any case for each battery. Should, however, these conditions not be fulfilled, the pressure on one side of the middle bar will be higher than that on the other unless a special means of artificial compensation is provided. This is now attained by the use of a main rheostat which can be arranged on one or the other side of the system. This rheostat is placed parallel to the batteries on the side of higher pressure, and so arranged that the requisite compensation is effected. When the current available has a pressure of 200 volts, it is provided that the above arrangement shall be doubled.

It has been possible to ascertain some figures concerning the cost of lighting 627 mail coaches in this manner from nine charging stations, which have been in operation for over a year. After providing 4 per cent. for interest on capital and 10 per cent. for redemption (20 per cent. for the batteries), the lamp hour with a 12 candle-power lamp works out at 3·52 pfennige (·42d.) This compares with 4·53 pfennige (·54d.) in the case of gas lighting, showing a difference of nearly one pfennig in favour of electrical illumination.

ELECTRICITY IN CHEMICAL WORKS.

Although power in chemical works does not occupy so important a position as it does in other industries, for instance in the textile industry, where the whole of the transformation is effected by mechanical means, it, nevertheless, plays an important part in numerous subsidiary operations, such as grinding, pulverising, pumping, compressing air or other gases, actuating cranes, hauling, &c. And so great is the competition in all chemical manufactures, that it becomes a matter of prime importance to determine what shall be used as a source of energy, whether steam, gas, electricity, or water. At a recent meeting of the Manchester Section of the Society of Chemical Industry, Dr. Bowman examined this question to some extent, but we do not think that he has dealt with the subject so exhaustively as it deserves. He has much to say regarding the use of steam, and gives some very interesting figures respecting the efficiency of this agent. The efficiency of the gas engine is also considered briefly, and data are given, but electricity is dismissed as impracticable, and those who read the paper are not likely to be convinced because the statement is merely supported by Dr. Bowman's opinion. If the paper were to be a useful contribution to an important subject, comparisons between gas, steam, water, and electricity should be properly drawn, data should be given for each source of power, which should be entirely comparable. This Dr. Bowman has failed to do entirely, and the matter is in the same position as it was before he touched it.

Of course, it is advisable to avoid mechanical operations as much as possible in chemical works, and when they are necessary the machinery should be simple. Chemical works abound in dust, dirt, gases, and liquids which injure the machinery, and we agree with Dr. Bowman that it is advisable to use the very simplest forms of engine which can stand the wear and tear to which they have to be subjected. Then again, chemical works usually cover a large area of ground, and operations are rarely simultaneous, and the general practice is to rely upon small independent engines—a very bad plan indeed, for even under the best conditions the steam engine is a wasteful machine. In large chemical works power has to be distributed over miles of pipes exposed to the condensing action of the air, which of itself accounts for a very large percentage of inefficiency. Indeed, Dr. Bowman himself admits a doubt whether, in many of the small engines, more than 5 per cent. of the power originally in the fuel is actually used. In addition to all this, steam is not a good vehicle for obtaining power, because it can never be a perfect gas unless absolutely dry, and the moment it begins to expand—which it must do if worked economically—it ceases to be a dry gas.

Although these considerations seem to point directly to electrical distribution as the most economical method of working a chemical factory, Dr. Bowman contends that it is almost impossible, for dust and gases have a marked effect on conducting wires and electric motors. He says that lead-covered wires, even with a coating outside, are eaten through in a short time, and except where motors can be enclosed in special rooms or boxes, and conducting wires kept out of reach of corrosion, electric distribution of power is not suitable for chemical works. It seems to us that this form of distributing energy should not be so jauntily dismissed. It is quite true that there are many difficulties in the way; a manufacturer does not like to risk having his installation worn out by corrosion shortly after he has laid it down. But have we probed all the possibilities? We wonder in how many instances electric distribution has been tried with such disastrous consequences as Dr. Bowman seems to imply would necessarily follow. Surely it is possible to place the generating plant in some part of the works, which, as Dr. Bowman says, are always large, where it can be safe from corrosive gases; or the construction of a special building, with double doors and windows, ought not to be impossible. If either of these two courses can be successfully observed, then the problem of protecting the wires ought not to be insurmountable, whilst the motors themselves could surely be enclosed in special rooms or boxes. We do not think that Dr. Bowman has made out a bad case against electric distribution in chemical works, for he has simply dismissed it with a meagre statement of difficulties and a strong statement of his own opinion.

On the other hand, he concludes his paper with a remark that electric distribution can best be applied in chemical works to lighting. He says that at least twice the quantity of light can be obtained by the arc lamp than by burning gas or even Wells's light, and, finally, he says that to compete with steam as the motive power, electricity must be supplied at not more than ½d. per Board of Trade unit, or half this cost to compete with gas. These latter, however, are statements which are entirely unsupported by comparative data, and we are invited to accept Dr. Bowman's opinion. Thoughtful people will require a good deal more than that, and we hope that the attention of electrical engineers will be aroused by these statements, and that some comparative data may be obtained from an actually working installation.

As regards electro-chemical processes, the conditions are somewhat different from those obtaining in chemical works generally; but we shall await with interest Dr. Bowman's promised paper on the subject. We hope that it will be more copiously illustrated with facts than his present paper.

ELECTROLYTIC TREATMENT OF SLIMES.

If we were asked what among the applications of electricity is the one which seems the most remarkable, there would be a majority in favour of wireless telegraphy, which, however, has not yet come into general practice, and is only just emerging from the experimental stage.

The admirers of X rays, and those of the utilisation of the Niagara Falls energy, would be numerous; but for an electro-chemist, and especially an electro-metallurgist, the solution of the problem of the economic extraction of gold from slimes, that clayey mass through which no solution can percolate, looks as if it were most decidedly the greatest achievement accomplished in the electrical world.

Mr. Charles Butters in his valedictory address to the Chemical and Metallurgical Society of South Africa, of which he is the president, described the treatment of the slimes, in which, up to the present, large treasures were buried and considered as lost for ever.

Ten years ago, the great question was to extract the gold from the heaps of tailings which were lying as barren sands. To-day, it is the turn of the slimes, with this difference, that gold can be recovered from tailing solutions by means of zinc, although not so well as by the electric current, while the precipitation of gold from an extremely weak cyanide solution is quite an easy operation by electrolysis, but cannot be effected by zinc shavings.

This question is of so much importance to the mining industry that it marks an epoch in the metallurgical world that is well worthy of consideration.

It was only the production of such gold-bearing material as tailings, and the enormous quantities in which they were produced that brought the necessity of the treatment of tailings before the public in a very marked degree; and in the same manner the enormous production of slimes, their storage and value, demanded an economic method of treatment.

It was found that if they were allowed to be deposited in dams for a comparatively short time, even for a few days, decomposition of the pyrites took place, and the question of their treatment directly as received from the mill thus became a subject for study. These researches have successfully resulted in the working out of a practical method which consists essentially in the coagulation of the slimes in battery water, by means of lime, their concentration by spitzkasten, and final settlement in continuous overflow vats or pits. The coagulation of the particles in clayey soils in agricultural operations by the addition of lime has long been known and practised, and the use of lime for the flocculation and precipitation of the slimes suspended in battery pulp is but another adaptation of the same principle.

General Features of the Slimes Problem.

"In slimes, says Mr. Butters, we found a substance which could not be backed, or through which the solution would not percolate, but which we were obliged to wash per decantation. With decantation, the washing of the material takes place by dilution, one wash does not displace another wash, but simply mixes with it; and since the amount of solution or wash which this clayey mixture retains is from 40 to 50 per cent., the amount of dilution necessary to extract a satisfactory percentage of the gold necessitates the use as washes of from 6 to 8 tons of liquid per ton of slimes treated. Consequently, in sand treatment, where 4 dwts. are extracted from 1 ton of sand, with 2 tons of solution, the average value of the solution is 2 dwts.; while in slimes treatment, if 4 dwts. are extracted from 1 ton of slimes, the average value of the solution would be 12 grains. In the case of the sand, the value of the first solution leached off might easily be 6 dwts., while with slimes, the first solution would probably not be over 1 dwt. The result is, that in the latter case you have a very large volume of much diluted solution to deal with, and at the same time the slimes retain a moisture nearly their own weight of solution. In order, therefore, that slimes may be economically treated, it is necessary to use a very dilute solution of cyanide, so that too much cyanide may not be lost with the residues when discharged, and that too much may not be decomposed during treatment. How to obtain gold from this solution presents an entirely new problem to the metallurgist. Dilute solutions containing from 0·01 to 0·001 per cent. of cyanide, and from 6 to 24 grains of gold per ton, had not hitherto been successfully handled."

The Solution of the Gold.

"The dissolving of the gold in fresh slimes is a comparatively simple matter in comparison with the dissolving of the gold in accumulated slimes. In fresh slimes, there are usually very few reducing or oxygen-consuming compounds, while in accumulated slimes there can be various substances which will absorb oxygen; and if we wish the cyanide gold-dissolving solution to act, oxygen must be present. In old slimes, decomposing organic matter, arising from different sources, as well as the various products of the decomposition of pyrites, are always present; all these substances have, in common, the property of absorbing oxygen in a more or less degree. Therefore, during the operation of dissolving the gold in old slimes, oxygen must be constantly supplied.

The principal of oxidation of the reducing substances in slimes by means of aeration, was put into practical use by Mr. W. A. Caldecott, who has given the reasons that render this operation specially necessary in the treatment of accumulated or acid slimes. This operation was first carried out at the Robinson slimes plant by the introduction of atmospheric air through a perforated pipe in the bottom of the vat containing the charge of pulp undergoing agitation. After preliminary oxidation of the pulp had taken place, in order to lessen cyanide consumption, cyanide was added, and aeration continued. It was found that the gold dissolved as readily by this method as in the case of fresh slimes."

The Precipitation of the Gold.

In the foregoing operations the ordinary methods of metallurgy have been reversed. In every other metallurgical operation, successive concentration is the means by which we finally obtain the metal for which we are working; but in this case we pursue the opposite course. The final operation of winning the gold takes place from a grade of material worth less per ton than was the material with which we started. We have simply changed the physical conditions of the gold from the state of a solid into that of a liquid, and it is with this diluted liquid that we have now to deal. Precipitations of metals from solutions present many curious and interesting problems, and one of these is, that with the same re-agents, it is very much more difficult to produce perfect precipitation from a very dilute solution than from a concentrated solution.

In electrolytic precipitation we have a different set of laws governing the electro-deposition of metals from those which operate in chemical precipitation. In the course of our experiments on the precipitation of dilute cyanide liquors, we have tried many methods of precipitating solutions containing 6 to 12 grains of gold per ton, but failed completely with such dilute liquor; whereas the same methods acted perfectly on 5 dwts. or 10 dwts. solution. With a solution of gold down to 6 dwts. per ton, which is about one part in 100,000, it would be natural to think if it was one part in 100,000, or one part in a million, or one part in 10 millions, there would not be a very great difference in the resistance of such very minute proportions of dissolved gold to precipitation, whether by electromotive force or by chemical reaction; but the difference between the action of a liquid containing 6 dwts. per ton and one carrying 6 grains per ton is most marked, both in chemical precipitation and in electrolytic deposition. In general, we have found that we could effect the precipitation of the gold in these dilute solutions best, and most economically, by means of electrolysis.

The principal points in electrolytic precipitation that it is desirable to study are the amount of current per square foot of anode and cathode, and the time the current is exerted, taken in conjunction with the value of the solution. One of the first points requisite in the electrolytic deposition of gold is that the liquor shall contain no solid matter; that is to say, that it will be absolutely clear.

The liquor from accumulated slimes contains a considerable amount of iron and lime salts in solution, and the settlement of the fine clayey particles is retarded. This may, possibly, also be due to the organic matter which it contains.

Other substances in the liquid which affect the surface of the cathode are those salts which are in solution upon entering the box, and are there deposited on the large surface exposed, or are electrolysed. Lime, which has been used for settlement, and also to neutralise acidity, is in the form of carbonate of lime, sulphate of lime, or hydrate of lime. This precipitates partly as carbonate and partly as sulphate upon the anodes and cathodes, more especially on the former, and is precipitated by means of the electrolytic current. Then there are the products of the decomposition itself, which (in the case of iron salts resulting from the decomposition of the pyrites in the ore) are separated in the form of Prussian blue and hydrate of iron. These, again, are the products of the decomposition of the anode plates.

The clearness of the solution depends largely on the solution of the anodes. The iron plate anode in use to-day in the Siemens and Halske boxes, with properly proportioned current, is a very perfect anode, easy to be obtained in any quantity, and as easily manipulated and secured in the boxes. With a current density as low as 0·03 or 0·04 ampere per square foot, very little decomposition of the iron anode takes place. An anode $\frac{3}{16}$ths of an inch in thickness and with a current density of 0·035 ampere per square foot, should last for five years, and possibly much longer. There seems to be a limit of current density up to which an iron anode will show very little corrosion; but beyond that point, oxidation seems to take place more rapidly than the proportionate rise of current density would indicate. Where the division and tension of the current has been very carefully studied and regulated, very little decomposition of the anode need take place.

With the peroxide of lead anode, which was discovered by Mr. Emile Andreoli in the early part of 1895, practically no corrosion of the anode takes place, and although, up to now, this anode has only been used in a small way, one is confident that its introduction into this country on a large scale would prove satisfactory. With perfectly filtered conditions, and with peroxide of lead anode working with fresh slimes, and by watching carefully the amount of lime added to the slimes, there should be very little trouble in maintaining a perfectly clear anode surface for the plating of the gold.

The subject of the production of suitable anodes for precipitation of gold from cyanide solutions is probably not exhausted, but the field has been very thoroughly explored by able electricians and chemists, and beyond the two anodes mentioned, we do not know of any that will fulfil the required conditions. The anode has attracted a good deal of study, but the subject of the cathode is not less interesting and important. Many substances have been tried, which have performed their functions more or less completely. Lead has been used in thick plates, in thin sheets, in ribbons or strips, and in the form of shavings, while zinc has been used in the form of amalgamated plates and as shavings; amalgamated copper plates have similarly been tried, together with iron plates and various other forms of iron; and the same with mercury. Zinc, copper and iron, in various forms have been utilised by Mr. Andreoli for this purpose. Mercury is in use in the United States in the Pelatan-Clerici process; on these fields, at present, lead strips and lead shavings are in use, and zinc shavings are used by Mr. Bettel at the Comet. Each of these various cathodes have their peculiar advantages. Lead strips are used everywhere in the plants using the Siemens process except at the Central works, where part of the boxes are charged with lead shavings.

We may look upon the slimes treatment as it has been developed in this country by the members of this society as a new metallurgical process, which will be adopted all over the world, and we think that its main features will be practically retained. The use of lime for settlement, the use of spitzkasten for collecting, tanks for "natural settlement," dissolving the gold by means of agitation or centrifugal pumps, the decantation of the liquid, and the precipitation by electrolytic method, are, probably, permanent features, which in detail may be modified to some extent, but which will remain with us.

SUBMARINE TORPEDO BOATS.

A paper dealing with the subject of torpedo boats and their influence on torpedo boat architecture, by Captain W. H. Jaques, was presented at the recent conference of the Institution of Naval Architects. The author, after referring to the four preliminary submarine boats built in the United States under the direction of Mr. John P. Holland, proceeded to describe the *Plunger* and the *Holland*, which are now receiving considerable attention in that country.

The boat constructed by the Holland Company for the United States Navy Department was named the *Plunger* by the Department, and was launched August 7th of last year at the constructor's yard in Baltimore. She is the fifth one designed by Mr. Holland, and is 84 feet long, of circular section, 11 feet 6 inches diameter, surface displacement 149 tons, submerged displacement 165 tons, with a reserve buoyancy of about a quarter of a ton. The guaranteed speed is 15 knots on the surface and 14 knots with her steam machinery while awash, with 1 foot of the turret above the water. Her totally submerged electrically running speed must be 8 knots for six hours.

There is a turret amidship with 4 inches of protection and a superstructure for a fair water. Two down-haul screws have been added, although they are not considered by Mr. Holland a requisite of the system. There are two openings in the nose-piece through which service-torpedoes are to be discharged. In addition to hand-gear for horizontal steering and diving, there are automatic devices for maintaining submergence at predetermined depths. A camera lucida has also been fitted. The hull has been constructed to admit a submergence of 75 feet. Some of the water-tight compartments serve as water-tanks; others contain oil fuel; others are employed for compensating discharged weights. A special device compensates for the oil consumed. There are four rudders, two for steering horizontally and two vertically, controlled by automatic devices. For running on the surface or awash, steam generated by petroleum is employed, while electricity from storage batteries is used under water. There is one water-tube boiler of the Mosher type of 3,000 square feet heating surface, fitted with a system of oil fuel capable of consuming 2,000 lbs. of oil per hour. There are two main, vertical, triple-expansion steam engines of 600 H.P. each, and one auxiliary of the same type of 300 H.P. The electric machinery is composed of one main motor of 70 H.P. for propelling the boat when submerged, operating either the side or centre shaft, or used as a dynamo for recharging batteries. There are additional electric motors for operating down-haul screws and performing other services as required. Air for tank and ventilation service is supplied from commercial reservoirs. There are special fittings for closing smoke pipe and air ducts quickly before submerging, and the tank operations are very simply controlled by Kingston and compressed air reducing valves. The *Plunger* has three propellers (in addition to the down-haul screws), any one, or all of which can be operated by either steam or electrical machinery.

The author then referred to the *Holland*, a smaller and similar type of boat, and proceeded to suggest the possibilities of such craft to take the place of second-class torpedo boats on battleships, and of semi-submerged boats of almost any dimensions, having armour enough above water to afford ample protection, at the same time protecting all the rest by water. In conclusion, he pointed out that the great need of the hour for harbour and coast defence is a small torpedo boat that can be submerged, having within it a storage battery of sufficient power to give it a submerged range of a few hours, with 9 or 10 knots surface speed, and from 6 to 8 knots submerged.

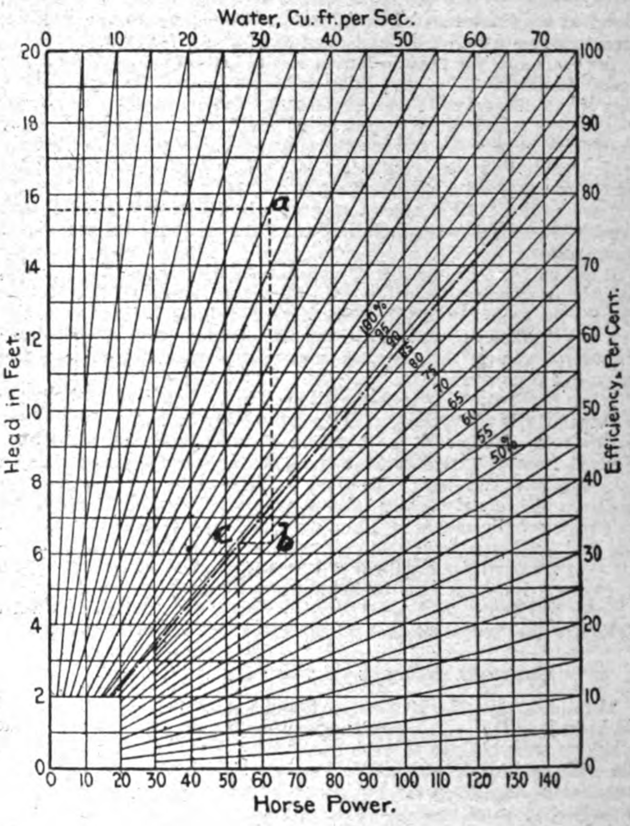
WATER POWER DIAGRAM.

The accompanying diagram, for which we are indebted to the *Electrical Engineer* of New York, is due to Mr. O. H. Landreth. It is a graphical representation of the formula, H.P. $= \frac{\text{H Q D E}}{500}$, where H is the effective head in feet, Q is the quantity of water in cubic feet per second, D is the weight of a cubic foot of water $= 62{\cdot}4$ lbs., and E is the percentage of efficiency of the wheel.

There are two sets of radiating lines from the left lower corner of the diagram. Those which pass to the top line are lines of supply; those to the right hand vertical line are efficiency lines, except the dotted line near the 90, which is a conversion line for horse-power. To use the diagram there is assumed as an example a head of 15·6 feet, at which a supply of 40 cubic feet per second is used in a wheel of 75 per cent. efficiency.

The following is the mode of using the dotted line showing the procedure: From the left vertical scale of head in feet, viz., at 15·6, draw a horizontal to touch the inclined line from the 40 cubic feet division on the top scale. From this point of intersection, *a*, drop a vertical to the inclined line from the 75 per cent. division of the efficiency scale. From this second point, *b*, draw a horizontal to the conversion line. From this final intersection, *c*, a vertical line to the lower scale shows the horse-power, 53·2.

The conversion line is drawn at such an angle from the vertical as makes the tangent $= \frac{1}{2}(0{\cdot}1134)\ 75\,\frac{v}{h}$ where v and h are the numerical values of the vertical scale of head and the horizontal scale of



quantity, the $\frac{1}{2}$ being introduced to make the scale of horse-power half the scale of the upper line of quantity, and the decimal 0·1134 being the coefficient in the formula H.P. = 0·1134 H Q E for horse-power on the basis of the weight 62·4 lbs. per cubic foot. For amounts of head and volume beyond the range of the scale, the figures may be used as though of tenfold value, or to any convenient other multiple, the final reading being similarly multiplied.

CARBON BRUSH-HOLDERS.

By ERNEST KILBURN SCOTT.

Part I.

Although Prof. Forbes first suggested using a block of fine grained carbon on dynamo commutators so long ago as 1885, practically nothing was done to develop the idea until about 1892. Since then, however, the carbon brush has rapidly pushed its way into favour until it threatens to oust the metal brush out of the field altogether.

As the published information on the subject is somewhat meagre, the writer proposes, in the following article, to give a few of the rules which govern the application of carbon brushes, and also to describe some of the leading types.

One point on which there is a lack of definite information is:—How many amperes per square inch of area of contact on the commutator should be allowed for carbon brushes? So far as the writer's experience goes, 40 amperes per square inch is a good average, but some makers employ as low as

25 amperes per square inch of area of contact, whilst others allow as much as 60 amperes per square inch. A good deal depends on the size of the machine, the density being usually lower in a small machine because it may be convenient to use standard sizes of carbons. On the large generators for the Waterloo and City Railway, for example, giving 450 amperes at 550 volts, a quite sparkless collection is obtained by five carbon brushes, each with an area of contact on the commutator of 2 inches long by 1 wide. This gives

$$\frac{450}{5 \times 2 \times 1} = 45 \text{ amperes per square inch of contact.}$$

The ordinary 25 horse-power tramcar motor geared at 4·8 to 1 to a 33 inches tramway wheel, usually takes 15 amperes, but it may be suddenly called upon for five times that amount. The brush has an area of $2\frac{1}{2}$ inches by $\frac{1}{2}$ inch. In the more recent motors there are two carbons, each $1\frac{1}{4}$ inches by $\frac{1}{2}$ inch, or a total of $1\frac{1}{4}$ square inches, and we see, therefore, that the current density is usually somewhere about $\frac{15}{1{\cdot}25} = 12$ amperes per square inch, but it may rise on an emergency to 60 amperes per square inch. No doubt there is sparking at the high loads, but the results taken over a long period are undoubtedly much better than if metal brushes were to be employed for the purpose, even if they could be got to work well with the armatures running both ways.

It is interesting to compare the above with what is allowed for ordinary gauze brushes:—On a large 180-kilowatt dynamo giving 1,500 amperes at 350 revolutions per minute and with a commutator 12 inches in diameter, the current was collected by 12 brushes each 2 inches by $\frac{5}{16}$ inch on face. They were arranged in three sets of four in each set and a space of about $\frac{1}{8}$ inch was left between adjacent brushes.

The contact density works out at $\frac{1{,}500}{3 \times 4 \times 2 \times \frac{5}{16}} = 200$ amperes per square inch. Again, a multipolar machine with series armature has five brushes, each 2 inches by $\frac{3}{4}$ inch, (1 inch face) to collect 1,150 amperes, $\frac{1{,}150}{5 \times 2 \times 1} = 115$ amperes per square inch.

With reference to the actual conductivity of the carbon itself, this will vary with the quality. The Carré brushes, made from lampblack, naturally give the highest conductivity, but they are expensive, and a commoner quality made from petroleum coke, tar, and plumbago, in about the proportions of 70, 20, and 10 parts, is now most generally used. The plumbago acts as a kind of lubricant.

Good conducting carbon specially supplied for the purpose will easily carry 60 to 70 amperes per square inch of cross section without getting unduly hot, but, of course, the current density may be higher in small section carbons than in those of large section, on account of the proportion of the cooling surface to the area being so much greater in the first case. The curve given in fig. 1 shows how the temperature varies

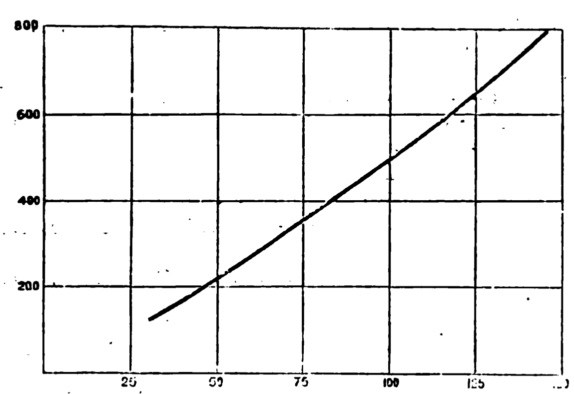


Fig. 1.—Curve showing the Heating of Carbon Brush pressed on to a Copper Plate.

with the current for a carbon block 1 inch square. In actual running it should be mentioned that the carbons are kept cool by the draught of air, and owing to the loose carbon dust the contact resistance is improved.

This matter of conductivity does not enter into the question so much with those brush-holders giving a metal support to the carbon to within, say, $\frac{1}{4}$ inch of the commutator; but where there is considerable overhang, as in the heavy Siemens type, conductivity becomes important. In fact, one objection to the use of carbon brushes on large dynamos, especially if they must pass a strict guarantee clause for efficiency, is that there may be an extra loss of 1 or 2 per cent. due to

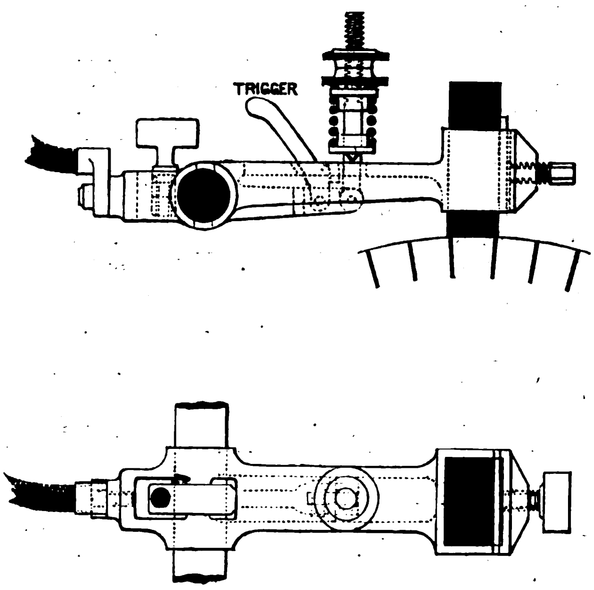


Fig. 2.—Plan.
Greenwood & Batley's Carbon Brush-Holder.

the brushes themselves. For example, the dynamos for the Leeds tramways were specified to have carbon brushes. The guarantee test for efficiency was made with metal brushes, with the result that Messrs. Greenwood & Batley, Limited, earned a good bonus, whereas if the carbon brushes had been used they would have only just scraped through. Fig. 2 shows the type of brush-holder (made of aluminium) in use on these machines, and it may be mentioned that the collection is as nearly perfect as possible, there isn't a sign of a spark however the load may vary.

One of the earliest recognitions of the fact that the use of carbon helped to stop sparking was made by Messrs. Crompton & Co., Limited, on some large machines which they supplied for aluminium reduction. The current taken off the commutator was considerable, and in order to reduce the

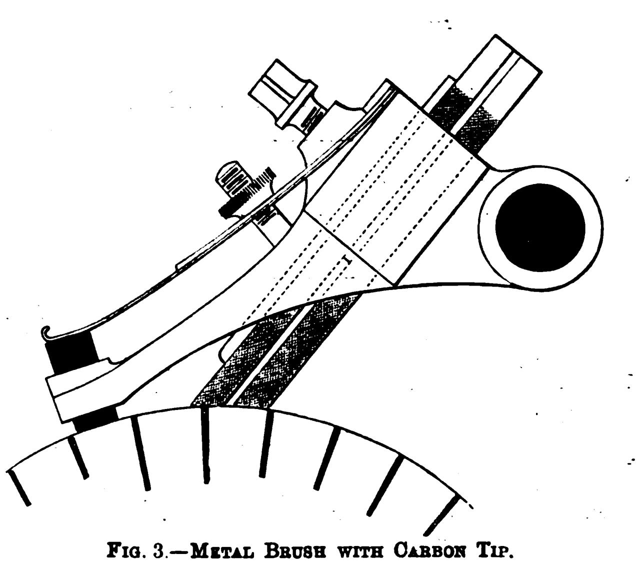


Fig. 3.—Metal Brush with Carbon Tip.

sparking as much as possible the ordinary metal brushes were fitted with carbon tips. Since then this method has been adopted on many other machines, especially where there were great variations in the load as well as large currents to deal with. A simple method of carrying the carbon block is shown in fig. 3. Arc lamp carbon may be used for the purpose, or the little dovetail blocks clamped to the end of a flat spring.

Before going on to describe the various types of brush-holders it would perhaps be as well to enquire into the reasons why the mere substitution of a block of carbon instead of a metal brush improves the commutation. In order to do this properly, it will be necessary to consider for a moment the various causes of sparking. For, although armature reaction is the fundamental cause, there are other reasons, such as the impedance of the coil under short circuit, the time interval, and the thickness of the brush, which effect the question to a greater or less degree.

In the single core continuous current transformer the armature coils connected up to one commutator are paralleled by another set connected to the other commutator, and thus the magnetic effect of one is neutralised by that of the other. In other words, there is very little armature reaction and practically no lead to the brushes. Yet those who have worked these machines know that sparking is not necessarily eliminated.*

There is Messrs. Mavor and Coulson's combination of an auxiliary pole and the Sayer's reversing coils, also Messrs. P. R. Jackson's development of the latter. The partial reduction of the cross magnetising effect by an exaggerated chord winding as described in Mr. Mordey's paper on "Dynamos," and the thorough lamination of the poles (at right angles to the lamination of the armature core), as suggested by the writer, see *Proceedings of Institution of Electrical Engineers*, Vol. xxvi., page 598. Partial lamination of the field poles and shaping the poles away at the horns which tend to be strengthened by the cross magnetism, is, perhaps, the simplest method of reducing the lead.

All these arrangements are good as far as they go, but there are other causes of sparking which require to be attacked from the entirely external standpoint of the brushes themselves.

Any device which makes good commutation possible with a considerable lead on light loads, means that the machine can be successfully operated with little or no change of lead under varying loads.

Now, experiment has shown that this may be effected by placing an extra resistance in the circuit of the short-circuited coil. With a metal brush this can be effected by making it in several sections with a high resistance coil of small area (platinoid wire) between each. The heat waste and sparking caused by the difference of potential between adjacent segments respectively in contact between the advance and hinder sections of the brush is thus prevented.

(*To be continued.*)

* Dynamos have been designed (Prof. Ryan) on the lines of a continuous current transformer with the second or neutralising coils wound in slots in the pole faces. As these slots were filled with copper they added considerably to the reluctance of the magnetic circuit, and it was therefore proposed to make the conductors of slabs of wrought-iron insulated from, but bolted to, the poles. The writer went into this with Mr. Mordey in 1893, but came to the conclusion that the cost of machining, insulating, and connecting up at the ends was too stiff a price to pay for the somewhat doubtful advantage of eliminating the lead of the brushes.

NEW PATENTS.—1898.

Compiled expressly for this journal by W. P. THOMPSON & Co., *Electrical Patent Agents*, 322, *High Holborn, London, W.C., to whom all inquiries should be addressed.*]

8,019. "Improvements in or relating to alternating motors." A. J. BOULT. (O. Patin.) Dated April 4th.

8,024. "Improvements in means or apparatus for electro-plating." H. V. R. READ and N. G. THOMPSON. Dated April 4th.

8,037. "Improvements in the manufacture of the peroxide elements of secondary batteries." D. G. FITZ-GERALD. Dated April 4th.

8,043. "Improvements in sockets or holders for incandescent electric lamps." J. W. MACKENZIE. (Allegmeine Electricitats-Gesellschaft, Germany.) Dated April 4th.

8,054. "Improved means for fixing or fitting incandescent electric lamps into lanterns." J. MOORES and H. O. FARRELL. Dated April 5th.

8,059. "Improvements in apparatus for lighting miners' safety lamps by electricity." B. D. WILLIAMS. Dated April 5th.

8,070. "Improvements in electric trolly wire section insulators." W. WOOD. Dated April 5th.

8,085. "Incandescent electric light decorations." A. A. POLLOCK. Dated April 5th. (*Complete.*)

8,097. "A medical electric generator or hot-air bath for the application of heat to the human body." A. E. GREVILLE. Dated April 5th. (*Complete.*)

8,104. "Improvements in electrical measuring instruments." F. M. BENNIT. Dated April 5th.

8,140. "Improvements in switches for electric circuits." G. WRIGHT. Dated April 5th. (Date applied for under Patents, &c., Act, 1883, Section 103, September 18th, 1897, being date of application in United States.)

8,142. "Improvements in systems of electrical distribution." B. G LAMME. Dated April 5th. (Date applied for under Patents, &c., Act, 1883, Section 103, September 18th, 1897, being date of application in United States.)

8,149. "Improvements in electric welding machines." C. NIELSON. Dated April 5th.

8,179. "Improvements in and connected with means for electrically lighting railway carriages." E. DICK. Dated April 6th.

8,192. "Improvements in electrical connections, switches, and terminals." R. F. HALL. Dated April 6th.

8,202. "Apparatus for quickly and tightly closing, and quickly opening portable electric batteries." S. F. WALKER. Dated April 6th.

8,222. "Improvements in clutches and brakes for arc electric lamps." G. BYNG and A. E. ANGOLD. Dated April 6th.

8,233. "Improvements relating to electric tram and like cars." J. T. HIMMEGER and J. CROWLEY. Dated April 6th.

8,262. "An improved controlling device for electric motor vehicles and the like." G. H. RAYNER. (H. Leitner, France.) Dated April 6th.

8,273. "Improvements in and connected with electric bells." H. OPPENHEIMER. Dated April 7th.

8,274. "Improvements in and connected with electric bells." H. OPPENHEIMER. Dated April 7th.

8,275. "Improvements in and connected with annunciator movements." H. OPPENHEIMER. (Actien-Gesellschaft Mix & Genest, Germany.) Dated April 7th.

8 276. "Improvements in and connected with primary batteries." H. OPPENHEIMER. Dated April 7th.

8,277. "Improvements in and connected with keys or switches for multiple switchboards." H. OPPENHEIMER. (Actien-Gesellschaft Mix & Genest, Germany). Dated April 7th.

8,278. "Improved fuse box for electric light cables requiring resin, oil, or other compounds as an insulating material at terminal joints, &c." D. S. STRANG. Dated April 7th.

8,298. "Electro-photo-telegraph." A. BEIN and J. BREUER. Dated April 7th.

8,301. "Improvements in the construction of Morse's registering telegraphic instruments." E. DUCRETET. Dated April 7th. (*Complete.*)

8 314. "Improved electric pile." G. ROSSET and J. ROSSET. Dated April 7th.

8,319. "Improvements in electrodes, and in the method employed for producing them." K. KREBS. Dated April 7th.

8,328. "Improvements in or relating to electric arc lamps." A. ROSS. Dated April 7th.

8,348. "Improvements in electrical measuring and indicating instruments." A. C. HEAP. Dated April 7th.

8,371. "Improvements in electro-magnets." M. BOUCHET. Dated April 7th.

8,374. "Improvements in arc lamps." G. C. FRICKER. Dated April 7th.

8,391. "Improvements in high-tension transformers and induction coils for Röntgen ray work, and for other purposes." A. L. DAVIS. Dated April 9th.

8,393. "Improvements in electric arc lamps." H. V. JAMES. Dated April 9th.

8,398. "Improvements in electric motors." P. S. SWAN. Dated April 9th.

8,441. "Electric recording system." C. L. JAEGER. Dated April 9th. (*Complete.*)

8,442. "Improvements in electric meters, cores, and circuit controllers." W. D. MARKS. Dated April 9th. (Date applied for under Patents, &c., Act 1883, Sec. 103, September 10th, 1897, being date of application in United States) (*Complete.*)

8,477. "Improved electric accumulators." B. A. BOUVIER and G L. AUGIERAS. Dated April 9th.

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THE SHIFTING SITE OF NATIONAL INDUSTRIAL SUPREMACY.

THE aspects of national industrial supremacy in the iron trade have been ably dealt with of late in the *Engineering Magazine* by Mr. Jeans, who now again writes under the above title, and argues the question of cheap and dear labour. Mr. Jeans has left over this article until he could, in some measure, estimate the result of the strike, and he is optimistic on the prospect. He endorses our already expressed opinion, that if the result of the strike be to put a stop to the bad and dishonest conditions which have been prevailing, there is much brighter prospect for British industry. Great Britain, says Mr. Jeans, has suffered more loss of prestige to her industrial character from the bad side of trades unionism than from any other cause. Mr. Jeans has otherwise a high estimate of British labour—its skill, doggedness and capacity to produce good work, and no Englishman need be afraid of comparison with Continental products.

A factor in industrial supremacy is a large home demand. This it is has built up trade for the United States. Home demand brings works into existence, and these expand, and finally are able to produce for outside. The absence of home trade has kept unprogressive countries in a backward condition as regards metallurgy. For example, take Russia, with a population in 1880 of 100 millions, and a pig-iron manufacture of only 465,000 tons, of finished iron 292,000, and of steel 307,000, whereas undeveloped America produced four million tons of pig and three million of finished, or partly finished, products. America was progressive, and has now obtained the first place in iron production, though still second in production per head of population, and very low down in production per area. Mr. Jeans is of opinion, and he claims that his opinion is based on experience, that no country possesses such resources as to give it a supremacy in so widely diffused an industry as iron and steel making for a very long time. The ore and coal deposits of New South Wales are so great as to afford the expectation of production as cheaply as in any other country. Then there are the resources of British India, of China, Siberia, Japan. In India especially the coal and iron resources are great and are widely spread. In Spain there are good prospects, and the newer Spanish ironworks are well equipped, and there are the conditions in embryo that would enable pig to be made as low as 28s. per ton—practically the cheapest price in Europe. Russia is now progressing, and the demand in Siberia may become great now that railway facilities are provided. The total iron production of the world, which was not five million tons in 1850, grew to 12 million tons in 1870, and then in 1880 to 18, and now to 32 millions. It will be 46 millions in 1916, and 60 millions in the lifetime of most young engineers now living, if the present rate of growth be continued.

Where can anyone at present see the source of the extra 50 million tons of ore to provide for the demand in 36 years hence? Great Britain certainly cannot hope to do more than put out her present annual 15 millions of tons. Germany is in no better case. France has stuck for many years at 3½ millions, despite the large deposits of the Meurthe-et-Moselle district. That country, apparently, must be first which can put out the biggest weight of ore. But it is not materials alone which tell. Much depends on the character of the people. A skilled and industrious population is necessary, such as found in Great Britain or the United States, and rarely in semi-civilised countries like Russia, or in fallen-back nations like Spain. The unquestioned efficiency of the British workman—when he chooses—may in the future be found allied with the willingness of the American, and show itself in the running of plant for all it is worth. If so, the change will greatly modify the present conditions. In the best American works it may be assumed there is now little or no reserve of force. In Great Britain we have a reserve of *30 to 60 per cent.*—the italics are ours.

If Mr. Jeans be right, and he only voices our own ideas, the geographical and climatic advantages of Great Britain must tell powerfully in the future as in the past. Already a few of our leading works, Barrow, Dowlais, Bolckow, Vaughan & Co., now compare favourably with any in America as to costs, and the old country has plenty of "kick" still left, and one of the surprises of the future may be a resurrection of British supremacy on a scale quite undreamed of. John Bull is so very pessimistic—he does not magnify his powers or achievements, and when it is considered that Great Britain has everything but ores, and they can be so readily and cheaply imported, it is unlikely that she will suffer eclipse.

Lately, conditions have not been fair. Germany and America have kept up home prices by pools and syndicates, and dumped surplus production into neutral markets at prices only possible under the pooling conditions at home. In fact, the German and American public have been really presenting iron to foreigners in the way France and Germany present sugar.

The near future, probably everywhere, will bring the legislative cost of production a little higher. Already this is 1s. 3d. to 1s. 6d. per ton in England, and it is considerable in Germany. It is likely to increase in America as greater care of life increases. The United States also are not likely to be so free of war burdens, or Europe maybe will drop some of her crushing load by federation. With a quarrelsome America the Continent of Europe might find it necessary to federate for its existence, and America has already evinced strong desires to go outside her own territory and drop the Munroe doctrine of non-meddlesomeness.

The present Spanish imbroglio seems likely to result in heavy war expenditure in America, demanding taxes which will even up costs of production and place American industry under charges more approaching to those borne by others. Such would seem to be the outcome of the note struck by Mr. Jeans in his article, for already he states few of the leading American works have been of late making large profits. One notable exception remains, which we take to be the Carnegie Company, and this has made handsome profits on account of efficiency of administration and singleness of purpose rarely equalled in manufacturing annals.

The Belleville Boiler at Sea.

At the time of the much lauded trials of H.M.S. *Powerful* we ventured to doubt the propriety of such an expensive and serious experiment. Hints as to the fearsome coal consumption of this fine ship do not tend to re-assure us. A paper just presented to the Institution of Engineers and Shipbuilders of Scotland by a Russian engineer detailing his experience on board the ss. *Kherson* adds further testimony to the inadequacy of the circulation in Belleville boilers. In the *Kherson* there are 24 boilers placed back to back athwartships—this position, to our mind, being specially suited to put a check on proper circulation. In each boiler are eight elements of 20 4½-inch tubes each, the lowest tubes ⅜-inch, the two next $\frac{5}{16}$, and the top two rows ¼ thick. When first tried the port side boilers did not work so well as those on the starboard, the bottom box joints to feed collectors leaking. When the trial was over it was found the ship listed 10½° to the starboard. At a second mooring trial the list was 5° and reversed, and the same faults were repeated, but also on the opposite side, and the faults were less pronounced, owing, perhaps, to less list and a shorter run. The faults developed consisted of the bending down of the tubes from 1 inch to 1½ inches. Throughout the voyage faults always occurred on the side opposite to that towards which the ship listed, and a point of peculiar interest was that previously bent tubes tended to become straight, and some even bent upwards, as, indeed, is the normal tendency of the lower tubes of Belleville boilers. Mr. Gretchin attributes, we think rightly, the trouble to the list causing the odd rows of tubes to become horizontal if the list is 2½°, and to incline the wrong way when the list exceeds this amount. Mr. Gretchin's experience points to the need of very skilful firing of fires 3 to 4 inches thick, and he details the system of routine working, continuous repairs at sea and in port, and, altogether, his paper is lively reading for anyone who knows even a little of life at sea, and can picture the succession of bent tubes, leaks, split welds, the rattling of non-return valves as the ship rolled as if to prove the need of these in the mud boxes. Nothing that has yet come to light concerning the Belleville boiler has tended to re-assure us as to its suitability for steam raising in defence of the empire.

Permanent Indicator Rigs.—The *Street Railway Review* describes a convenient permanent indicator rigging which gives a thoroughly perfect movement. It consists of a shaft parallel with the piston rod, and supported in bearings bolted to the underside of the upper guide. The shaft is sufficiently to one side to clear the crosshead, yet close to the guide frame, to allow free access to the gland, &c. To the shaft is fixed a brass strip, so curved as to form a portion of a high pitched helix. This is engaged by a fork belted to the crosshead. The fork carries rollers. A movement of the crosshead of 60 inches gives the shaft, by engagement of the fork and helix, a rotation of something less than 60°. Motion is carried by means of cranks and connecting rod from the shaft to a second shaft, carried in brackets on the side of the cylinder. Small cord wheels on this second shaft carry the cords to the paper barrel. We think we have somewhere seen a similar arrangement carried out by means of a slightly twisted square bar, such as is used in the valve gear of a fire engine. Any device to be successful at high speeds needs to provide for the shortest possible cords, and should be of great rigidity compared with its weight, or at least its moment.

"FREE" AND "EASY" PAYMENT SYSTEMS OF HOUSE WIRING.

By V. ZINGLER, A.I.E.E.

(*Concluded from page* 533.)

Now there is no doubt that Mr. Rider has only put forward this ingenious scheme with the idea of enabling the Corporation to increase their electricity supply, and so to benefit the public not only by the general distribution at cheaper rates of a healthy illuminant, but also by saving their pockets from the heavy initial outlay otherwise involved by the adoption of the electric light. It is questionable, however, whether the scheme will commend itself in its financial aspects to students of scientific economy.

It is a curious medley of municipal socialism and reactionary individualism. Much as we all desire to see the general application of electricity either by private or by municipal enterprise, it is doubtful whether such a scheme as this should not be considered as dangerous — alike from the nature of the thing and the abuses it may bring forth. For what does it amount to? It is a scheme by which a municipality—a public body—takes upon itself the compound function of money lending and the support of one-man businesses. And what can it lead to? Nothing but bribery and corruption. What is to prevent councillors from having interests in the wiring firms thus supported, or from being themselves in receipt of "relief" on account of such work done for them, with the accompanying possibilities of fraud, commission, &c., which it is better not to enter into?

Consider the litigation which the Corporations will get into over clause (*a*)! Suppose that the satisfaction of the consumer does not correspond with that of the borough electrical engineer, and that the consumer refuses to pay anything further. Also, to whom will the installation belong during the period from completion to payment on the part of the Corporation? Who is to adjudicate upon extras, such a favourite item in a wiring contractor's bill? No doubt these are only minor points, and could be duly allowed for in any agreement; but the broad principle of the thing remains the same. We have not got so far in our social conditions that the community should be called upon to pay the debts of one of its items, or to suffer loss through the defaulting of a member.

It may be argued that there is no difference between this scheme and the Corporation wiring the man's house themselves, as in any case they spend the ratepayers' money. But there is a difference between paying a man's debts in money and in kind; if the consumer absconds or declares himself bankrupt, the money is as good as lost, as it does not follow that another consumer will always take the same house at once, or, having done so, will use the electric light; and he could not be compelled to do so, as the agreement would only be between the original tenant and the Corporation; whereas, if the Corporation wired the house themselves, they could come to terms with the landlord, so that their ultimate payment, with interest, would be assured.

These remarks are merely looking at the question from the standpoint of the community, and, apart from the fact that altruism does not flourish sufficiently among us that we should have a rabid desire to advance each other money *ad lib.* (for where electric light trades have this advantage others will also require it), it is questionable whether such powers could be exercised by a corporation without the permission of Parliament, or whether Parliament would give that permission.

Mr. Rider summarises the advantages of his scheme from the standpoints of Corporation, consumer and contractor, as follows:—

To the Corporation the advantages would be—

(*a*) The accession of a large number of consumers who would otherwise not be able to afford to adopt the electric light.

(*b*) The excellent control the Corporation would be able to exercise over the wiring of the premises, and the consequent raising of the standard of work.

To the consumer the advantages would be—

(*c*) The adoption of electricity as an illuminant without any heavy initial outlay.

(*d*) No extra price for current, as in the free wiring scheme.

(*e*) The cessation of all payments for wiring after a certain time, when the work would become the property of the consumer.

(*f*) The guarantee of first-class work, under the direct control of the Corporation.

To the contractor the advantages would be—

(*g*) A large increase of work in wiring premises.

(*h*) The certainty of payment on the satisfactory completion of the work.

Let us just consider these:—

(*a*) is no doubt the best advantage that the scheme has to offer. It may, however, be asked, are there many consumers who, if they could not afford to pay £100 down, would readily assent to a quarterly tax of over £12 for 21 months for the sole object of afterwards owning certain fixtures in a house which does not belong to them?

(*b*) If the control were to be greater than that adopted now, the Corporation would have to engage a larger staff. Besides, the controller would always be subject to being squared, or to getting on too friendly relations with contractors, as often happens now.

(*c*) The same remarks apply to this as to (*a*).

(*d*) This will be dealt with afterwards.

(*e*) Dealt with under (*a*).

(*f*) Dealt with under (*b*).

(*g*) Excellent for the wiring companies, subject to the scheme becoming popular with the public.

(*h*) Also good for the contractor, if no legal difficulties such as have been suggested before intervene.

We may now consider the scheme of the Free Wiring Company in conjunction with that of Mr. Rider's, in the relative positions of their advantages to the consumer, *i.e.*, to his pocket; for, after all, this is what the average man considers, and rightly enough, before all. And this comes in special relation to (*d*).

The consumers catered for under either of these schemes are those whose incomes are from £500 downwards, and who could not afford to pay £100 (or a proportional amount as their income decreases) in cash down for electric light. To these people—and they form the great majority of possible consumers—the question of the general application of the electric light and the consequent reduction in the charge per unit or in the parish rates, is as nothing compared with the sudden expenditure of one-fifth of their income. No doubt they would be glad to have the rates reduced, but not by the offer of such a sacrifice. What such a man has to consider then, under these alternative schemes, is this: Assume, for convenience, that he has 100 lights to be wired for at £1 each, consuming 18 units each per annum. Under Mr. Rider's scheme he will pay £100 + 5 per cent. = £105, in eight quarterly instalments of £13 2s. 6d. each, spread over 21 months. As Mr. Rider points out, this is equivalent to getting credit for the full amount of £105 for $10\frac{1}{2}$ months, or at the rate of about $5\frac{3}{4}$ per cent. per annum. He will thus not only lose his interest on the £100 he spends, but he has to pay an additional 5 per cent. for the loan. His consumption per quarter will be, at 6d. per unit,

$$\frac{18 \times 100}{4} \times 6 = £11\ 5s.$$

Of course he may not burn anything like this, but the figures may be taken for purposes of comparison.

Now, if he takes up the scheme of the Free Wiring Company, he will have to add one-sixth to this latter sum, assuming that the charge is 1d. extra per unit consumed.

This will make his quarterly bill for current £13 2s. 6d., or, curiously enough, just equal to what he would be paying off quarterly under Mr. Rider's scheme for nearly two years, to obtain certain fixtures as his own property which are of no more value to him than the water-pipes in his house.

The sum he pays under the Free Wiring Company's scheme per quarter is £1 17s. 6d., or at the rate of $7\frac{1}{2}$ per cent. per annum.

To sum up, under the one scheme he will be paying £24 7s. 6d. per quarter for two years, and £11 5s. per quarter afterwards, and own certain fixtures in, probably, another man's house, which would not realise anything; to this would be added legal proceedings if he got into arrears. On the other hand, he would pay £13 2s. 6d. per quarter as long as he liked, with no disabilities attached except the cutting off of the light if he failed to pay.

It is for Corporations anxious to take up a scheme of this sort to consider human nature first, and to ask themselves which scheme they would prefer if they were in the position of this man.

As the writer is not aware whether Mr. Rider's scheme has been adopted at Plymouth or elsewhere, no figures as to its operation can be given; but there is no doubt that the scheme of the Free Wiring Company is being taken up by many supply companies and corporations. It must be evident that it is of great assistance to the supply companies and corporations for increasing their load; in fact, this is so to such an extent that some of them have decided to charge the consumer nothing for the hire of the wires and fittings—presumably instead of reducing the cost of the unit as the load increases. If the thousands of small houses in the suburbs which are without the electric light are considered, the possibilities of any scheme of this sort are immense; and that it is not only the small consumers who sometimes take advantage of it is shown by the fact that in one district worked on this scheme and started contemporaneously with the supply authority, considerably over one half of the consumers have been "free wired," and these used over 80 per cent. of the total current supplied.

Under this system the consumer has the option after five years of purchasing the installation on payment of the original cost plus 20 per cent., and less $1\frac{1}{2}$ per cent. per annum from the date of installation for depreciation. It is not probable, however, that many consumers would avail themselves of this. Certainly, 20 per cent. seems a large profit, and $1\frac{1}{2}$ per cent. a small depreciation after five years, and after paying $7\frac{1}{2}$ per cent. interest.

But the system has this advantage—that the landlord does not in any way become responsible for the defaulting of any tenant, as the wires and fittings remain the property of the company, who can remove them if payment is not forthcoming. They are, however, bound to make good any damage caused by this removal.

In conclusion, it may be pointed out that when the gas companies saw their lighting business threatened by the introduction of the electric light, they applied themselves to encouraging gas cooking and heating by letting out stoves, &c., on hire for a very moderate sum. That there is a demand for these is shown by the fact that the gas companies' profits have not decreased, despite the great progress made by the electric light. As borough engineers and others are always grumbling at the great valley in their load curve, because most of their machines have to stand idle during the daytime, it is curious that no effort is made, either by the supply authorities, or some company, to let out on hire electrical cooking and heating apparatus, not to speak of motors. Owing to their cleanliness and economy in heat, there would no doubt be a ready demand for them, and the item of wiring would be extremely small.

THE MECHANISM OF ELECTRICAL CONDUCTION.*

We print in another column of the present issue (page 596) the latter part of an interesting and suggestive paper recently read by Mr. Reginald A. Fessenden before the American Institute of Electrical Engineers. The paper consists of two parts; the first, highly speculative, discusses the mode by which electricity is conveyed through solids, liquids, and gases, and supports the general view that all conduction is essentially convective, if the circumstances of the constitution of materials, solid or fluid, which determine whether they are conductors or insulators, are considered. We confess we do not follow throughout the reasoning of this part of the paper, but some account of its argument may induce our readers to refer, perhaps more intelligently than ourselves, to the original. The second part of the paper deals with the properties of insulating substances used in engineering practice, and appears to us of so much practical interest that we print it *in extenso*. That many of Mr. Fessenden's views admit of much controversy does not detract from their interest.

The author begins by drawing a careful distinction between the two qualities necessary to an insulator, viz., non-conductivity and dielectric strength; to both which qualities, he complains, the term resistance has been indiscriminately applied. He points out that water is, so far as the latter quality is concerned, at least as good an insulator as India-rubber, and, in another section of the paper, that only its enormous solvent power prevents its being a good non-conductor.

The paper then considers the mechanism of conduction in four sections: conduction by convection, conduction in solids, fluids, and gases.

Liquid insulators, even very perfect non-conductors, will conduct by convection, and this may cause serious leakage in high potential distribution. Convection is not recognised as occurring in solids, but is well marked in gases, vapours, and fluids. The mechanism of convection is the repulsion from a charged body of other bodies which have been in contact with it, which move away carrying with them part of its charge. Now, small bodies charged from another, comparatively large and smooth, are not repelled from but attracted to it; and though it is stated that the relation between the size of the particle, the voltage, and the radius of the charged conductor, when the particle after touching the conductor is neither attracted nor repelled, can be obtained by the method of images, no numerical results are given, for which omission the author apologises. Leakage between conductors in a liquid insulator, so far as it is due to convection, is caused by a motion of a portion of the oil as a whole, and not of its individual particles. Leakage by convection in a liquid insulator can be prevented in three ways:

"1. By using oil of great viscosity, in which case, however, we lose the chief advantage of oil insulation, *i.e.*, its ability to re-insulate quickly after a discharge."

"2. By putting pure dry cellulose in some form or other between the charged surfaces loosely, so that the oil can filter through it easily and any air escape readily, but sufficiently close to prevent any rapid flow. Pure cellulose has the great advantage that when well boiled in the oil it has approximately the same specific conductive capacity as the oil. No varnish or shellac should be used in the oil for reasons given later."

"3. By dissolving a solid, non-dissociating substance in the oil in such excess that it crystallises out at ordinary temperatures and forms with the oil a soft gelatinous mass, not fluid, but yet capable of allowing the oil to ooze through its substance. This has many of the disadvantages of 1, but it has one advantage, in that the substance chosen may be one, like paraffin, having a large specific heat of liquefaction, and consequently an overload will not raise the temperature of the oil above a fixed point till the paraffin is all melted."

No rapid movement of the liquid can occur in any of these arrangements, and the convection currents must be very small. It is further pointed out that the well known discharging effect of points is due not only to the great density of the charge at places of large curvature, but largely to the fact that very small particles are repelled from points, and can move rapidly away, carrying their charges, while they would not be repelled at all from rounded knobs or surfaces of small curvature.

In relation to the conductivity of solids, the author refers to a relation between the properties of a metal which he discovered and announced in 1892.

The conductivity of a pure metal is proportional to

$$\sqrt{\frac{\text{elasticity}}{\text{density}}} \div \text{valency}:$$

or in other words, the product of the conductivity of a pure metal and its valency is proportional to the speed at which it conducts sound. In evidence of this law figures are given of 10 other metals referred to silver, but they closely satisfy the formula in only three cases, viz., gold, aluminium, and cadmium; the values in those cases being as follows:—

* "Insulation and Conduction." A paper read by Mr. Reginald A. Fessenden before the American Institute of Electrical Engineers, New York, March 23rd, 1898.

Metal.	Atom. Vol.	Atom. Wt.	Valency.	R. calculated.	R. observed.
Silver ...	10·2	108	1	100	100
Gold ...	10·2	197	1	135	137
Aluminium	10·5	27	3	152	159
Cadmium	13	112·2	4	456	450

In other cases there are discrepancies from 13 to 83 per cent. The worst case is that of iron, in which the calculated resistivity is 480, and the observed 646. Iron is taken to be octovalent, and if tetravalent the figure would be only 240, but Mr. Fessenden observes that "the magnetic metals, as iron and platinum, are very difficult to obtain pure. Their true resistance is, therefore, at present doubtful." The values attributed to the valencies of the metals seem somewhat arbitrary, and upon this point the author, referring to a diagram, in which, by the way, cadmium is assigned a valency 2, writes: "But there is no very definite rule. Among the univalent elements some unite with bivalent atoms, as does copper, and in general all that can be said is, that a certain valency holds generally and not in general. Consequently when we find that by taking a group of metals having very closely the same value of Young's modulus, as, for instance, gold, silver, and aluminium, their conductivities are, within the limits of errors of observation, proportional to the velocity of sound ÷ valency: and that in any of the group of metals having the same valency, the conductivity is directly proportional to the velocity of sound, within experimental errors, we are to a certain extent justified in making a choice of valencies when this is needed."

If this law be established it points clearly to convection as the mode of conduction in solids. To quote again:—"This formula throws a certain light on the nature of conductivity in solids, and why some solids are insulators. For the formula $\sqrt{\frac{\text{elasticity}}{\text{density}}}$ is the same as that for velocity of sound in a body. Now, in the convective discharge, the electricity was handed on with the same velocity as that with which the particles moved. In fluids, as we shall see, the electricity is handed on with the velocity with which the ions move. In both cases the electricity travels along on the particles of matter." A long quotation from Prof. Lodge follows indicating that this idea was well founded in his mind 10 years ago, and it is suggested that had he known of a formula subsequently discovered by Mr. Fessenden, and published in the *Electrical World* (New York), August 22nd, 1891, his views would have been much strengthened.

"The formula refered to is:

$$\text{Young's modulus} = \frac{78 \times 10^{12}}{(\text{atom. vol.})^2}$$

"Hence it is possible to predetermine the velocity of sound in wires by the formula:

$$\text{Velocity in cms. per sec.} = \frac{883 \times 10^4}{\text{atom. vol.} \times \sqrt{\text{density}}},$$

"and the electric resistivity is given roughly by:

$$\text{Resistivity} = 45 \times 10^{-9} \times \text{atom. vol.} \times \sqrt{\text{density}} \times \text{valency}.$$

"This formula possesses a general interest, inasmuch as it would seem that while the strain in the dielectric is propagated with the velocity of light, *i.e.*, $\sqrt{\kappa\,\mu}$, the actual electricity in the wire were handed on with the velocity of sound, and is proportional to $\sqrt{\frac{\kappa}{\mu}}$."

Mr. Fessenden thus arrives at the general conclusion that metals probably conduct by handing on charges to one another as they meet or collide in the course of their natural vibrations, and that the rate at which charges can be passed through their substance, *i.e.*, their conductivity, is proportional to the number of collisions in a given time, and inversely to the valency. The action of a high valency in reducing the conductivity of the metal is not very clear, but we understand that Mr. Fessenden looks on a high valency as involving small freedom of motion among the molecules, and so fewer collisions. An ingenious mechanical arrangement of balls carried on stretched strings is described, which would behave analogously to the author's conception of a conductor.

We find it difficult to follow the writer in his discussion of the molecular qualities necessary to produce solid dielectrics. He points out from a table of the elements constructed on Mendeléeff's principle that, as we proceed from the highly conducting metals used in commerce towards those of lower rows and higher valencies the substances get more crystalline, highly polymerised, and capable of existing in allotropic forms, and adds a number of general considerations on the effect of highly complex structure on the transmission of vibration. He concludes that for solid insulators we require "substances which are strongly linked together, of great density, and of small modulus of elasticity." In considering the conductivity of liquids the results arrived at by a number of well-known physicists are briefly stated, the condition that determines whether a given solution is an electrolyte or an insulator being the attraction of the molecules of the solvent for the ions of the solute. If this attraction is sufficiently great to overcome the cohesion of the molecule of the solute, and break it up into ions, the liquid is an electrolyte, but if not it remains an insulator. To quote Mr. Fessenden:—

"The conductivity of a solution is thus dependent upon the following:

"1. How powerful the attraction of the molecules of the solvent is for the ions of the solute, for on this depends how much of the solute is disassociated, *i.e.*, how many ions are set free to carry the current.

"2. How fast the ions move.

"3. What the valency of the ions is.

"In designing insulations the first is the important point, for from it we see that two good insulators mixed do not necessarily make a good insulator. A solid may dissolve in one substance and be an insulator in solution, but in another solvent may conduct quite well.

"This is what makes the chief difference between fluid insulators, for practically all the fluids which are not simple elements, like mercury, have very high ohmic resistance, and all have practically about the same dielectric strength. The ohmic resistance of pure water is, according to Kohlrausch and Heydweiller, about 1 megohm per cubic centimetre, consequently on account of its non-inflammability and great specific heat, its great heat of vaporisation and low boiling point, it would be a very valuable insulator for some types of apparatus were it not for the fact that it dissolves almost everything in slight proportions and splits them up into ions. Varnished paper will dissolve in some high resistance oils, forming a conducting solution."

In treating conductivity in gases, Mr. Fessenden adds little to what he has already said. Looking on all conduction as essentially convective, calling it electrolytic when the charges are conveyed by disassociated ions, he has no doubt that conduction by gas is usually electrolytic, but thinks it may take place by convection, using the word in the usual sense, in the arc and in the vacuum tube. "As regards the electrolytic discharge, this can only take place when the gas is disassociated by heat or by a strong slope of potential."

Our copy of this paper is an advance proof kindly sent to us from America.

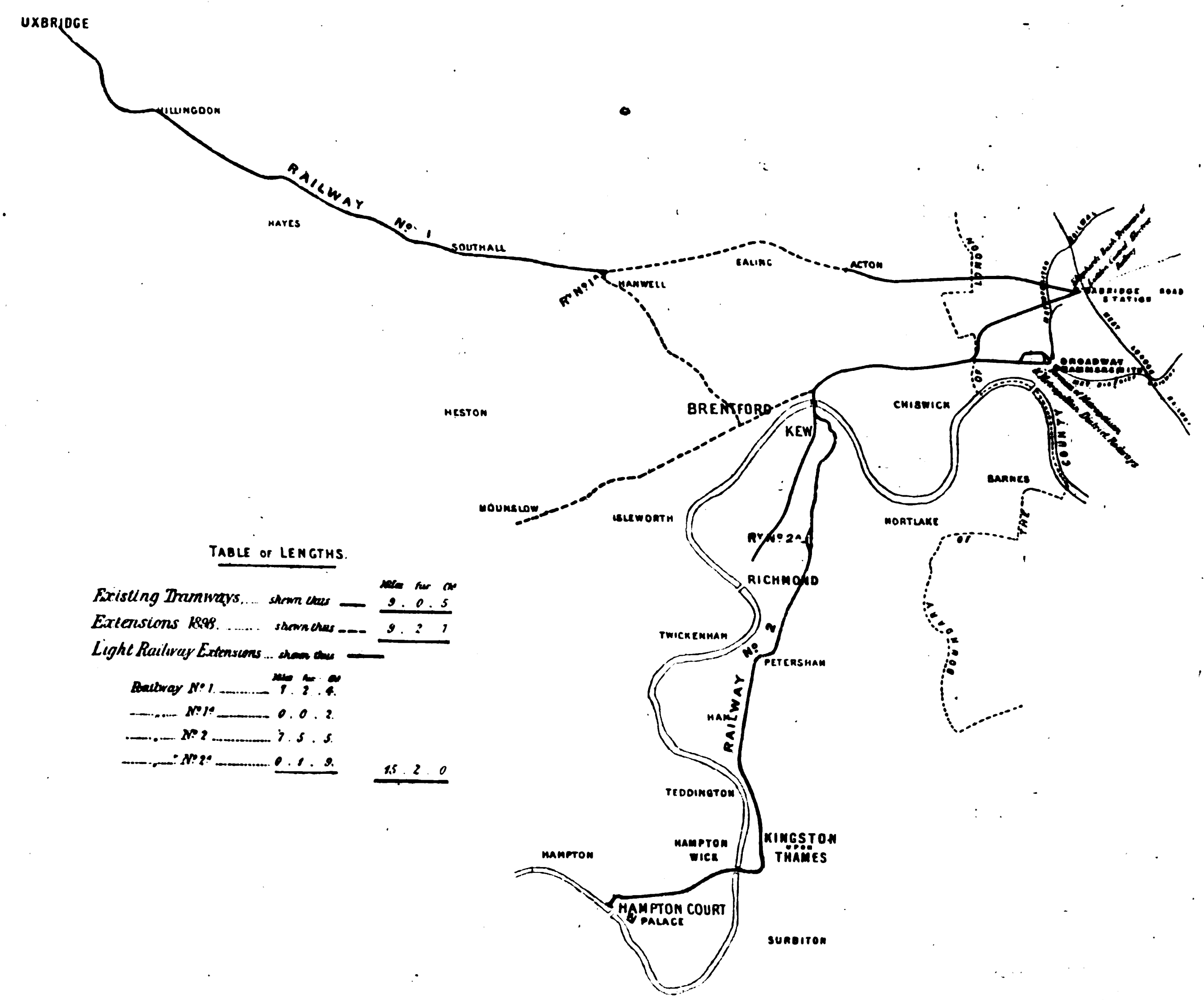
A GREAT SCHEME OF ELECTRIC TRAMWAYS.

The most ambitious scheme of electric tramways ever promulgated in this country is one that will provide a quick service of electric cars between Uxbridge Road Station and Uxbridge on the one hand, and Hammersmith Broadway and Hampton Court on the other hand. The proposed routes are clearly shown in the annexed map, from which it will be seen that the scheme embraces the equipment of existing horse lines with electrical plant and extensions into new districts. The present tramways are owned by the London United Tramways Company, of which Mr. Clifton Robinson is the engineer and managing director. It is perhaps hardly necessary to say that Mr. Robinson has been, and is, associated with most of the electric tramways that have been laid down in this country, so he may be said to be well fitted to fight the cause of electric tramways in West London. For there has been a battle royal waged round electric tramways in the two parishes of Ealing and Chiswick; indeed, so high did local feeling run that the elections of the Chiswick and Ealing District Councils, which took place some two or three weeks ago, were fought on the question of permitting or preventing the admission of electric traction into the districts. The result of the elections was a signal victory for those candidates who sought the suffrages of the electors on the grounds that it was desirable to permit the tramways company to introduce electrical working on to that part of the system which passed through the district. The result of this appeal to the ratepayers is distinctively interesting, because it reveals in the clearest possible manner the attitude of the public on the subject of electric tramways, despite the insidious attacks and unfair arguments of its opponents.

The existing lines of the London United Tramways Company are nearly nine miles in length, and the system com-

districts which appear to offer greater prospects for the successful working of electric tramways than the neighbourhood west of Hammersmith. The thoroughfares are wide and the population is exceedingly dense (in numbers). A well-equipped tramway system would prove a real blessing to the inhabitants and would, moreover, open up the country beyond Ealing and Hanwell which would be advantageous to property owners and residents alike. We have never seen a better equipped horse line than the system of the London United Tramways, the horses are excellent specimens and the track is kept in a highly perfect state; it needs only electricity to make it an ideal system.

It is not only, however, the inhabitants along the proposed route that will benefit from the efforts of the London United Tramways to introduce electrical working, for they are successful in inducing Parliament to grant them powers, they will have broken down the barriers that have hitherto prevented the introduction of electric tramways into London.



prises lines from Hammersmith Broadway to Kew Bridge, Uxbridge Road Station to Acton, Goldhawk Road connecting Uxbridge Road with Hammersmith and Kew Green to Richmond. The Bill, which is now before Parliament seeks to extend the Acton line to Hanwell, and the Kew Bridge line to Hounslow, connection being made between Hanwell and Brentford.

Mr. Clifton Robinson is not, however, satisfied with this very considerable extension, because he is seeking on behalf of the company powers under the Light Railways Act to carry the system to Uxbridge on the one side and Hampton Court on the other, as shown in the map. Although the scheme is meeting with much favour from inhabitants, local authorities are inclined to resist the invasion of electric tramways, and no doubt a big fight will ensue. Some days ago we had the privilege of inspecting the present tramways systems and passing over considerable portions of the proposed route, and we must confess that we have visited no

THE NATIONAL TELEPHONE COMPANY'S STAFF DINNER.

For the fifth time the members of the staff of the National Telephone Company have met and dined together. The event took place at the Trocadero Restaurant last Friday evening, and when we say that it was as successful as former gatherings we are according it great praise.

This annual meeting of the staff of the Telephone Company is an imposing, and at the same time, an interesting ceremony, because it may be regarded as the only occasion in the year that permits a representative gathering of the engineers and managers responsible for the telephone system of the country. It also furnishes an excellent opportunity for letting a little daylight into the arguments levelled against the existence of the Telephone Company.

A noticeable negative feature of the dinner was the absence of Post Office officials, so we may take it that the ardent and disagreeable reformer, who last year made their presence at the annual dinner the subject of a Parliamentary heckle, has achieved his purpose. The directorate of the company was strongly represented, though the absence of the president, Mr. J. Staats Forbes, was regrettable. Lord Harris and Sir James Ferguson were there, while Prof. Hughes, Mr. Henry Edmunds and Mr. Gustav Byng were among the principal guests.

It was a dinner of few toasts, and was, perhaps, no worse for that. Mr. Gaine, the general manager, in proposing the National Telephone Company, spoke of its healthy condition. During the past year they had opened 90 new exchanges, and had increased their subscribers by 12,000, after allowing for those who ceased to be subscribers. They had been very active during the past year in laying lines underground. The great municipalities had recognised the commercial advantages of this means of communication, and had recognised that it was advisable in the public interest to make arrangements with the Telephone Company. The consequence had been that they were enabled to make great strides in all the large English towns in placing wires underground, and bringing the plant into efficient condition. He denied that the service was an inefficient one. Where facilities had been afforded the National Telephone service would compare favourably with that in any part of the world. Mr. Gaine, in speaking of the telegraph and telephone services, pointed out that by means of the latter, 480 millions of effective messages were sent last year, while the telegraph system sent 73 millions. Then the speaker passed on to consider the telephone systems of other countries, though he did not attach very much importance to the figures. Germany, with a population of 52 millions, had 107,000 subscribers; while England, with a population of between 38 and 39 millions, had 106,000 subscribers, that is, there was one subscriber in every 300; in Germany, 1 in 400; in France, where there were 30,000 subscribers, 1 in 1,200; in Austria, 1 in 1,500; in Belgium, 1 in 680; and in Holland, 1 in 1,000. He was not going to trench on political affairs, but it had been proved by experience that competition in their business was an impossibility, the system should be under one control and that an Imperial one; it always had been a monopoly and always would be.

Lord Harris in responding on behalf of the company compared face to face conversations with the telephone. If they saw a friend across the street engaged with someone else, or if they called at his office when he was engaged, they had to wait till he was disengaged. The same thing applied to the telephone service. If a subscriber used the telephone to a very great extent, the real remedy was to have more instruments. All they asked for was fair justice; they sought a fair inquiry, and they did not fear the result if the judges would hear not merely those who condemned them, but those impartial critics who were judges of the difficulties of telephony.

The toast of the guests was responded to by Sir James Ferguson, and shortly afterwards the gathering dispersed.

THE EXTENSION OF THE PARSONS TURBINE PATENT.

The steam turbine is so very new an application of the direct action of steam, that we think every one will concur in the extension of the patent for a further term of five years. Now that the turbine has established itself as an economical steam engine and has, in the "Turbinia," given the world a taste of its qualities, we think the patentees will be able to look after themselves fairly well during the period of extension. Undoubtedly engineers have required a good deal of bringing round to the side of the turbine, and we believe they were at one time equally sceptical in regard to that other direct user of steam—the injector. Like the steam turbine the injector has a peculiarly economical side. Excepting so far as it has to lift its water supply we cannot see how the injector spends any heat excepting only what it loses by radiation, for all the steam it uses is returned to the boiler whence it came either as heat or in the form of motion of the water jet, which becomes converted into heat by friction with the water in the boiler. In the steam turbine a loss common to all heat engines of cylinder type is entirely avoided. We refer to the loss due to the phenomena of cylinder condensation and re-evaporation. These arise from the varying temperature of the working fluid, be this steam or the products of exploded gas, and the endeavour of the cylinder to approximate its temperature to that of the fluid in contact with it. The cylinder metal is in a continual state of change of temperature, and this is a condition which is universally conceded to be extremely inimical to the possibility of economical working. In the steam turbine, however, the working fluid flows in a steady stream through the various passages. True it falls steadily in pressure as it passes from disc to disc, and its temperature continuously falls also as it progresses towards the exhaust outlet. But at any one portion of the turbine passages the steam which passes that portion always presents itself at one steady temperature, and as this steam passes forward to other portions of the turbine passages, 1 inch, 2 inches, 7 inches or 2 feet distant, it will still encounter surfaces at each portion of its route which are at its own temperature. There is no interchange of heat between the turbine and the fluid passing through it unless it be the small amount required to make up any slight radiation losses. The steam will lose some heat by conversion into work, and to such extent will become moist, but the moisture will not be re-evaporated by the metal of the turbine; it will simply be carried along with the steam, and to some extent will retard the flow of this steam, and generally it will, we should say, act prejudicially, but only in a mechanical sense, and even this slight condensation will be prevented by a little initial superheat sufficient to provide the heat which disappears, or a portion of it. Indeed, the free expansion of the steam itself which probably occurs without performance of work will be effective to some degree in making good the heat which is changed into work. The enormous velocity of steam and the difficulty in applying such velocities to direct driven mechanism have been against the success of the direct use of steam. These difficulties have been very well overcome in the Parsons turbine, and such as they are, they are counterbalanced by the entire abolition of that *bête noir* of the reciprocating engine, loss by cylinder condensation—a loss which, though by some considered to be over-estimated and to be partially debited to leakages, is nevertheless a very serious item. The turbine, like the dynamo, can laugh at balancing troubles. If only made well and balanced, as pulleys are balanced, it ought to run without vibration at the highest speeds. With five years for further effort in front of them, we hope to see greater improvements still effected in the economy of the steam turbine by its makers.

THE PURIFICATION OF SEWAGE EFFLUENT BY ELECTROZONE.

We have been favoured with a pamphlet, "The Sterilisation of Sewage Effluents and Purification of Water Supplies by the Electrozone Process," containing reports made by Prof. Henry Robinson, Prof. A. A. Kanthack, and Dr. Samuel Rideal. The introduction of this pamphlet begins as follows:—"Under the patents owned by the British Electrozone Corporation, by the application of a current of electricity to sea water, or to an artificial salt solution, a steriliser, deodorant and purifier, called Electrozone, is obtained."

Electrozone is then no longer what a well-known Q.C. said in 1896 before the Board of Trade, something in which "there is neither electricity nor ozone."

We are not told what these patents are, nor what sort of electrolytic plant was erected near the outfall at Maidenhead in December, 1897. What strikes us *primâ facie* is that the conclusions of these reports are much more favourable to this electrolytic disinfectant than the previous reports made during the last few years by specialists and scientists on the same disinfectant.

We must be pardoned if we declare that we do not merely see in this the question of the deodorising and sterilising power of an hypochlorite of sodium produced by electrolysis. The discussion of the bacteriological reports of Messrs. Robinson, Kanthack and Rideal on the germicidal properties of chlorine is not in our province; the main point which interests us is the production of the chlorine, and, to a certain extent, we should be justified in complaining of the reticence of the experts on the electrolytical question.

"As regards the efficiency of production of chlorine (expressed in grains of chlorine per Board of Trade unit), says Prof. H. Robinson, I have carefully analysed the figures contained in the daily reports from Maidenhead, and have made special trials with a view to ascertain the best conditions of working such as I could obtain from plant of a more permanent type than that now in use. Upwards of 3,000 grains of chlorine can be produced per Board of Trade unit in regular working with the existing plant, but I have obtained efficiencies, even with this plant, for short periods as high as 4,939, 4,813, 3,784, 3,538, 3,430, 3,420, 3,230, &c., and I am confident that much higher efficiencies than have hitherto been obtained in continuous working can be obtained in permanent works where the detailed arrangements of the plant and of the working are properly considered.

"In my estimates of the costs of the electrozone system, given hereafter, I have adopted only 3,500 as the efficiency to be relied upon in properly equipped plants for permanent work."

We do not in the least deny the disinfecting properties of electrozone; the whole affair is a question of £ s. d., but once more we must protest against the misleading name of Electrozone; it is simply ridiculous. "Electrozone" made by chemical means is Eau de Labarraque, hypochlorite of sodium or potassium; made by electricity, it is the Hermite electrolytic hypochlorite.

We must defer giving our opinion until we know something more about the electrolytic installation, the voltage, the amperage, the nature of the electrodes, the density of the electrolyte, &c. How much chlorine is produced with different densities of electrolytes? What is the yield of chlorine per kilowatt when the electrolyte used is sea water, and when the density of the liquid is 5, 10 or 15° B? This is rather important, as when tons of chloride of sodium solution are run into the sewage effluent, there is an enormous quantity of salt lost, owing to the considerable proportion of undecomposed salt.

We are decidedly partisans of the electrolytic production of chlorine for the purification of sewage. Whether it will be by the Webster, the Hargreaves, the "Electrozone," or any other process, is rather immaterial to us. In this respect we are like Iago, who does not care "whether he kills Cassio or Cassio him, or each do kill the other."

Provided we have plenty of chlorine at a low price, we are satisfied. Will it be the chlorine of the Electrozone that will solve this problem? This remains to be proved. And it is not out of place to ask what has been done by the American Electrozone Company during the last three years? Has it sterilised the effluents of Philadelphia, Boston, Chicago? We remember having read some very promising American reports on the purification of sewage by Electrozone. Is it possible that this work of sanitation has been discontinued, and if so, why?

We should like to see that the disinfecting liquid formed by the electric current is a great and indisputable success.

But although Messrs. Robinson, Kanthack, and Rideal may be very good electro-chemists, and know how to get the highest yield of chlorine from an electrolysed chloride of sodium solution, we are very desirous to be enabled to investigate the electrolytic method adopted by the British Electrozone Corporation and its superiority over other electrolytic processes.

We ought to have, for instance, one or two reports prepared by electro-chemists of high standing who would tell us how much chlorine is produced in a continuous process for a given expenditure of electrical energy in sea water or other cheap chloride solution. In plain words, we want to know the cost of chlorine per kilo.

There has been a good deal of controversy on the quantity of chlorine produced per ampere-hour, since the publication of the report, by some known experts, who stated that 1·45 grammes of chlorine was produced by 1 ampere-hour and 5 volts, equivalent to 80 kilos of chlorine per 272,300 watts. Prof. Robinson says that he can get 3,500 grains per kilowatt. This would make 226·64 grammes per kilowatt; and in round figures 272 kilowatts would give only 41 kilos 646 grammes, about half of what the Hermite experts, Raoul Pictet and others found.

We are the more inclined to insist on this, as Dr. Samuel Rideal himself, one of the scientists who report on this Electrozone process, does not seem to find that the electrolytic work is either admirable or perfect, since he says: "I estimate that the amount of available chlorine in the form of Electrozone could be obtained from a much smaller quantity of salt, whilst the power and labour would not materially differ."

We are asking in 1898 almost the same questions which Dr. Rideal asked in February, 1894, in a letter to *Industries and Iron*, in which he said:

"When we come to consider the behaviour of chlorine as a bactericide, the case is entirely different, as, without doubt, in order that it may be an effectual germ destroyer, sufficient of this element must be present over and above that required for the oxidation of the products of decomposition. It is very doubtful if the oxidising value of the Hermite liquor is sufficient to perform both these functions, and the adverse report on the sterilisation of the sewage at Havre points to the soundness of this conclusion."

"When information is forthcoming as to the actual quantity of salt electrolysed in the water, and the amount recommended for treating a given quantity of sewage, it will be easy to see whether the inventors of this process have made due allowance for the oxidation of the organic compounds which are associated with the bacteria whose destruction is aimed at."

His conclusion, then, was that it was desirable to obtain the following data:—

"1. The quantity of sea water electrolysed, and the efficiency of the electrolysis, *i.e.*, what percentage of the salt in the water is dissociated.

"2. The quantity of sewage treated, and the amount of chlorine required to oxidise it.

"3. The surface of metal exposed to the action of the electrolysed sea water, its rate of flow over it, and the loss of free chlorine in the passage of the water from the electrolyser to the sewage."

THE WAYS OF MUNICIPALITIES.

The electrical industry of this country is affected far more than it should be by the moods and fancies of Town and District Councillors, Vestrymen, and others. The scientific knowledge of these local dignitaries is seldom so accurate or extensive as it needs to be to make fair and reasonable criticism possible. The sum total of the knowledge of which they are possessed is, in nine cases out of ten, information read in some quasi-scientific publication specially intended for their edification, or in a daily or weekly newspaper. Of course there are exceptions, for in certain boroughs—few and far between—there are chairmen and members of electric lighting committees whose methods of dealing with electrical matters might be assimilated by the many councillors who have more delight in a heated squabble or a paltry quibble than a legitimate and reasonable discussion.

This is one of the evils attending the municipalisation of electrical undertakings, and as one occasionally sees how disastrous are the effects of the municipal magnate's ignorance upon the settlement of a question of this character—often delaying the carrying out of electrical works for several years, or tying the hands of those managing existing plants in an unreasonable manner, and hampering them in the fulfilment of their duties—then it is that one is convinced that the evil is of no mean proportions, but represents a state of things requiring to be grappled with.

To convince councillors that they don't know of what they talk is no easy matter, to instruct them were a better manner of dealing with them. If matters are to be satisfactorily settled, the municipal man must keep silence on points with which he is incapable of dealing. Otherwise there will be repetitions of the blind leading the blind with the usual result.

To merely state half the truth may sometimes do more harm than a downright falsehood, and the question of half truths is making itself felt in certain parts of the country at the present moment where electrical schemes are being considered. Some councillors having made up their minds to oppose a scheme make a practice of bringing forward facts and figures showing that similar undertakings have been failures in other towns, but they fail to mention or to take into account in any way the more numerous instances of successful and profitable operation which would far outbalance the quoted failures—if they are genuine failures.

The municipal mind is not beyond reproach. There is even now such a thing as unfairness and corruption in English municipal life. But that it should have touched electrical work is a matter to be deeply deplored. That contractors or promoters should lend themselves to practices making municipal corruption possible comes to us as a surprise, and calls for a complete exposure.

Our contemporary *London* has been waging a righteous war in the camp of the Hackney Vestry, and has also been making certain investigations which do not redound to the credit of Fulham. In regard to Hackney, it will be remembered that for several years past there has been trouble *re* the electric lighting question, and the chairman of the Electric Lighting Committee seems now to have a burning desire that the Vestry should hand its provisional order to a private company upon certain conditions, and insert in the agreement a clause of early purchase if desirable. He considers that loss is certain, and we remember being present at a meeting of the Vestry a few months ago when this gentleman brought forward some figures of municipal plants which he said had resulted in a loss. His statements showed that he had inquired into the electric lighting question less than an electric lighting committee chairman should do, for he quoted as losses plants which are earning a profit. The Vestry consequently invited offers from companies willing to purchase the powers, and one of the offers sent in has been seen by *London*, and is quoted from at length. Curiously enough, the electrical engineer of the very successful municipal electrical works at Brighton—who, as most of our readers have heard, is now connected also with the British Thomson-Houston Company—champions the cause of the company, if *London's* statements be correct, by trying to dissuade the Hackney Vestry from doing exactly what he has been enabled to do with so great success at Brighton. It appears that Mr. Wright says that it would be an almost inevitable loss due to mistakes of policy and system during the first risky years of such a business. We quote: "The serious nature of this risk may be judged from the fact that all the following municipalities who put down their own plant made last year in their electricity departments very considerable losses, which in nearly all cases had to be made good by the ratepayers," this statement being followed by names of 26 towns. Our contemporary's reply to this is worth quoting here:—

The list of places has been ingeniously selected. They either refer to works newly started or to places which have committed mistakes which a town now starting would avoid. Islington, for instance, had only a loss last year of £318, which is more than wiped out by the profit of the first quarter of this year. Mr. Wright ingeniously omits Hampstead, which in the second year of its enterprise had a surplus profit of £1,832. The loss in St. Pancras was incidental to the expansion of the undertaking. The profit in the previous year was £1,200, and on the whole of St. Pancras this enterprise has been profitable. The loss in Aberdeen was trifling, and in the previous year there was a profit of £435. Scotch towns do not seek to make a profit on such undertakings. The loss in Leicester was only £265, in Bolton it was £101, in Hanley £188, and in other towns the amounts were not "very considerable." But we decline to consider the deficits in the light of losses at all, as out of the gross profits the municipalities pay not only interest on the capital invested but set aside annual sums for depreciation of sinking fund. Judged by the same standard as companies would be, we find that the return per cent. on capital invested was as follows:—

St. Pancras	5·25	Dewsbury	7·21
Islington	3·60	Dublin	4·95
Brighton	6·83	Hanley	3·26
Bedford	3·74	Leicester	4·66
Bolton	5·51	&c. &c.	
Cardiff	3·64		

Only in three places which Mr. Wright mentions was there an actual loss. Mr. Wright could have very easily selected a list which would have been convincing to the people of Hackney. He could, for instance, have cited Tunbridge Wells, which in the first year of its enterprise had a return of 11 per cent. on its capital and a surplus profit of £887, and other places where the first and second years have turned out profitable, and where the profits on the third year wiped out all the small deficits. Mr. Wright could have gone further, and shown how the municipal works in Brighton which he manages make a profit of £6,000 a year; how Bradford brings a return of nearly 12 per cent. on the capital invested; that Manchester made a profit of £17,000 last year, Edinburgh a profit of £3,400, and so on. Nor is it right to make comparisons with other places where the production of electricity is not mixed up with the disposal of dust, as is contemplated in Hackney. This entirely introduces a new condition of things, with possibilities of enormous economies, as Shoreditch is already demonstrating.

Our contemporary challenges Mr. Wright to deny that the return per cent. of gross profit on capital invested is not on the average higher in the case of municipal electricity works than for private undertakings.

There have been all sorts of charges flying about Hackney in respect of this electric lighting affair since the offers were invited. The committee are charged with being "treated" in a variety of ways, but by whom is a question not yet cleared up. It has even been said that a cheque for £400 was paid to one vestryman and smaller cheques to others. But by whom? That is the question. If by any of the parties anxious to secure the provisional order then there is room for an immediate inquiry to be instituted. For the present, without actual evidence, we cannot bring ourselves to the belief that such a state of corruption and bribery exists in connection with electrical affairs. We do not like to think it possible, bad as the appearances are.

To turn to another matter in connection with the municipal man and electrical works. There have been in progress for some months past, two schemes having for their object the distribution of electric power over large areas at cheap rates. The scheme of the Midland Electric Corporation for Power Distribution takes in the towns of Wolverhampton, Coseley, Wednesbury, West Bromwich, Dudley, Oldbury, and a number of other places in that neighbourhood; but this company has been hindered by several of the municipal authorities. The West Bromwich Council had a discussion regarding it, and in regard to the financial side of the question one of the councillors brought forward some figures as the result of the working of nine companies, from which it is shown that the revenue of these companies was £527,938, and the cost of working £262,390, leaving a profit of £265,508, and that after setting aside £78,999 for depreciation they had distributed in dividends £179,507. These facts, taken in this way, are misleading as applied to the case of a town like West Bromwich, especially as bearing on the proposal that the Town Council should generate a supply of electric current themselves. To make the profits appear too great is a weakness of many who are enthusiastic for municipalisation, in the same way as to magnify losses is a means adopted by those championing the cause of private enterprise. Mr. Allbright, one of the promoters of the scheme, writing to the local press on the subject, points out that an analysis, not of nine companies, working under most favourable conditions, but of the accounts of all the Corporation-managed supply works in the Kingdom should be made.

He suggests that it is not fair to pick out say nine of the best and largest electric lighting undertakings working in localities where the consumption is very great, and where the price which can be obtained for electricity is still very considerable, and then on these figures to assume that such a town as West Bromwich can produce results of approximately the same description, or that such figures can even be taken as a basis on which to form a reliable opinion.

Figures can be made to prove anything, either for the purpose of municipalities or companies, and the municipal mind is powerfully influenced by them. But whoever produces them should first be assured of their accuracy, and no cooking should be resorted to for the sake of proving a case where an industry of this kind is affected.

As showing the unreasonableness of the Wednesbury Corporation in respect of this Midland power scheme, we may mention that after the promoters had been for many months negotiating, the Council at the last moment decided by a majority of eight votes to five to apply for an electric lighting provisional order in opposition to the company. The Council is acting within its legal rights, but whether the Wednesbury Council can do as well for itself as the company could by putting down its immense scheme—which would, of course, result in very low costs of generation and distribution—is questionable. However, municipalities have, in some parts of the country, treated companies in a merciless manner, for after securing powers they have often refrained from carrying them into effect, as the recent *Times* correspondence, reproduced in our issue of April 15th, goes to prove. We may, perhaps, just mention in connection with this power scheme a parallel case where gas interests were involved. There was formerly in the South Staffordshire district, a large gas company covering much the same area as the Midland Electric Corporation now proposes to do, and this gas company also supplied Birmingham. When Birmingham determined to go in for its own gas, some of the smaller authorities thought they would do likewise, and they set up their own plants in order to make a profit. Two of these authorities, at any rate, are now charging their ratepayers 4d. per 1,000 feet more, or about 12 per cent., above what they could have been charged by a large company. As these authorities, we believe, make some profit, it is seen that by their action they are not only keeping their ratepayers out of the advantage they might enjoy, but they are actually spoiling the use of gas in favour of the local rates, besides this the local authorities have incurred debts in each case of probably over £50,000. In the face of these facts, Wednesbury, a town of 24,000 inhabitants, has decided to oppose the Midland Electric Corporation and go in for its own installation, although the whole of the town is practically taken up with works, and there is very little outlook from an ordinary lighting point of view.

ACCUMULATOR ELECTRIC TRAMWAYS.

A DEPUTATION of the Blackpool Corporation, together with their electrical and tramway engineer, have issued an interesting report upon what they saw and heard on a tour through those Continental cities which have added electric tramways to their other means of locomotion.

Whether these trips in search of useful knowledge really have any influence in the decision of the questions regarding the systems to be adopted is very doubtful; at any rate, in one case, an important Yorkshire city corporation hurriedly settled the contracts for an American system of overhead trolley traction, and then sent out a deputation on a Continental tour, with their electrical engineer. Adopting a system first, and then making the grand tour, saves all bother in making reports and comparisons.

In the case of Blackpool, however, a really instructive report has been issued, with an earnest endeavour to arrive at facts regarding the results of actual practice on the Continent with the four systems of electric traction on tramways. They examined the overhead trolley, the conduit, the combined trolley and accumulator, and the accumulator systems.

Blackpool was a pioneer town in electric traction, and there the failings of the conduit system were laid bare. The deputation started out to ascertain the results of practice in accumulator traction, and it is from that point of view the report is interesting. Although it is not to be accepted as a correct comparison, nor its conclusions as authoritative, yet the information it gives is valuable so far as it goes.

They find that many disadvantages which were discovered in early accumulator systems have been entirely overcome, that the system is quite practicable, and has some advantages peculiar to itself; and the only reason why they cannot adopt it is one of expense. An accumulator system, to be worked successfully, costs much more in capital outlay and in maintenance than a trolley system, but not quite so much as the Blackpool deputation estimates.

The members do not take account of recent improvements in accumulators whereby an output of energy of 13 watt-hours per pound of battery has been reached; that is, nearly double the output of cells used for traction on the Continent. It may be said that these results require confirmation in practice before being considered, but still they show that the cost of battery traction (and that is its chief drawback) is being considerably lessened.

Then in calculating out the relative costs, no allowance is made for the fact that a battery charging plant costs less on capital outlay and in maintenance, and works at much higher efficiencies than a trolley traction power plant.

In the trolley system the power factor is very low, with the battery method it can be made over 90 per cent., while in the case of the trolley it is under 40 per cent.

The dynamos and engines in a trolley plant require to be large enough for the maximum current while running most of the time under half load, and the whole question has not by any means been decided by the report of the Blackpool Corporation deputation. The cost of current at a battery charging station properly laid out would be less than the cost of current from a trolley station, and still less than that from an electric light plant.

At present, of course, the accumulator electric tramways are in their development stage, while the trolley is in its fully matured state, so that corporations are not inclined to undertake much in the nature of experiments; but all the same accumulators go on improving, and we hope in the near future to find this system an active competitor with the successful trolley system.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

ON Thursday evening last week the Institution of Electrical Engineers met to resume the discussion on Mr. Robert Hammond's paper: "The Cost of Generation and Distribution of Electrical Energy."

Mr. Preece being unable to be present, sent a written communication thanking the author for his excellent paper. Prof. Kennedy opened the resumed discussion by expressing his intention of, as time was short, not wasting any time in flattery. His succeeding remarks showed, however, that he fully appreciated the value of the paper. He endorsed Mr. Crompton's opinions, and thought that to those who are dealing with the question of costs everyday, figures tell a great deal, and are readily capable of interpretation. An immense number of points might be dealt with, and things said, but he preferred to confine himself to one or two matters of some importance.

He did not regard with favour the method of arriving at *ideal costs** by taking the best figures from different stations, as we do not know how or why the various items are co-related. It is impossible to get the very best results for them all in any one works. Again, the table (No. XII.) showing load factor and units used in distribution, tells more distinctly than any other how complex the problem is; different systems astoundingly far apart, give more or less the same result. He hoped the uncomfortable person who thought he had discovered the *best* way of distributing electrical energy by a particular system, was dead and buried, as anyone who thought there was one, and only one, way of running a station, might learn something from a perusal of the figures in the table cited.

It would be foolish to deny that load factor is a very important matter, but he would not put it so high as Mr. Hammond does. Of course, if one could manage to get a nice comfortable rectangle it would be a boon, but the fact should be faced that apparently we shall always get a peak. Even if one could aim at a load diagram giving a rectangle, the rectangle in summer would enclose a much smaller area than in winter. Take the two Newcastle Companies, for example, with widely different load factors; it is a remarkable thing that the costs are practically the same, and the coal item is even higher for the company with the larger load factor. Many other features as striking as that might be cited.

Comparing the Charing Cross and Westminster Com-

* See page 305, No. 134, Vol. xxvii. of the *Journal of the Institution of Electrical Engineers*, or page 59 of the paper in proof.

panies, the costs are practically of the same order, and there is nothing to indicate that the difference in load factors affects the results at all proportional to what one would suppose. One might draw a curve from left to right horizontally or diagonally on Diagram III., showing units per 8-C.P. lamp per annum, and works' cost, and base almost any argument upon it, the conclusion being that the whole problem is so complicated in electricity supply that individual differences do not affect the result sufficiently to leave their mark. If the author had done nothing else, this deduction from his paper would have been valuable.

The engineer factor is a very big factor indeed, but can't be put on a curve. Prof. Kennedy does not suggest that the form on Table XVII. (p. 342 of the *Journal*) is any better than any other, but it is conveniently sub-divided to show the whereabouts of the remainder, after units sold to consumers, which should be known to the engineer in charge. When he had added up the losses and the quantity sold, a balance with the amount said to be generated should be obtained. He did know that in some cases the balance was struck within 1½ to 2 per cent. of the whole, and believed it was very much worth everyone's while to know it. Many items fall *pro rata* as the units increase, but stations are not working quite comfortably when up to ·4d. per unit has to be paid to the parish authorities.

Mr. Raworth first referred to the paper as a magnificent result of Mr. Hammond's labour on behalf of all those who had to do with electricity supply, and remarked briefly upon its bearing on the schemes for general supply of electric power over large areas. The personal element tells at once in a station. Thus, at Huddersfield, the item of oil, waste, &c., had been reduced to an infinitesimal 0·02d., and the most curious thing in the world is that this station is equipped with open type engines, which certainly do throw the oil about. Compare this remarkably low figure with stations at the end of the list, and it is found that several are using up to 0·40d., or 20 times the cost of oil, &c., at Huddersfield, while many stations spend actually less on coal than these latter do for oil, &c.

Coming to staff and management, it is apparent that London companies are much more liberal than municipalities. Some companies, such as the City of London, will never be able to show any record figures, as owing to the day load being variable, due to clouds passing over, a large staff, and many boilers under steam are the rule. The moment a man becomes financially interested in an electricity supply company he cannot be happy while the sun shines, and positively gloats over a fog. Prof. Kennedy, Mr. Raworth thought, was right, as works cost is not much improved by load factor. The effect is marked only when the increase of load factor is large enough. Thus the total cost of production in a certain works where a steady demand existed for 24 hours daily was 0·28d. per unit.

Mr. Shoolbred explained at length the use and effect on cost of batteries in low pressure stations, and thought they had a specially important bearing on financial results, in addition to simplifying regulation and acting as a reserve. He fancied that an electricity supply system ought not to differ from other supplies (gas and water), and cited the saying of gas engineers, that until storage is used electricity supply cannot be on a par with gas supply. Particulars of the load curves and cost of production at Birkenhead and Bradford were given, and it was shown that with small loads batteries are of great utility, but diminish in value as the load rises.

Mr. Patchell agreed that "salaries" ought logically to go into *generation* costs. He believed the statement of Mr. Arthur Wright that at Brighton the "charge is 1½d. per unit for all consumption beyond the average of one hour per day" was a most unhappy statement. So many people stopping short at the word "consumption." Mr. Patchell is by no means the only one who has found a wide-spread belief in this direction. He characterised *ideal costs* as "crazy patchwork." One station with 380 kw. installed and maximum load of 190 kw. is referred to in the table, and such should have practically no repairs. The Charing Cross Company found their theatre load lead to sudden calls upon the plant owing to rehearsals, and necessitated considerable stand-by machinery, thus affecting steam used and boiler losses. He wished he could get a huge, big, thumping battery, and rely on it. The speaker then drew attention to the care that must be taken if accurate results of *units generated* are desired, and thought stress should only be put on *units sold*. He noted that the sudden rise in "rents, rates, &c.," item synchronised with the new assessment in London.

Mr. Addenbrooke pointed out that the "load-factor" did not take into account how the units were generated before or after the time of maximum load: the rest of the load will vary with the breadth of maximum load in two load curves having the same maximum and factor. He elaborated this point by showing how the costs are affected by varying qualities, and mentioned that an article from his pen had appeared in the ELECTRICAL REVIEW some 18 months or two years ago bearing on the matters under discussion.

It was noteworthy that at this point the statement was made, that although Mr. Wright had in a bold way called attention to the incidence of works' cost, the matter was perhaps being pushed a little too far, and people were penalised who wanted to use the current for a short time. We have had indications that a feeling is gradually growing that the present Brighton scale is not perhaps quite fair to the short-hour consumer when the supply is under the control of the municipality, although perfectly logical from the works engineer's point of view.

Mr. A. J. Lawson showed that the interest, &c., on capital on London stations as an average represented (taking 50s. per lamp for the capital expenditure) 3d. per unit, and that, therefore, a unit could not be sold for much less than 4d. He next indicated that the heavy salaries and management charges in London tend to prevent very low prices in the metropolis, and deplored the multiplication of generating stations by every little local authority. He found that the day load caused by the trams at Dover reduced the works' cost 1d. per unit. Regularity of supply is not peculiar to continuous or alternating supply, while the loss is only slightly different. In the case of two stations he had to do with :—

RICHMOND.	WANDSWORTH AND ST. LUKE'S.
Direct current loss was 10 per cent. only. Economy in small stations of batteries very great, as one shift of men suffices.	Magnetising loss on the alternating system did not exceed 15 per cent., owing to care taken in switching off idle transformers.

Mr. Sayer proceeded to explain how losses could be separated and classified in direct current and alternating current stations. The load factor he thought was controlled by the tariff. At Bournemouth—

1895.	1896.	1897.
8d. per unit.	7d. with rebate.	7d. with rebate.
7·1 per cent. load factor	11·2 per cent.	12 65 per cent.

Expensive coal might be cheaper than low price coal. The calorific value is not much guide, as the hydrogen calories are practically useless in a boiler furnace. Mr. Sayer's remarks are worthy of attention when the authorised report of the discussion reaches our readers.

Mr. Gadsby gave an equation representing the price he thought a corporation ought to charge for supply, say, to trams or similar load:

$$y = \cdot 002\,x + 100$$

where y = £ monthly paid for current

and x = units taken monthly.

Mr. Cowan believed that the mean radius of supply from mean centre of supply influences the cost of supply, and briefly discussed the incidence of distance to which units are distributed upon works' cost.

After Mr. J. W. Swan had contributed to the discussion, Mr. Hammond replied. His principal points were: the Board of Trade should amend its form so as to give us all the facts and actual figures; no difference should be made between companies and corporations; the form should embrace schedule of losses and statement of units, which should be made an integral part of the accounts. No works has reached finality in capital expenditure. Mr. Hammond rather set himself to press home the objects of his paper than to meet critical remarks, as time did not permit a full reply.

The meeting then adjourned the formal and proceeded to the informal discussion.

ELECTRICAL ENERGY (GENERATING STATIONS AND SUPPLY).

Viscount Cross presided on Thursday last week over the first sitting of the joint committee of the House of Lords and Commons appointed to inquire into the above subject. At the commencement of the proceedings a large number of applications were made by gentlemen representing companies, local bodies, &c., asking to be allowed to be heard before the Committee by counsel.

The Chairman said the Committee would consider that question later on in the day.

Sir Courtenay Boyle, in reply to the chairman, said he was the permanent secretary of the Board of Trade. The number of orders which had been granted since the year 1888 for electric lighting was 316, and at the present time there were 274 still in force. The total number of electric lighting licenses in the same period was 25.

How many of them exist at the present time?—Only three. Witness said that they took the period since 1888, because the Act of that year extended the tenure to 42 years, during which the local authorities could purchase the undertakings.

Although the particular Act refers to electric lighting only, there is no limitation in the Act?—No, but the procedure under Electric Lighting Acts has always been for the provision of energy for electric lighting purposes, but that energy could be used for lighting, telephoning, for propelling vehicles, or for cooking, or other purposes.

As regards powers of compulsory purchase of land?—The Board of Trade have no power under the Electric Lighting Act to authorise by order the acquisition of land for such purposes otherwise than by agreement. As a consequence of that, no lands are scheduled in the orders. The fact is, the undertakers get their land by private agreement.

I presume you have acted upon the general principle that electrical works, *primâ facie*, ought to be conducted without causing a nuisance?—The Board of Trade have always had that in view, but, of course, it is very difficult to avoid vibration, smells, &c.

As to compulsory powers of purchase, what are the sort of considerations that arise?—The first consideration is, is it desirable that there should be large generating stations, and that is a point upon which I have very little doubt the Committee will have a great deal of expert evidence. From one point of view there are great advantages in a few large generating stations supplying energy in large quantities under specially guarded circumstances and conditions, but if that is done the generating stations must, in the nature of things, be outside the area of supply of the various undertakers. Consequently there would arise the necessity for more frequently breaking up the streets. At present you have the generating stations of the undertakers in the area of supply, and they break up the streets. In London, as a general rule, there are two undertakers in every parish who supply electricity. If, in addition, you have a generating station outside the area of supply, you will get another party breaking up the streets. On the other hand, the difficulty of acquiring sites is unquestionable. Undertakers find it very difficult to acquire sites for generating stations. Generating stations must be an inconvenience, but they need not necessarily be a nuisance.

Undertakers are prohibited from supplying energy or erecting works beyond the area of their supply?—If they do so there is power to revoke the order.

But there is nothing to prevent their erecting generating stations outside their area, provided they can get leave?—The local authorities in some instances have given undertakers power to break up streets outside their own areas. The law officers have advised the Board of Trade that such a proceeding is *ultra vires*.

If you have generating stations outside the area of supply, there is a difficulty when the question of purchase by the local authorities comes to be considered. That is a very great difficulty, and undoubtedly there must be some inconvenience caused.

What is the period of purchase generally?—Forty-two years, as a rule. It is variable, however, by provisional order.

On the question as to what pressure should be allowed, the Witness said that no doubt the Committee would have witnesses before them who would say that it was just as easy to convey electrical energy at a very high pressure as at a low pressure, but perhaps they might hear from others that electric energy was like a wild beast in a cage, always trying to get out. For ordinary purposes, 3,000 volts might be considered high pressure, but the Board of Trade had given power in certain cases to a higher pressure than that.

About the telephone and telegraph systems; are you afraid they might be injuriously affected by high pressure mains?—Well, there is no doubt that high pressure currents, if there is anything like leakage, are a considerable danger to the telephone and telegraph systems, and there is considerable danger caused by leakage from high pressure mains. Sir Courtenay Boyle then referred to the Bill of the General Power Distributing Company, and of an application which had been made for a provisional order for the supply of electric energy in a large area in the Midlands from a generating station situated at Wolverhampton, and said there were many important questions which would have to be considered before those powers were granted.

None of the companies have a monopoly?—Oh no. They have no monopoly, and it is contended by the promoters of this Bill that if they get the powers they seek, they will be able to supply electrical energy for the use of mines, factories and lighting purposes at a very low price. The Witness, continuing, said he was unable at that moment to give the Committee accurate information as regarded the generating systems of America and Germany; but he would take care to give the Committee information on that point at a later stage. It would be very difficult to apply the principle of purchase by local authorities to such a case as the General Power Company; in fact he did not see how it could possibly be done.

By Lord Knutsford: He would not give local authorities power to compulsorily purchase works outside their own area.

Replying to Mr. Kimber, Witness said that if generating stations were a long distance from the area of supply, the voltage power allowed must be higher than if the station was in the area.

And in consequence of that, the interference with other electrical industries, such as telephones, telegraphs, electric tramways, &c. would tend to be very serious?—My own opinion is that it would tend to increase the risk of interference; but there are many electrical experts who do not think so.

Lord Balcarres: What was the reason which led the Board of Trade to allow two competing companies in every district in London?—Witness replied that that was really the result of a compromise, arrived at after a very long and elaborate inquiry in 1889, which was held with a view of determining whether competition in London should be allowed, or whether companies should be granted a monopoly. It was held as a compromise that it was desirable to grant two companies power over the same area.

And that gives a certain amount of competition?—Yes.

Is there any parish in which there are more than two companies?—Yes; there is a parish not far from here in which there are three, but there is no parish in which there are four.

Lord Morley, Chairman of Committees of the House of Lords, was next examined as to the procedure relating to the granting of provisional orders. He said that, except as regarded tramways, the Electric Lighting Acts made no distinction between light and power. All companies applying for a provisional order must be limited companies incorporated under Act of Parliament. He said that Parliament was very jealous in respect to giving compulsory powers of purchase for any purpose, and the cases in which such powers had been given were generally under the Public Health Act, where it was clearly shown that the powers would be for the advantage of the public.

Would you be against granting compulsory powers simply to a limited company?—I don't like to go quite so far as that, but it is worth while the Committee considering whether the rule should be broken. It is an important rule, and I don't think it ought to be broken without the very clearest necessity being shown for it.

If compulsory powers are to be given, there are two ways to do it; either to come to Parliament, or to give the Board of Trade authority in the matter. Which process would you agree to?—I have rather a difficulty in answering that question. On the one hand I am extremely anxious not to break down the existing system, which has worked extremely well up to the present time by provisional order; and on the other hand I am reluctant that Parliament should give up its powers. It has been suggested that it might be possible, where companies require compulsory power, that they might come to Parliament first, and then go to the Board of Trade; but I think that would be too expensive and cumbrous.

Lord Knutsford: On the whole you are in favour of compulsory powers being granted only to companies that are incorporated?—Generally that is my opinion.

Of course companies cannot be incorporated under a provisional order, and therefore parties applying for a provisional order must be incorporated to meet your views?—Yes. Continuing, the Witness said that that delegation of compulsory power to the Board of Trade would throw a lot of extra work upon the department, and would introduce a new element of contention when provisional orders were asked for.

By the Chairman: It seems to me a very common sense point of view that it is desirable to get these large generating stations out of the large centres of population, the same way as gasworks are; but there are difficulties in the way.

By Mr. Kimber: He was not prepared to say that he would recommend the insertion of a "nuisance" clause if compulsory powers were granted, but he thought the Committee might very well consider how far these generating stations could be worked without creating a nuisance.

Lord Balcarres: With regard to the difficulty of purchase at the end of 42 years—is it at all likely that a local authority would wish to buy mains without plant, or plant without mains?—I should imagine not.

Need we take that into consideration when coming to a decision as to whether outside generating stations should be allowed or not?—Well, I believe thus far all the generating stations are within the area of supply.

Mr. Kimber: Excepting Deptford.

Lord Balcarres: But in the event of this General Power Distributing Company and this provisional order for the Midlands being passed, there would be two fresh cases in which a great central station will supply energy from points at from 12 to 26 miles distant?—That is so.

In considering this scheme, do you consider it necessary that we should contemplate that at the end of 25 or 30 years the local authorities would wish to buy bits of plant?—Of course it would be absurd for the local authorities to buy bits of plant.

By Lord Knutsford: It was quite possible they might wish to buy pipes in their own district, and have powers over them.

Mr. Chandos Leigh, Q.C., the speaker's counsel, was then briefly examined, and said that, generally speaking, he endorsed what the two previous witnesses had said.

The Committee then consulted in private for some time, and on the re-admission of the public the Chairman said the Committee had been considering the course of procedure in the matter. He wanted to call attention very specially to the exact order of reference, which was as follows:—To consider and report: (1) Whether, notwithstanding the provisions of Section 12 (1) of the Electric Lighting Act, 1882, powers should be given in any cases for acquiring land compulsorily for generating stations; and if so, under what conditions as respects liability for nuisance, notices to surrounding owners, and otherwise. (2) Whether compulsory powers of acquiring land for generating stations, if proper to be given in any case, should be given where the proposed site is not within the area of supply. (3) Whether, in case of a generating station, however acquired, not being situate within the area of supply, power should be given for the breaking up of the streets between the generating station and the boundary of the area of supply. (4) Whether powers should be given in any case for the supply of electrical energy over an area including districts of numerous local authorities, involving plant of exceptional dimensions and high voltage; and, if such powers may properly be given, whether any, and what, conditions should be imposed—(a) With respect to system and plant, and to the construction and location of generating stations, in view of the powers of purchase conferred upon local authorities by Sections 2 and 3 of the Electric Lighting Act, 1888; (b) with respect to the relations of the promoters to other undertakers and to local authorities within parts of the area. (5) Under what conditions (if any) ought powers to be conferred upon promoters seeking to supply electrical energy to other undertakers and not directly to consumers. The Committee had determined not to travel out of that record by one single inch, and they would have nothing to do with particular Bills which were before Parliament at the present moment, as they were only there to discuss questions of general principle. They had also decided that all applicants who desired to be heard should send in their applications in writing, stating the particular points upon which they wished to be heard, and the names of the witnesses they wished to bring. As regarded counsel, the Committee would only hear one counsel upon one particular head, and the parties interested must agree among themselves as to the witnesses they wished to produce and as to the counsel.

After another adjournment, representations were made to the Committee by counsel and Parliamentary agents on behalf of the parties interested in the inquiry as to the matters desired to be raised from the points of view of various electric lighting companies and local authorities.

The Committee adjourned until Monday.

Lord Cross presided on Monday over the second sitting of the Joint Committee.

Mr. Frank King, engineer-in-chief to the Chelsea Electric Supply Company, was examined on the first head of the reference, and said that in 1895 his company acquired the reversion of a certain lease. A portion of the ground was covered by houses and shops, and in the area was a row of houses known as Steer's Buildings, and a stone-yard belonging to the Vestry. The total area of the site was 65,700 square feet. There were certain unexpired leases on the land. The London County Council authorised them to build on the site, and there was partly built a generating station thereon. The station had been constructed so as to be economical to themselves and innocuous to other people. One of the principal features to consider in making a generating station was the minimum plant required. They could put on 1 square foot of land generating plant which would light 7½ lamps at an ordinary equivalent of 8 candle-power. The houses on the site were of a very small class and in very bad order. They had a chimney 100 feet in height and one 150 feet high. The result was that the air was very much clearer than it used to be. The Alpha Place station was approved by the London County Council two years ago, and they commenced the erection of works immediately. They found great difficulty in getting the site cleared, and they had to pay extraordinary prices to get them out in anything like time, and the result was that they had been delayed very considerably while they were under statutory obligations to supply the demands of the district. In one case they had to pay £600 for a little fried-fish shop which was not worth £100. It took six months for them to safely erect a chimney shaft, and it took them at least 18 months to complete a generating station. The result was that if they were delayed six months they found they could not meet the demand. They desired to extend the station, and they had to acquire a cottage worth about £150, but the vendor wanted them to buy other property at a cost of £39,000. It was obvious that if they were to meet the growing demands of electric light, their plant must be commenced at the earliest possible moment. They had machinery ordered now, but no place to put it in. They could get on if they could get a portion of the Vestry yard, but the Vestry would not listen to any negotiations whatever. If they got the whole of the site, its capacity would be about 150,000 lamps. They believed that the area under their provisional order would absorb 750,000 lamps, and their present accommodation, adding the stations together, was for about 400,000 lamps. It was only possible for nuisance to arise from vibration or smoke and steam. For the purpose of obviating the first, they had twice substituted machinery, and they had now an engine which was absolutely free from vibration. They had eight engines at work at present, representing over 2,000 horse-power, and on examination in the adjoining house, they had failed to find any vibration. With respect to smoke, they burned the best smokeless Welsh coal that money could buy. They were watched very assiduously by the Vestry, and never received any complaint at all. They failed to find any condensed moisture in the neighbourhood. They did not intend to build any shafts less than 150 feet in height.

In answer to Mr. Coward, representing various Corporations, Witness said he had no objection to Corporations having similar compulsory powers to the companies.

Mr. Coward: You are seeking here compulsory powers. Do you see any objection to local authorities having notice of your seeking compulsory functions, and to them being heard if they think fit in the interest of the ratepayers?—I can understand that in the case of a new company; but in the case of an old company, I think it would hamper them.

By Lord Knutsford: The engine he referred to as being free from vibration was Willans. It was largely used by other companies. The man who wanted to sell them his property complained of the vibration.

By Mr. Kimber: There would be no objection to having the construction of the chimneys supervised so as to avoid smoke nuisance whatever the coal used was.

Mr. Kimber: Are you prepared to say as an expert that adjoining properties would not be affected by the vibration or smoke?—I am not prepared to say that.

The Chairman: Have you considered whether the action of your company would in any way interfere with the telegraph or telephone?—It would not.

Mr. J. I. Courtenay, chairman of the Chelsea Electric Supply Company, was next called, and, in reply to Mr. Coward, said he saw no reason why local authorities should not have the right to be heard before the companies got compulsory powers.

The Chairman said that was a matter of policy for the Committee to consider.

Mr. Sydney Morse, solicitor for the Chelsea Electric Supply Company, chairman of the Electrical Trade Section of the London Chamber of Commerce, and member of the Council of the Institute of Electrical Engineers, gave evidence regarding the standing orders of the Houses of Parliament before the change in 1893 and after. In a number of electrical railways Bills a clause was inserted with respect to generating stations. There would be great difficulty in incorporating electric light companies, because incorporated companies could only borrow to a certain extent, whereas the majority of the electric light undertakings had, under Stock Exchange rules, borrowed considerably in excess of the standing orders.

Answering Lord Balcarres, Witness said progress had been made to prevent nuisance arising from generating stations, but, of course, an engineer might not consider a thing a nuisance which a householder would.

Mr. Albert Gay, engineer to the Islington Vestry, said his Vestry had experienced some slight difficulty in regard to their generating station for the want of compulsory powers. They selected a site for the station which was bounded on two sides by a railway, but on one side there were several small houses they endeavoured to buy, but found a certain life interest in two of the houses which prevented them being sold.

This concluded the evidence on the first head of the reference, except that Sir Frederick Bramwell may be called. The Committee then proceeded to deal with the next two heads of the reference, dealing with generating stations outside the area of supply for the power of breaking up the streets.

Mr. Eustace Balfour said he was chairman of the St. James's and Pall Mall Electric Lighting Company, which started in 1888. He was also the chairman of the Central Electric Supply Company, which had a scheme before Parliament that session. It was proposed to acquire a site and supply electric current both to the St. James's and Pall Mall Company and the Westminster Company. The St. James's Company had had to pay very heavily for sites, and he did not know where it was possible to acquire a new site in the area. They had two stations, and there was no railway or canal convenience for bringing coal. Their coal consumption roughly came to about 200 tons a week. To get a generating station outside the area they would have to get compulsory powers to lay mains or else get the consent of the local authorities. It would, however, only mean the laying down once of a trunk main. The Central Company proposed to acquire a station in the parish of Marylebone which would furnish current to St. James's and Westminster. The demand for electric current was largely in excess of anticipation.

By Mr. Coward: The power sought to be acquired would enable the undertakers to break up the streets without the consent of the local authority, but considering the small amount of interference required, he did not think there should be any objection. He was not aware that in Manchester all the mains under the streets were acquired by the Corporation for the purpose of obtaining proper control over the streets. He was prepared to agree to a reasonable clause in conjunction with the local authorities. He would have no objection to paying a moderate rent for the use of the streets.

By Mr. Stevens: He did not know how far the principle of the General Company supplying other undertakers had gone, but if the St. James's Company had a breakdown, they would go at once to the London Company for a supply of current. The Central Company did not intend to supply the public.

Examined by Earl Spencer: The rapid growth of the use of electricity had forced them into having a central company to supply electricity to other companies.

By Mr. Kimber: In saying there would be one trunk line, he took it that they would keep others out; but still, if there was a rival the breaking up of the streets would not be what it is now.

Replying to Lord Knutsford, Witness said the Central Company had arranged to supply two companies, but they did not ask for a monopoly.

By Lord Cross: He agreed that England was behind other countries in electrical progress, and the compulsory purchase by the local authorities in 42 years had crushed many earlier attempts. He had not worked the figures out to see if it would pay to form a great central supply station to supply electricity for 50 miles round, but if it would he thought it would be a good thing.

Prof. Kennedy, F.R.S., engineer-in-chief to the Westminster Electric Lighting Company and joint engineer of the Central Supply Company, which had a Bill in Parliament to obtain compulsory powers, said that in two years' time the St. James's and Pall Mall Company and the Westminster Company would be at the end of their tether in supplying current. His company worked very smoothly with the local authorities.

Replying to Mr. Kimber, Witness said they hoped in the future to be able to supply current even cheaper. What they wanted ...

was power to be able to continue to fulfil their statutory obligations. The average price the Westminster Company charged to the consumer was 5½d. per unit. The cost of production was about 3d. per unit. He thought the only company that produced more cheaply was the Pall Mall Company. The Central Supply Company was promoted by the Westminster Company and the St. James's Company to obtain energy cheaper if possible.

By Sir Leonard Lyell: The mains they proposed laying down would not require to come up for 30 years.

By Mr. Ashton: The longer the distance away the generating station was the higher voltage would be required, but there had been no accident in London yet. The highest voltage in London was 10,000, and they only proposed to have 2,000.

Mr. Dobson, engineer to the St. James's and Pall Mall Electric Light Company, said they had had considerable difficulty in getting sites for stations in the area. They could put in enough plant in their present stations to carry them through two more winters; they would require 2½ miles of mains to connect their station with the proposed station of the Central Supply Company, and those mains could be carried through by streets.

Mr. Moss recalled, produced a copy of the Bill of the Brompton and Piccadilly Railway Act, showing a generating station to be outside the district served. The station of the Strand Company was in Lambeth, and originally at Bournemouth, the site was outside the area of supply. It was a common thing for companies to cover several areas. He thought it would be impossible to turn electric lighting companies into incorporated bodies, for all electric lighting companies were limited liability companies.

CORRESPONDENCE.

Re-winding Field Coils of Dynamo.

I have a two-pole dynamo coupled to Willans GG engine, wound to give 115 volts and 275 amperes. With my load this is attained at a speed of 350. I wish to re-wind the field coils to get 135 volts and 275 amperes at 400 revolutions. Present coils are wound with No. 8 B.W.G. wire, covered to 5 B.W.G. They heat badly at 115 volts. There are 82 coils of wire outside, measuring around outside 6 feet 7½ inches, and the depth of the windings is $2\frac{13}{16}$ inches. The inside of the coil frame is 1 foot 10½ inches by 10½ inches. What diameter of wire, covered and uncovered, should I use for the new winding, and what will be the approximate length on each pole?

Subscriber.

[There is, evidently, not enough wire on the field-magnet, and probably no room for more. To get 135 volts the speed would require to be raised to 415, and No. 10 B.W.G. wire used on shunt laying on as much as space will allow. More specific instructions had better be obtained from the makers of the dynamo.—Eds. Elec. Rev.]

Jerry Wiring.

As a wireman of about 17 years' experience, during which time I have been engaged on bell, telephone, and telegraph wiring, arc and incandescent lighting (both alternating and continuous), transmission of power, accumulator and tramway work, and also in connection with electro-chemistry, I think I may speak with some authority on this matter, and I can assure Mr. Jeckell that the jerry wiring fiend still flourishes in other places besides South Shields, in spite of regulations and testing sets. I have known personally of tests made which never reached beyond the first group of branch cut-outs, these being placed close to the ceiling and the fuses left out, and the testing inspector contenting himself with the assurance of the man in charge that all fuses were in. Turning in another direction, I once worked for a firm in this town for nearly four years, and carried out many fairly large installations for them. A slack time came and every man in the shop, except myself, was discharged for want of work. I was promised by the senior partner, in the presence of the only other partner, that if I would stand by them they would find me as much work as they possibly could during the slack time, and send me out in charge of the first decent job they got. This was about Christmas. About April I discovered accidently that they had on at a popular watering place, a job of 300 incandescents and eight arcs, and that they had about 10 men on it, all working overtime, while I and my family were scraping along as best we could on about three days per week. On reminding the firm of their promise to me, I was very coolly informed that I had not been, and could not be sent to the job, as I was too expensive, as these fellows were working for 6½d. per hour, while I wanted 8d., and asked for no expenses, whereas I had always had from the firm 14s. per week without any demur. You will see, therefore, that on a 50 hours' week, as we worked, these fellows each cost £1 0s. 3d. per week less than I did. But were they wiremen? To my own personal knowledge four of them had never done an inch of wiring in their lives, having been for a short time previously labouring for wiremen, one of them having been an outside telephone labourer. Now what can you expect under these circumstances but jerry wiring of the worst possible kind? When the better class of contractors combine with consulting engineers and insurance companies to induce the Board of Trade to oust the jerry wiremen and the jerry contractor from the business by establishing a scheme of compulsory registration for wiremen and persons in charge of jobs or electrical departments, each having to pass a practical examination before being registered and receiving his certificate, then we may kill jerry wiring, but all the exposures in the world will not do it, as they will still revert to their old tricks in dark places, such as false roofs, &c.

Wireman.

Back E.M.F.

Will you please advise me whether the method I adopt for determination of the back electromotive force (B.E.M.F.) of an electrolytic bath is correct.

At a slow speed I get at the brushes 84 volts (E) and 143 amperes (C). At an increased speed I get 116 volts (E + e) and 249 amperes (C + c).

Difference in reading 32 volts (e) and 106 amperes (c).

$$\text{The B.E.M.F.} = (E - e) - \left(e\,\frac{C - c}{c}\right) = 40{\cdot}9 \text{ volts.}$$

If this is correct, is the actual electromotive force generated in the dynamo at full speed 116 + 40·9 = 156·9 and the electrical horse-power $\frac{156{\cdot}9 + 249}{746}$?

E. D.

Steam Relief Valves.

Several serious accidents have recently taken place owing to water in engine cylinders. The small steam space in many water-tube boilers has, in some instances, contributed to this.

In the description of electric works in your columns, I have not found reference to precautions against such accidents. It appears to be admitted that ordinary relief valves cannot get rid of any serious rush of water. What are the best means to adopt? Is a large steam separator sufficient to hold, on an emergency, the water due to bad priming, or due to a burst or failure of another engine? If so, what are the proportions?

Colonial.

[Our descriptions may not perhaps make special reference to the means for overcoming the effects of priming, because these appliances are by no means general. At the same time, we have referred to such means in other articles—one recently in which we discussed the recent breakdown at Yarmouth. It is hardly possible to say how big a separator should be, but we incline to the use of a separator of the pot or U type between the boiler and engines, and we are also of opinion that engine steam pipes should branch from the top of a steam main, not from its side or bottom. We certainly would not trust to cylinder relief valves for relief of priming due to overfilling of boiler. With the steam pipes arranged as above, the steam main ought to be well drained at its lower end, and such abominations as ring mains ought not to be allowed with their multiplicity of valves and connections, which introduce far more complication and risk of accident than is likely to occur with a well-designed steam main.—Eds. Elec. Rev.]

Shoreditch Destructor.

I have been very much interested in reading the report of a deputation from Tunbridge Wells to Shoreditch. Please read enclosed copy; can you give any explanation of the very extraordinary fact that the great fun of the whole affair, "thermal storage," finds no place in the said report, also that the financial statement is now "expected" to be issued in June next—if I remember right it was to have been at the end of March—and further, that no particulars of cost, &c., for comparison could be obtained, &c.

Power.

[From the cutting enclosed the report appears to be that of a deputation from Maidstone.—Eds. Elec. Rev.]

BUSINESS NOTICES, &c

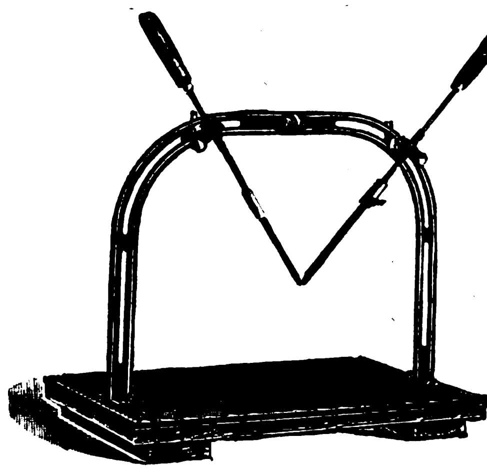
Electrical Wares Exported.

Week Ending April 26th, 1897.	£	s.	Week Ending April 26th, 1898.	£	s.
Adelaide	21	0	Adelaide	122	0
Alexandria	200	0	Alexandria	25	0
„ telephone ...	64	0	„ Teleg. mat.	205	0
Amsterdam	332	0	Amsterdam	110	0
Antwerp	394	0	Bangkok	13	0
Auckland	28	0	Barcelona. Teleg. mat.	41	0
Bombay...	20	0	Beira. Teleg. mat. ...	47	0
Buenos Ayres	413	0	„ Teleph. mat. ...	372	0
„ Teleg. mat.	110	0	Bombay. Teleg. mat....	416	0
„ Teleg. wire	338	0	Bordeaux. „ „ ...	74	0
Calcutta...	273	0	Boulogne	67	0
Cape Town	311	0	Brisbane. Teleg. mat.	1,251	0
Christiana. Teleg. mat.	73	0	Buenos Ayres	280	0
Colombo	53	0	Calcutta...	344	0
Copenhagen	75	0	Cape Town	292	0
Durban	1,138	0	Christiana	40	0
„ Teleg. mat. ...	2,971	0	Colombo	83	0
East London	352	0	Copenhagen	75	0
Flushing	213	0	Delagoa Bay	490	0
Ghent	14	0	Demerara	8	0
Gibraltar	18	0	„ Teleg. mat. ...	104	0
Grenada. Teleg. mat....	15	0	Durban	934	0
Hamburg. Teleg. mat.	610	0	„ Teleg. mat. ...	1,780	0
Kurrachee	166	0	East London	215	0
Madeira...	882	0	Flushing	49	0
Melbourne. Teleg. mat.	280	0	Fremantle	105	0
Port Elizabeth	1,205	0	Hamburg	135	0
„ Nolloth	14	0	Lisbon	15	0
Rangoon. Teleg. mat....	75	0	Malaga	353	0
Reval. Teleg. mat. ...	15	0	Melbourne	332	0
Rio Janeiro. Teleg. mat.	510	0	North Sea. Teleg. cable	5,996	0
Rockhampton	17	0	Oamaru	858	0
Rotterdam	250	0	Piræus	110	0
St. Petersburg	1,040	0	Port Elizabeth... ...	107	0
Shanghai. Teleg. mat.	24	0	Porto Alegre. Teleg. mat.	30	0
Singapore	110	0	Rio Janeiro. „ „	4,704	0
Stockholm	156	0	Saigon	30	0
„ Teleg. mat....	214	0	Santander	50	0
Sydney	1,132	0	Shanghai	37	0
Wellington	351	0	Stockholm. Teleg. mat.	165	0
„ Teleg. mat....	66	0	Sydney	966	0
Yokohama	240	0	Townsville	400	0
			Trieste. Teleg. mat. ...	400	0
			Vera Cruz	57	0
			Wellington	291	0
			„ Teleg. mat.	337	0
Total ...	£14,791	0	Total ...	£22,919	0

Foreign Goods Transhipped.

	£	s.		£	s.
Calcutta...	55	0	New York	177	0

An Improved Electric Furnace, Welding, or Brazing Machine.—The investigations and experiments by M. Moissan, Prof. Roberts-Austen and others, as to the behaviour of metals, alloys, ores, and other materials when subjected to the intense heat of the electric arc, together with the practical use of electric furnaces for the reduction of ores, notably those of aluminium and others of a refractory nature, have resulted in the desire of other investigators to enter the same field and rendered the subject of some importance in technical education. The want of efficient apparatus at a low cost for the purpose of experiment and illustration has hitherto resulted in the operator manufacturing his own out of materials at his command. To meet the demands for such apparatus, the following—originally designed some years ago by Mr. W. Clark Fisher for private use—has been placed upon the market by Mr. R. W. Paul, of Hatton Garden. In the design it was sought to provide an instrument alike suitable for furnace, crucible, open hearth, welding, brazing, and hard soldering, &c., for which purpose it was desirable that the carbons should be capable of universal movement admitting of their being placed at any angle in any plane. In order to achieve this, as shown by the illustration, the framework supporting the carbon holders consists of a slotted arch of metal cast in two halves mounted upon a fire-resisting and insulating base and efficiently insulated from each other at the top where they are bolted together. The carbon holders have a swivel action fitted with thumbscrews so that they may be clamped in any position, the swivel action is attached to an insulated bolt which passes through the slots in the framework and allows of adjustment to any height. Each carbon holder having an action



entirely independent and thoroughly insulated from each other and the framework, it is easily seen that they may be arranged as in the illustration for crucible, welding, or brazing work at a suitable angle, or both placed horizontally, or one horizontal and the other vertical, &c., for furnace work, and to suit requirements. The apparatus at present is made in two sizes, one for 10 to 15 amperes at 50 to 100 volts, the other 60 to 80 amperes at 50 to 100 volts.

Chain Gear Catalogue.—We are in receipt of an advanced copy of the chain gear catalogue of Mr. Hans Renold, of Manchester, who has made chain gears a specialty, and by his peculiar system of chain has overcome the objections which formerly obtained on account of wear, which varied the pitch of the chain. In Mr. Renold's chain the variation of pitch due to wear of the pins corrects itself by the assumption by the chain of a larger radius of revolution, and the design of the links is such that they enter and leave a wheel without rubbing friction. Mr. Renold claims to be able to run these chains up to a velocity of 1,600 feet per minute, at which speeds the chain is no more noisy than a leather belt. Like many other mechanical appliances, the chain has fallen into perhaps undeserved disuse on account of its bad construction. Mr. Renold aims to make a chain perfect, and expects thereby to make it satisfactory, and from all we hear is doing well, and producing good and reliable chains equal to claim.

Change of Address.—Messrs. Allingham & Fennell, electrical engineers, have removed from 27, Bower Road, Victoria Park, to Harrow Green, Leytonstone, N.E.

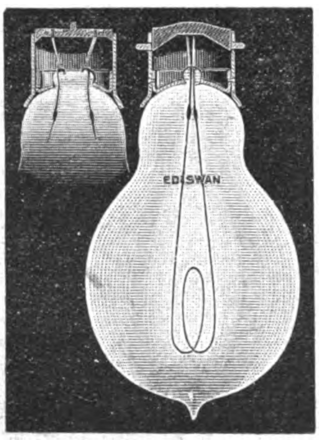
Church Lighting.—Messrs. Calvert & Company, of Manchester, have recently carried out a number of church lighting installations, near Manchester. The latest, the Emmanuel Church, Southport, was completed for the opening service on April 10th. The installation consists of some 250 16-C.P. lamps, in fittings of 26, 12, and 10 lights inside the church, and 100-C.P. lamps on ornamental posts outside, the lights being arranged so that either one-third or two-thirds may be switched on at once from the main board in the lobby. This firm have also carried out the electric lighting of St. Luke's Church, Southport.

Electric Light Cables and Wires.—Mr. Isidor Frankenburg, of the Greengate Rubber and Cable Works, Salford, Manchester, has sent us a list and samples of electric light cables and wires manufactured by him. The conductors of all the cables and wires which are given in the list consist of the best copper wire having a guaranteed conductivity of 100 per cent. of pure copper (Matthiessen's standard). In the various tables there are given dimensions, weights, resistances, and capacity of the conductors, and prices appear of taped wires and small strands, taped and braided ditto, taped and braided vulcanised electric light cables, wires and cables for aerial work, also cables and wires insulated with pure rubber. We have examined the various samples sent, and they all appear to be well made mechanically.

Electro-Zincing.—We understand that electro-zincing has been adopted by Mr. Peter Brotherhood for his air compressor tubes, and a plant is now being erected at his works on the Cowper-Coles regenerative system.

The Hook of Holland.—After many complaints, says the *Times* Rotterdam correspondent, about the insufficiency of the lights at the entrance by the Hook of Holland, the Minister of Marine has decided to ask for a credit in next Budget for two electric lights of the highest power to take the place of the present two red oil lights.

Dry Cap Lamp.—The dry cap lamp shown in the illustration is specially recommended by the Edison & Swan United Company for use in damp places or outside lighting. The lamps are specially suited for mines, pier lighting, or damp cellars, where it has been found that the plaster of Paris softens after the lamps have been in use for a little time. The cap is attached by means of a brass disc and is fastened to the glass bulb by specially prepared cement, which is thoroughly damp-proof, and the leading-in wires



are perfectly free, so that the lamp has an air insulation in the interior of the cap. It is important to note that although there is an air insulation, by using the thin layer of cement between the brass and the glass, it acts as a non-conductor and consequently there is very much less heat conducted than there would be if the brass and glass were not intercepted.

Meeting of Creditors.—At the offices of the Manchester Official Receiver, on 19th inst., a meeting was held of the creditors of James Fletcher and John Arthur Hirst, trading as Fletcher, Hirst & Co., electrical and mechanical engineers, at the Bankfield Works, Curzon Street, Burnley. The statement of the debtors' affairs showed liabilities expected to rank for dividend £2,184, and assets £424. It was stated that debts to the amount of £1,131 had been proved. The debtors made an offer of 6s. in the pound, to be paid—3s. within seven days of the creditors' acceptance of the offer, and 3s. after the lapse of six months. The creditors present were willing to close with the offer, but it was pointed out by the chairman that it was neither within their power nor that of the Court to do so. The lowest composition that could be accepted and approved was 7s. 6d. The meeting was therefore adjourned for a month, to give the debtors an opportunity of making a further offer to the amount required by the statute.

Price Lists.—Messrs. Laing, Wharton & Down, Limited, have issued some advance lists of new alternating and continuous current apparatus which they are introducing. The lists particularise "Whardown" transformers, G type, illuminated dial measuring instruments, transformers for voltmeters and wattmeters, economy coils, single-phase motors, also "Whardown" continuous current motors and dynamos and combined fans and motors. We understand that the firm attaches great value to the entirely new style of switchboard instruments which are illustrated, and although they are only listed for alternating current work, they may shortly introduce a line of continuous current ones. Special attention is directed to the 500-volt motors and motor fans in view of the demand likely to arise for motor current at this voltage in connection with the supply of current for electric traction.

Messrs. Wilhelm & Co., London agents for Mr. K. Wienert, of Berlin, sends us a list of the "Sonja" long hour arc lamp with enclosed arc burning from 100 to 200 hours for continuous and alternating current.

The Vestry of St. Mary, Battersea, v. The County of London and Brush Provincial Electric Lighting Company, Limited.—On Thursday, April 21st, Sir Francis H. Jeune, sitting as an additional judge of the Chancery Division of the High Court of Justice, resumed the hearing of the above-named action, which was brought in order to have the question decided whether the defendant company, who hold a provisional order enabling them to supply the electric light within the district of Wandsworth, were entitled thereunder to lay their pipes in Trinity Road, Battersea, part of which was, admittedly, in the parish of St. Mary, Battersea, and within the area of supply of the Battersea Electric Lighting Order. For the defence it was contended that this was not a case for a mandatory injunction, even if the defendants were in fault. Mr. R. Bray, Q.C., and Mr. Chapman appeared on behalf of the Vestry, and Mr. Cripps, Q.C., for the defendant company. The case was opened before His Lordship on March 9th, and a note on the subject appeared in the Electrical Review at the time.

On Thursday last week, when the case came up again, His Lordship pronounced judgment, and said he should have been very glad if the case could have been settled between parties, but that had been found impossible. Public bodies as well as individuals were entitled to have their rights adjudicated upon, even although they afterwards might see fit to arrive at an arrangement. Dealing with this case purely as a matter of law, the only question he (the judge) had to consider was that of the remedy to which the plaintiffs were entitled. That the defendants were wrong in what they had done, was, to His Lordship's mind, beyond doubt. The Act of Parliament approving the order under which the defendants worked, clearly defined their rights and powers, and it was equally clear to his mind that the plaintiff Vestry had vested in them—whatever the words might mean—the area in which the defendant's wires had been laid. It was also clear that the defendants had no right, without the consent of the plaintiffs, to lay their wires in that area. The defendant company was clearly wrong in what it did, and he felt bound to say that their conduct was as wrong as the principle under which they had acted, because it appeared that sometime before the particular act complained of the company had acted in a precisely similar manner, and laid down wires in another part of the same road, and when their attention was drawn to it they took up the wires and apologised. Afterwards they applied for leave to place their wires in the same area, but that being refused, they took the law into their own hands, in the manner which had been put before the Court. Under the circumstances the question was what was the remedy to which plaintiffs were entitled, and as to that he thought the case was governed by that of Goodson *v.* Richardson, which was a decided authority in plaintiffs' favour. The conclusion to which he (Sir F. H. Jeune) had come, was that the defendant company should be called upon to remove the wires in question, and that there ought to be judgment for the plaintiffs for a mandatory injunction, and a declaration as prayed for with costs. His Lordship, however, on the application of Mr. Cripps, suspended the operation of the injunction for three months, with liberty to apply in the meantime for leave to appeal.

ELECTRIC LIGHTING NOTES.

Aberdeen.—The Gas and Electric Lighting Committee had under consideration last week the suggestions by Prof. Kennedy, with reference to the extension of the electric lighting to the west end of the city. It was decided to carry out the proposal by which the extension could be effected at a cost of £5,700. The Committee also resolved to extend the Union Street electric main at a cost of £168. The offer of Mr. Henry Brechin to supply steam coal for the electric station at 8s. 6d. per ton has been accepted.

Ashton.—A circular *re* electric lighting, drawn up by Mr. Clirehugh on behalf of the Council, is being distributed in the borough.

Bangor.—The City Council has resolved upon gas extensions, and at the same time has decided to establish electric lighting works for supplying current for Garth Road and High Street at a cost of about £10,000. Ratepayers have given a guarantee of £500 a year for the electric lighting.

Barking.—On 21st inst. a Local Government Board inquiry was held into the Urban Council's application for a £15,000 electric lighting loan. The Barking Gas Company and a body of ratepayers appeared in opposition. Mr. W. C. C. Hawtayne, the consulting engineer, explained the scheme in detail. He estimated the working expenses as 2½d. per unit, and the annual gross revenue at £2,600. After paying for working expenses and allowing for renewals and repayment of capital and interest, and assuming that in addition to the public lamps the Council supplied private consumers with an equivalent of 3,000 8-candle-power lights, there would be a profit of £309 available for the reduction of rates or other purposes.

Bradford.—The Bolton Road and Morley Street tram routes are to be lighted by means of arc lamps at a cost of £500 a year. The charge for lighting current is to be reduced from 5d. to 4½d. per unit, with a sliding scale for the motive power.

Belfast.—The engineer recently presented a report on the comparative cost of electric and gas lighting for streets, with particular reference to some of the main thoroughfares, which, briefly summarised, conveyed the information that the present method of lighting the principal streets is, if considered sufficient, the cheaper, taking into account the fact that it is done at a loss; but if electric current were employed for the purpose, 3·75 times the light could be given for 2·2 times the cost, without loss to the department, while the ordinary street lamp could be replaced by incandescent electric light at the price at present paid. The report, in an amplified form, will again come before the committee.

Chislehurst.—The Board of Trade have approved of the Chislehurst Electric Lighting Order.

Croydon.—Mr. G. W. Willcocks held an inquiry at Croydon, on behalf of the Local Government Board on Tuesday, respecting the application of the Town Council to borrow money for the purpose of additional plant in connection with the electricity works, for additions to the electric lighting station buildings, and for £1,000, the sum payable by the Corporation to the British Thomson-Houston Company, Limited, upon the Corporation determining the period of working at the end of the first year, as referred to in Clause 18 of the agreement dated March 12th, 1896, and made between the British Thomson-Houston Company, Limited, and the Corporation. The total amount required by the Corporation is £6,772; but the inspector said an item of £2,772, required for the additional plant at the electric lighting station, did not really come within the scope of that inquiry. Alderman Miller said they asked for sanction for these items in consequence of the increased demand for supply. They already had double the number of customers, and were still increasing at the rate of about 150 lamps per week, and they were compelled to hold over applications until additional plant was put. Unless they got this by September, they would be unable to supply the demand during the winter.

Dartford.—The District Council has appointed a Special Committee to deal with the electric lighting question.

Edinburgh.—After referring the matter back to the Lighting Committee, the Council has now adopted the recommendation to light certain streets by means of arc lamps. The salary of the resident electrical engineer has been raised from £500 to £600.

Fermoy.—The Town Commissioners have resolved that the agreement with Mr. Haynes Reed with reference to the electric lighting scheme for the township shall be signed without further delay, so that the lighting may be introduced before next autumn.

Fulham.—A special meeting of the Vestry, held on Wednesday last week, decided to carry out the provisional order and proceed with the erection of an electric lighting station, a dust destructor and disinfector. The cost of the scheme is estimated at £56,000.

Glasgow.—The Corporation has agreed to supply current to the Clyde Trustees for the lighting of the Queen's Dock and Prince's Dock at 2d. per unit, the trustees to provide all the necessary lamps and carbons for same, and to undertake the trimming of the lamps. Negotiations are to be opened with the Glasgow Harbour Tunnel Company, Limited, for obtaining a wayleave for laying and maintaining one or more electric cables therein.

Greenock.—The application of the North British Electricity Supply Company to the Board of Trade for a provisional order to supply electric lighting to Greenock, Port Glasgow, and Gourock has been meanwhile declined by the Board. Representatives from the three towns and of the company interviewed the Board of Trade on Friday last, and Sir Courtenay Boyle said that in the event of the Greenock Corporation not taking advantage of their provisional order for the supply of electric light to the town and district within a year, the application of the company would be favourably considered.

Hackney.—Deputations appeared before the Vestry on Wednesday, both in favour and against the disposal of the electric lighting order to a company. No conclusion was come to, however, for the matter was referred to the joint committee. It appeared from the proceedings that Mr. Medhurst has served a writ on the Vestry. A special committee has been appointed to deal with the matter.

Hampstead.—The Lighting Committee received a report from the chief electrical engineer explaining the advantage of adopting the use of demand indicators on the premises of all consumers of electric current, and recommended that demand indicators be fixed on all consumers' premises, present and future, in order that the charge for current supplied may be uniform throughout. Mr. Cottam stated that the indicators would cost about £2 each. The total outlay would be nearly £1,600. The recommendation was defeated by 18 votes against 15.

High Wycombe.—The Electric Lighting Committee, after having an interview with Mr. Bastian (on behalf of Messrs. Hodges & Todd, the electrical engineers appointed by the Corporation), and also with Mr. Wigham (engineer on behalf of Edmondson's Electricity Corporation, who are constructing the works for the Wycombe Borough Electric Light and Power Company), have made various recommendations to the Council regarding the general details of the undertaking, and these have been adopted. The positions for the arc lamps for street lighting are to be settled later.

Huddersfield.—The Electric Lighting Committee reports that the number of consumers this month is 650, an increase of 18 compared with March. The lamps connected during April are 44,047, an increase of 752, compared with the previous month.

Kimberley.—According to the last advices, a private Bill is to be introduced during the next Session of Parliament to empower the Borough Council of Kimberley to supply electricity for the purpose of lighting, heating, or furnishing power to public buildings and other places, and to borrow a sum of £25,000 for this purpose.

Leyton.—On 20th inst. a Local Government Board inquiry was held into the District Council's application for sanction to borrow £15,000 for electric lighting purposes. Mr. Bishop, the electrical engineer, explained matters. There are at present 6,780 lamps (public and private), 29 being arcs, and 500 or 600 lamps waiting for connection.

Longton.—The Corporation of Longton, who have resolved to take up the question of municipal electricity supply, have retained Mr. Robert Hammond as their consulting electrical engineer to lay a scheme before them.

Loughborough.—The General Purposes Committee has resolved, upon the Gas and Electric Lighting Sub-committee's recommendation, to apply for an electric light provisional order, and to spend £50 for professional assistance for the purpose of the proposed application. The matter will come before the Council.

Lowestoft.—The General Purposes Committee of the Town Council considered last week the alterations made by the Board of Trade in the electric light provisional order.

Lyndhurst.—Before committing themselves to the electric light, the Parish Council want to know terms. A letter from an electric lighting company has been before the Council.

Maidstone.—The Maidstone Town Council have resolved by eleven votes to six to defer the matter of the electric light until the result of the first year's operation of the Shoreditch electric light and dust destructor scheme has been ascertained.

Manchester.—We briefly mentioned in a "Note" last week the estimated surplus of the Corporation electricity undertaking for the ensuing year. We now give the exact figures as stated by Alderman Higginbottom at last week's meeting of the Electricity Committee. The estimated expenditure on revenue account is £53,829. The leading items are: coals, £7,700; oil, waste, water, &c., and current used on works, £4,300; repairs and maintenance, renewals of plant (transfer), £9,000; interest on mortgage debt, &c., £9,700; and sinking fund, £10,328. The estimated income, by sale of current and meter rentals (including £1,500 receivable from the city fund for public lighting) is £66,000, leaving a profit balance of £12,171, out of which it is anticipated that £12,000 will be devoted to the relief of the rates. Last year the estimated income was £55,000, and the actual income £57,800, which yielded a surplus of £14,080. The estimate of expenditure on capital account for the year ending March 31st, 1899, is as follows: land (sub-stations), £6,900; buildings (sub-stations), £5,000; buildings and foundations (Dickinson Street), £5,000; machinery, £59,000; mains, £60,000; meters, £3,000; cable stores and workshops, £5,000; total, £143,900. The estimate of expenditure on street lighting for the same period is: current for public lighting, £1,500; lamps and connections, £5,500; making the amount required to be raised in the current year's rate £7,000.

At an adjourned meeting of the City Council on 20th inst., with the consent of the Council, Mr. Alderman Higginbottom was permitted to introduce, out of the ordinary course, the recommendation of the Electricity Committee to make application to the Local Government Board for their sanction to the borrowing of the further sum of £150,000 for the purposes of the electricity undertaking of the Corporation. In moving the adoption of a resolution approving the Committee's recommendation, Mr. Higginbottom said the money was required for electricity purposes in the city, Moss Side, Levenshulme, and Withington, under orders which had been sanctioned by Parliament. In Manchester it was needed to provide (1) six new feeders to supply the old network. These would be necessary to convey the current from the new generators to the distributing mains. (2) Distributing mains in Chester Road and City Road. These mains it had already been determined by the Committee to lay forthwith. In addition to these, it would be desirable to connect up with Moss Side along Denmark Road and Moss Lane, and also along Preston Street. Borrowing powers would also be required for the erection of cable stores and a testing room on the land at the Polygon, and for purchasing sites for transformer sub-stations in various parts of the city. The high pressure feeders would be necessary for supplying some of these sub-stations, and also the sub-stations in Moss Side and Levenshulme. Provision was also made for carrying out the street lighting which it had been decided to provide for winter. There had likewise been included a sum for new services and meters in the city area. In regard to Moss Side, the money was required for the distributing mains in the compulsory streets and for the high pressure mains. At Levenshulme the money was required for a site for a transformer sub-station, for distributing mains in the compulsory streets, and for high pressure feeders. At Withington the money was required for sites for transformer sub-stations, for distributing mains in the compulsory streets, and for high pressure feeders. The following was a summary of the estimated cost:—Manchester, £73,300; Moss Side, £15,600; Levenshulme, £8,970; Withington, £48,920; total, £146,790. This would leave a sum of £3,210 for "sundries and contingencies." Sir John Harwood suggested that the sum asked for should be £200,000, and moved an amendment accordingly. This was seconded by Mr. W. Pollitt, and the Council agreed to it.

Metropolitan Asylums Board.—At the meeting on Saturday the Works Committee submitted a report in regard to the proposed electric lighting of the Northern Hospital. The Committee stated that Messrs. Burstall & Monkhouse, the consulting engineers, had informed them that in view of the great rush in the engineering trade, and in order that the engines and dynamos, as well as the boilers required for the electric lighting, might be delivered before next winter, it would be desirable to issue the specification for these works in advance of the specification of the wiring and other electrical work. The consulting engineers suggested further that, from the nature of the work, it was desirable to obtain tenders from a limited number of approved firms, rather than by advertisement. The Works Committee therefore recommended, and it was decided to apply to the Local Government Board for assent to obtain tenders for the engines, dynamos, and boilers for the electric lighting of the Northern Hospital in the manner suggested by the engineers.

Messrs. Handcock & Dykes, of Westminster, S.W., have been appointed consulting electrical engineers in connection with the electric lighting of the Tooting Bec Asylum.

The Brook Hospital Committee reported having consulted Prof. Kennedy, who designed the installation at that hospital, in regard to the maintenance of the storage battery. The Committee suggested that an agreement should be entered into for the maintenance of the battery for three years, but by the consent of the Board the recommendation was withdrawn for the time being.

Newmarket.—The Council does not approve of the site suggested by the electric light company.

Norwich.—A local paper says that the construction of the tramway track is now being proceeded with.

Peterborough.—Official intimation has been received by the Town Clerk that the Local Government Board has, upon further consideration, agreed to sanction the Peterborough Corporation borrowing a loan of £15,000 for electric lighting.

Plymouth.—The foundation stone of the Corporation electricity works was laid by the Mayor (Alderman J. T. Bond) on 21st inst. Mr. A. R. Debnam, chairman of the Electric Lighting Committee, explained the extent to which it was at first intended to provide current for lighting and traction purposes.

Portsmouth.—Last Saturday a visit was paid to Portsmouth by Mr. Gilbert, the president of the Boston Electric Light Company (U.S.A), and Mr. Hosman, the engineer and secretary to the company. They are stated to be making a tour of Europe to discover the best system of electric street lighting, in order that it may be introduced into Boston, which already boasts the largest plant in the world, the street arc lamps there numbering no less than 2,800. Mr. Gilbert is reported to have declared that though he had been all over the Continent, he had never seen so good a system of arc lighting as there is at Portsmouth.

Ripley.—A petition is being signed in Ripley in favour of electric lighting.

Shanklin.—The Shanklin Trade Union had a discussion on electricity v. gas a few days ago.

Sheffield.—A public meeting of the owners and ratepayers of the city was held on Tuesday to consider the Council's proposal to promote a Bill for the purchase of the electric light undertaking and raising money for the purpose. The proposal was not approved by a majority of those present, and a poll is to be taken in May, the result to be declared on May 25th. A Sheffield paper implies that the meeting was attended by a number of electrical traders who were afraid that the Corporation might take away their wiring and fitting business, and they seem to have been responsible for the voting.

Southampton.—At the last meeting of the Harbour Board, the Works Committee reported that the electrical engineer (Mr. J. G. W. Aldridge) had submitted plans of the necessary electric mains for the new cranes at the Quay, estimated to cost about £350. He stated that the cable could be purchased of the makers and laid by the Board's staff. The Board accepted the Committee's recommendation to adopt the plan of the electrical engineer.

St. Pancras.—The profit on the last year's working of the electricity undertaking has sufficed not only to wipe out a deficit of £800 on the previous year's accounts, but to provide a balance in hand of £5,717.

Swansea.—At a special meeting of the Corporation on Friday a report of the sub-committee was received showing that they had failed to arrange with the British Electric Traction Company to supply the latter with electricity for the trams at 1½d. per unit up to 400,000 units, and 1¼d. per unit for any subsequent amount per annum. The company explained that it was undesirable that the tramway power should be secondary to the lighting, and continuity of supply was imperative. The company also could not pay any more than the actual cost of production, and therefore would provide their own works. The sub-committee advised the immediate proceeding with the Corporation's own scheme, in combination with a dust destructor, as it was most necessary to have the station in their own hands. Mr. Manville, the electrical engineer engaged, attended, and after a long discussion it was decided, with only two dissentients, to proceed with the scheme, and to borrow £60,000 for the purpose.

Taunton.—The Council last week adopted a recommendation of the Electric Lighting Committee that the sum of £11,500, instead of £10,000, as previously agreed upon, should be applied for in order to provide for renewal of plant. Messrs. Kincaid, Waller & Manville, electrical engineers, of Westminster, presented a long report, which was explained by Mr. Manville, who attended the meeting. He said the electric light installation in Taunton was one of the first in the Kingdom for public lighting purposes, and they necessarily had to start with plant which was usual in those days, and in fact the only plant that could be obtained, and in the extensions made by the Bill since they took the works over from the old company they had proceeded on the lines originally laid down. Those lines did not involve the greatest amount of efficiency in the running of the station, and his firm were anxious that the whole system should be brought up from the present somewhat antique design to the most modern lines, so that the station might be as efficient as any existing. If his recommendations were carried out a gross saving of £539 a year would be effected on the basis of the present output, and there would be a net saving of £373 a year after providing for payment of capital and interest on the money required for the proposed alterations. The report was adopted.

Tipton.—The District Council on Tuesday heard representatives of the Midland Electric Corporation, and, after discussion, resolved to withdraw the opposition to the scheme.

West Ham.—Last Friday a Local Government Board inquiry was held with respect to an application by the Town Council for sanction to borrow £2,841 for the purpose of lighting the public buildings in the borough by electricity.

Wolverhampton.—Public notice is being given, signed by Mr. Harman Lewis, the borough electrical engineer, to the effect that on or about 28th inst. (yesterday), the supply of electric energy is to be commenced at a standard pressure of 220 volts, from Albany Road, on the north side of Darlington Street, on both sides of Chapel Ash, Tettenhall Road to the Clevelands, Compton Road to Chapel Terrace, and Merridale Road to Oaks Crescent.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Bristol.—The chairman and vice-chairman of the Bristol Sanitary Committee (Alderman Cope Proctor and Mr. G. Pearson) having talked over questions of electric traction still in dispute with the representatives of the Bristol Tramways Company, reported to their committee the result of their negotiations and made certain recommendations as to the course to be taken. A draft report to the Council was drawn up and this was dealt with and revised at another meeting of the Committee held on Monday It will be presented to a meeting of the City Council on Friday. It shows that there have been concessions on both sides, but there are still terms remaining unsettled. One point upon which the company has agreed is that of the capital required for works not less than £200,000 is to be raised in such a way that the rate of interest thereon shall not exceed 4 per cent. They are also willing that the fares shall be reduced so as to average ¾d. per mile for ordinary passengers, and ½d. per mile for workpeople's cars, the times for running which are to be extended. The controversy over the period at the end of which the Corporation shall be permitted to purchase resulted in 17 years from May, 1896, being agreed upon. The draft report set forth that the company should not be required to pay a wayleave for the permission to use electric traction, but this the Committee at their second meeting altered, and the report advises the Council that no arrangement would be satisfactory which does not require the company to pay a moderate wayleave, that there should be a further reduction of fares, and that the Corporation shall have the right to veto the overhead system in certain limited areas of the city.

Bournemouth.—The British Electric Traction Company and the Bournemouth, Poole and District Light Railway Company having informed the Council that they propose amended schemes, the Council has resolved that it is still undesirable that tramways should be laid down in the borough, and that steps are to be taken to prevent powers being granted.

Buenos Ayres.—The chairman of the City of Buenos Ayres Tramways Company, Limited, addressing the shareholders last week in London said that the question of the adoption of electric traction instead of horse-power had been fully considered by the board and by the local committee and general manager. They had received a report from the local committee regarding the possible advantages and disadvantages of the adoption of electric traction. That report was handed to an eminent firm of experts, who arrived at the same conclusion as the local committee—namely, that the substitution of electricity for horse-power was not desirable either in the interest of the public or of the company. After serious consideration of the whole question, the board had come to the decision that although the electric motor system might possibly be adopted with advantage to suburban traffic, it was absolutely unsuitable to the narrow streets in which their lines were laid.

City and South London Railway.—Lord Morley's Committee of the House of Lords has passed the City and South London Railway Bill, which confers extension powers. The company is also to raise £133,000 additional share and loan capital. The powers originally sought for the purpose of selling a portion of the undertaking to the City and Brixton Company have been struck out of the Bill.

Dundee-Barnhill.—A private meeting of the Broughty Ferry Police Commission was held last week at which representatives of a Leeds firm submitted plans of a proposed electric railway between Dundee and Barnhill. The system proposed is of the overhead trolley type, and the proposed route will be from High Street, Dundee, thence along Seagate, Blackscroft, and Ferry Road, crossing the railway at the Oil Mills, and onwards to Broughty Ferry, along Queen Street, Monifieth Road, to Barnhill. The Broughty Commission is stated to have agreed to support the scheme. Official notice of the scheme, published in a Dundee paper, is signed by the solicitors and Parliamentary agents, and also by Messrs. Greenwood and Batley, Limited, Albion Works, Leeds, promoters; Mr. Robert Ord Ritchie, M.I.E.E., Albion Works, Leeds, electrical engineer; and Messrs George Hopkins & Sons, 30, Parliament Street, Westminster, S.W., civil engineers.

Ealing.—The old District Council pledged itself to strenuously oppose the scheme of the London United Tramways Company, but now that there is a new council in office, eight of its members being in favour of electric traction, there seems to be some prospect of the matter receiving careful reconsideration. Notice of motion has been given for the question to be discussed at the next Council meeting.

Hastings.—On 20th inst. the Town Council held a special meeting to discuss the tramways question, and a resolution was passed by 24 votes to 14 applying to the Light Railways Commissioners for an order authorising the Council to construct and work light railways in various parts of the borough.

Hungary.—According to recently published statistics, the total length of street railways in Hungary at the end of 1897 was 115 miles, of which 64 miles were worked by electricity. In the past year the introduction of electric traction on the street railways of Buda-Pesth was completed, and, besides two new railways worked by electricity were opened, namely, the "Miskolezer electric street railway," and the "Maria Theresiopoler electric railway." The traffic on some of the Buda-Pesth electric railways show a considerable falling off in 1897 when compared with 1896; a result which is ascribed to the Millenial Exhibition in the latter year.

Malaga.—It is proposed to convert the horse tramways in the town of Malaga, Spain, into electric lines.

Moscow.—The April *Board of Trade Journal* has some interesting notes regarding the proposed electric tramway schemes for Moscow. It seems, according to H.M. Consul at that town, that the municipal authorities of that city purpose converting the present horse tramways of Moscow into electric tramways. The two tramway companies of Moscow have placed themselves in communication with two financial syndicates in Berlin and Dresden, and certain propositions have been made to the Mayor of the town—Prince Galitzin—who has referred the whole business to a special commission to draw up a report and furnish H.M. Consul with a statement of what is actually required. This document will not be ready for some months, but should the Mayor eventually receive tenders from British firms, he promises that the same will have careful attention from the Commission and exactly the same chance of being accepted as the tenders from other countries.

Richmond.—On Friday night a meeting of the Richmond Town Council was held, when objection was made to the scheme of the London United Tramways Company for an electric tramway to traverse Richmond—by a "back road" route—and Kingston to Hampton Court.

Rochester.—Last Friday an inquiry by the Light Railways Commissioners with reference to the application by a private company to establish a system of electric trams connecting New Brompton, Chatham, Rochester, Strood, and district, opened at Chatham. The two Town Councils and the Urban District Council of Gillingham are in favour of the project.

St. Helens.—Major Cardew, R.E., has been holding a Board of Trade inquiry into the application by the St. Helens Corporation for sanction to use electrical power on local tramways on the overhead system, and to the borrowing of £25,000 for purposes connected with the adaption of the line, &c., to electrical traction.

Switzerland.—The three-phase electric railway which is being built near Zermatt on the Gorner Grat was recently tested for the first time, in presence of the Swiss inspector of railways. The section just finished has a length of 1,600 m. and a gradient of 12 in 100. The experiments were very successful; the up and down journeys on the gradient were performed without difficulty; the full speed of the locomotives being maintained by the motors. The descent on the steepest part of the gradient was carried out with ease, with a fully load train. The new rack railway has a length of 9·8 km., and a maximum gradient of 20 in a 100. The power is taken from the Findelenbach, which drives four turbines of 250 H.P. each, coupled directly with three-phase dynamos of 5,000 volts and 40 periods per second. The voltage in the trolley wire is 550. Every locomotive carries two three-phase motors of 90 H.P. each, which are geared to the driving wheels by toothed gearing. The three-phase motors act as generators, and require as much power to drive them as they give out; if in the descent they are driven 2 to 8 per cent. above the speed of synchronism, the locomotive gives back power to the leads. When all the locomotives on the line are descending, the excess power given back is absorbed in a water resistance in the power station. The electric part of the installation has been carried out by Brown, Boveri & Co., and is on the system which this firm has used on the Lugano line. They have also applied the same system to the Jungfrau Railway, and are at present applying it to the line from Stanstaad to Engelsburg, which will be opened this year. The line from Burgdorf to Thun, in the canton of Berne, will also be built on the three-phase system by this same firm.

TELEGRAPH AND TELEPHONE NOTES.

Cape Town to Blantyre Telegraphs.—Mr. Cecil Rhodes received the following letter on 21st inst. from the Postmaster-General at Cape Town:—"Through telegraphic communication from Cape Town to Blantyre (British Central Africa Protectorate) was established yesterday (Wednesday). Congratulations." The distance between the two points exceeds 2,000 miles.

Communication with the Cape.—We learn from the *Cape Argus* of the 23rd ult., that during the period when the West Coast route was interrupted last month, at the same time that the Delagoa Bay-Natal cable was interrupted on the East Coast, messages from the Cape to London had to pass *viâ* the Transvaal. It can hardly be pleasant reading for many of the merchants, and others connected with the Cape, to know that they have to thank the South African Republic for affording them at that time the only means of transmitting their telegrams.

The Delays in Australian Telegrams.—In our various notices concerning the delays and interruptions to Australian trunk landlines, we find we omitted to mention that on Feburary 23rd last, "West Australian section: Owing to the presence of a hurricane between Israelite Bay and Eucla, that section of coastal line worked only simplex very badly; inland line also affected by heavy weather between Balladonia and Eucla, which prevented quadruplex working on this wire, fair duplex circuit available; our inward business suffered delay. South Australian section: Both lines worked duplex well till 10 p.m., when reduced to simplex; the new line worked badly, and the old wire fairly well till clear. Outward clear by West Australia 11.35 p.m. Outward clear by South Australia 2.30 a.m." From this it is clear that as regards the inefficiency of the South Australian, as compared with the West Australian landlines, there is little or nothing to choose; both appearing to be equally infirm; and yet it has been suggested that such lines as these should form a portion of the cable system which it was proposed to extend from London to Australia *viâ* the Cape of Good Hope.

A Pacific Cable.—An American exchange says that late advices from Honolulu announce that the Hawaiian Legislature is considering a Bill authorising the construction by the Pacific Cable Company of a cable between the United States and the islands. The Hawaiian Bill gives the company exclusive cable rights for 20 years. The cable must be laid within 18 months after the passage of the Act by the American Congress, and extended to Japan within three years. It must be capable of transmitting 15 words a minute, and the toll rate between Honolulu and San Francisco is not to exceed 35 cents a word, and to Japan it is not to exceed 90 cents a word.

Queensland and the Pacific Cable.—In a speech made last week at Brisbane by the Hon. T. J. Byrnes, the new Premier of Queensland, as to the past and future policy of the Government of that Colony, amongst other statements the speaker said: "He was thoroughly favourable to the Pacific cable, and the Government were prepared to take a strong lead in the matter." This is quite in accordance with the conclusions arrived at by the majority of the Premiers of the various Colonies at the recent conference held in Melbourne, where "It was resolved that if Great Britain and Canada each contributed one-third of the cost of the Pacific cable, New South Wales, Victoria, Queensland, and Tasmania would be in favour of contributing the remaining third. Mr. C. C. Kingston (South Australia) and Sir John Forrest (Western Australia) dissented from the resolution, expressing preference for the cable route *viâ* the Cape of Good Hope." The dissentient vote of the two latter is, of course, easily understood, as it is in the interest of the colonies which they represent to retain as long as possible control of European traffic, which at present passes over the landlines of South Australia and Western Australia; but it seems that, in view of the great frequency of interruptions to both lines, these gentlemen would have advanced the interests of Australia as a whole by voting with the majority.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1898 ...	...
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Cayenne-Pinheiro ...	March 24th, 1898 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Cable beyond Gurupa ...	April 4th, 1898 ...	
Cyprus-Latakia	Feb. 10th, 1898 ...	...
Bolama-Bissao	April 12th, 1898 ...	...
Cape Town-Mossamedes ...	„ 14th, 1898 ...	...
Maranham-Para	„ 17th, 1898 ...	...
Benguela-Mosoamedes ...	„ 20th, 1898 ...	...
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Cartagena-Barranquilla ...	July 4th, 1896 ...	...
Saigon-Bangkok	April 20th, 1898 ...	April 20th, 1898
„ „	„ 21st, 1898 ...	„ 23rd, 1898
„ „	„ 24th, 1898 ...	„ 25th, 1898

The name of the company should be *Bermudas*, not Bermuda.

West African Telegraphs.—A Reuter despatch, dated Lagos, April 25th, says that telegraphic communication has been established between Lagos and the British post of Jebba, situated on the Niger a little north of the ninth parallel. The whole of the work through the Ilorin State has been successfully carried out on the Lagos side by Captain Turner, R.E., and Mr. Stone, of the Lagos Public Works Department.

CONTRACTS OPEN AND CLOSED.

OPEN.

Aberdeen—The Council invites tenders for the supply and laying of about 10 miles of ·67 single core feeder cable, 5 miles of ·2 three-core network cable, and 3⅜ miles of arc lamp series cable. The cable is to be armoured and laid in wooden casing. Under another contract the Harbour Commissioners invite tenders for the supply and erection of 62 arc lamps and three leading lights, each consisting of four arc lamps. All lamps to be Brockie-Pell or Crompton-Pochin. Both the contracts will have to be completed by August 31st, and particulars in both cases can be obtained from the Corporation Electricity Works, Cotton Street. See our "Official Notices" April 22nd.

Belgium.—May 31st. The Municipal Authorities of Ixelles, a suburb of Brussels, are inviting tenders until May 31st for the exclusive concession for the supply of electrical energy for lighting and power purposes during a period of 26 years, that is, to September 1st, 1924. Tenders to be sent to the Secretariat de la Commune d'Ixelles, Brussels, from whence particulars may be obtained.

Edinburgh.—May 6th. The Corporation wants tenders for the wiring of the St. Leonard's police station. Particulars from the resident electrical engineer, 5, Dewar Place, and see our "Official Notices" this week.

France.—May 5th. The French Post and Telegraph Authorities in Paris are inviting tenders until May 5th for the supply of about 139 kilometres of electric cables (gutta-percha insulated). Particulars may be obtained from, and tenders to be sent to, Le Sous-Secretariat d'Etat des Postes et des Telegraphes, Rue de Grenelle, Paris.

Great Eastern Railway.—May 12th. The directors invite tenders for the supply of stores and materials. For particulars see our "Official Notices" this week. Forms of application from the secretary's office, Liverpool Street Terminus, E.C.

Hyde.—May 5th. A Corporation Committee invites tenders for the supply and fixing of gas engine, dynamo, wires, fittings, &c., for electric lighting at the new technical school and free library. Engineers, Messrs. Lacey, Clirehugh & Sillar, 78, King Street, Manchester. See our "Official Notices" April 22nd for particulars.

London.—May 17th. The Bethnal Green Board of Guardians invites tenders for the supply of plant, and installing the electric light at the new infirmary, Palestine Place. Plans, &c., to be obtained from the architects, Giles, Gough & Trollope, 28, Craven Street, Charing Cross, W.C. See our "Official Notices" April 22nd for particulars.

Roumania.—April 30th. Tenders are being invited until the 30th inst. by the Roumanian Post and Telegraph Authorities in Bucharest, for the supply of 50 tons of galvanised iron wire, 10 tons of galvanised steel wire, and 5 tons of tinned copper wire. Particulars may be obtained from, and tenders to be sent to, La Direction Générale des Postes et Telegraphes, Bucharest, Roumania.

Sunderland.—April 29th. The Corporation is inviting tenders for the supply of a high-speed 225-kw. steam dynamo, and two Lancashire or Galloway boilers. Borough electrical engineer, Mr. J. F. C. Snell. See our "Official Notices" April 15th for particulars.

Victoria.—June 24th. The Council of the city of Hawthorne (Colony of Victoria, Australia) is inviting tenders for the supply and erection of buildings, boilers, engines, dynamos, transformers, mains, meters, arc lamps, poles; also running the plant for three years. See our "Official Notices" March 11th.

West Ham.—May 10th. The Council wants tenders for certain electroliers, standards, &c., required for its public buildings. Mr. J. J. Steinitz, borough electrical engineer. See our "Official Notices" this week for particulars.

CLOSED.

Bournemouth.—The following is a list of the tenders sent in for supplying and fixing cables, conductors, lamps, columns, fittings, &c., for the lighting of the Bournemouth Pier and Lower Pleasure Grounds by electricity. F. W. Lacey, M.Inst.C.E., borough engineer and surveyor, can perhaps inform us how the enormous differences originate:—

——	Pier installation.			Pleasure grounds installation.			Arc lamps for pier and square.			Total.		
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Crompton & Co., Limited ..	2,900	0	0	1,780	0	0	524	0	0	5,204	0	0
Johnson & Phillips	1,353	6	0	1,386	12	0	66	0	0	2,805	18	0
Brush Electrical Engineering Company	816	17	6	702	0	0	221	2	6	1,740	0	0
Laing, Wharton & Down, Limited	786	0	0	694	0	0	227	0	0	1,707	0	0
Leonard G. Tate	825	0	0	507	0	0	270	0	0	1,602	0	0
British Insulated Wire Company, Limited	725	4	7	582	0	2	326	10	0	1,583	14	9
Bournemouth and District Electric Supply Company	576	17	8	485	2	8	352	19	8	1,415	0	0
Cash, Robinson & Co. ..	588	3	0	472	0	0	192	14	0	1,252	17	0

The following were informal:—Scott, Anderson & Beit, R. Whipp & Co., Bow, McLachlan & Co., Mendham & Co., Lovell-Simons & Co., Fippard & Cooper, E. G. Bryant.

Leyton.—We understand that the Council has accepted the tender of Messrs. Siemens Bros. & Co. for the supply of dynamos at £737, that of Messrs. Wells Bros. for gas engines (£1,708) and that of Messrs. Laurence Scott & Co. for switchboards at £150. The buildings contract is in the hands of Mr. Coxhead. We gave particulars of the tenders last week.

Newcastle.—The Lunatic Asylum Visiting Committee of the Newcastle Corporation has considered the tenders for the installation of the electric plant for the lighting of the new extension at the asylum, and that of Messrs. Corlett & Company (£2,388) has been accepted.

Watford.—We understand that Mr. Henry J. Rogers, Watford, has received instructions to supply all the arc lamp columns and arc lamps for the Watford electric lighting scheme.

FORTHCOMING EVENTS.

1898.

Saturday, April 30th.—Association of Municipal and County Engineers at Wimbledon, 11.15 a.m. Paper by Mr. A. H. Preece, electrical engineer to the Wimbledon Council, on "The Works to be carried out for the Supply of Electrical Energy to the District"; at 4.15 p.m. the members will inspect the Conduit and Insulation Company's works at Summers Town, and a paper will be read by Mr. F. H. Bathurst on "Electric Wiring Practice."

Monday, May 2nd, at 8 o'clock.—Society of Arts. The first of a series of four Cantor lectures on "Electric Traction," by Prof. Carus Wilson.

Thursday, May 5th, at 8 p.m.—Chemical Society. Papers to be read:—"The Reactions of the Carbohydrates with Hydrogen Peroxide," by C. F. Cross, E. J. Bevan and Claud Smith; "The Properties and Relationships of Di-hydroxytartaric Acid," Part II., by H. J. H. Fenton, M.A.; "The Affinity Constants of Certain Hydroxy-Acids," by S. Skinner, M.A.; "Molecular Weights in Solution of Permanganates, Perchlorates and Periodates," by J. Murray Crofts, B.A., B.Sc.

Extra meeting of the Institution of Electrical Engineers, to be held at the Society of Arts, to hear a paper by Mr. Leonard Andrews, A.I.E.E., on "The Prevention of Interruptions to Electricity Supply." This arrangement was subject to the discussion on Messrs. Parshall, Cardew and Trotter's papers finishing last night.

Friday, May 6th, at 8 p.m.—The Institution of Junior Engineers at the Westminster Palace Hotel. Paper to be read and discussed:—"Evaporative Condensers and Independent Air-pumps for Same," by Mr. Harry Fraser (member).

Monday, May 9th, at 8 o'clock.—Northern Society of Electrical Engineers at Manchester. Paper by Mr. W. C. C. Hawtayne.

Friday, May 13th, at 5 p.m.—Physical Society. Paper on "Galvanometers," Part II. By Prof. W. E. Ayrton and Mr. T. Mather.

NOTES.

Institution of Civil Engineers.—At the annual general meeting of the Institution of Civil Engineers, held on April 26th, Sir John Wolfe Barry, K.C.B., president in the chair, the result of the ballot for the election of officers was declared as follows:—President, Mr. W. H. Preece, C.B.; vice-presidents, Sir Douglas Fox, Mr. James Mansergh, Sir William Anderson, K.C.B., and Sir William White, K.C.B.; other members of council:—Mr. James Barton (Dundalk), Mr. Horace Bell, Sir Alexander Binnie, Mr. Thomas Forster Brown (Cardiff), Mr. Henry Deane (Sydney), Mr. W. R. Galbraith, Mr. George Graham (Glasgow), Mr. J. C. Hawkshaw, Mr. Charles Hawksley, Mr. G. H. Hill (Manchester), Dr. Hopkinson, Mr. J. C. Inglis, Mr. Alexander Izat (India), Dr. Alex. B. W. Kennedy, Mr. John Kennedy (Montreal), Sir James Kitson, Bart., M.P. (Leeds), Mr. A. G. Lyster (Liverpool), Mr. William Matthews, Sir Guilford Molesworth, K.C.I.E., Sir Andrew Noble, K.C.B. (Newcastle-on-Tyne), Mr. Alexander Siemens, Mr. Thomas Stewart (Cape Town), Mr. F. W. Webb (Crewe), and Sir Leader Williams (Manchester).

Institution of Electrical Engineers.—Before this Institution last night papers were read on "Earth Returns for Electric Tramways," by H. F. Parshall, member; and "Notes on Electric Tramways," by Major P. Cardew, R.E., and A. P. Trotter, members.

Cables in War Time.—In the House of Commons on Tuesday Mr. Nussey (Pontefract) asked the First Lord of the Treasury whether he could inform the House if either belligerent had the right, and if so to what extent, to interfere with cables between the territory of the opposing power and any other part of the world. Mr. Balfour in reply said: "A convention, to which Great Britain, Spain, and the United States were parties, was concluded at Paris on March 14th, 1884, providing for the protection of submarine cables. But by Article XV. thereof in time of war a belligerent signatory to the convention is free to act with respect to submarine cables as if the convention did not exist. I am not prepared, therefore, to say that a belligerent, on the ground of military exigency, would, under no circumstances, be justified in interfering with cables between the territory of the opposing power and any other part of the world."

The *Times* concludes a leader on the war by some remarks on the fate of the cables. The article says:—

Messrs. Eyre & Spottiswoode write to us to-day quoting a decision that they are commercial property, not liable to seizure, or at least to destruction, even if they carry war messages among others. But Mr. Balfour last night, in reply to a question, quoted a convention to which England, Spain, and the United States were parties, providing for the protection of submarine cables, yet reserving to a belligerent the right to treat them as if the convention did not exist. It seems, therefore, to be an open question what is the precise position of submarine cables under existing usages, though there can be none as to the position that ought to be assigned to them in conformity with the spirit of the Declaration of Paris. As the Power which can cut them can generally tap them and stop all messages injurious to its interests, there seems the less reason for exempting this form of neutral property from the protection of the neutral flag.

A telegram published early in the week in the *New York Herald* from its special correspondent at Key West says:—"The United States lighthouse tender *Mangrove* has picked up the cable between Havana and Key West. All the despatches passing over the cable to or from the Cuban capital are being read. The Government now has its own operators in Key West and a cable office. All despatches are subjected to censorship."

The Postmaster-General on Tuesday notified that telegrams for all places in Cuba by the North American cables, *via* Key West, must be handed in at telegraph offices under the control of the British Post Office, written in plain language, and will be accepted only at the sender's risk.

The Physical Society.—Before this Society on Friday last, Dr. S. P. Thompson exhibited a model apparatus made by the Helios Company, to illustrate the three-phase method of transmitting power. It consists of a small generator, driven by hand, and a small motor. The generator is separately excited by a small secondary battery; it has three independent coils. The six ends of the coils are connected to six commutator rings. The motor has three corresponding pairs of opposite coils; these can be grouped in various ways for connection to the brushes of the generator. The six coils are on a hinged frame, so that, if necessary, they can be laid down flat for other rotation experiments. Two armatures are provided, either of which may be used. The first is an iron wheel, with peripheral copper bars arranged like a squirrel-cage; the other is a simple iron disc, without added conductors.

Electric Wiring at Buenos Ayres.—The editor of the *Review of the River Plate* recently inspected several electric lighting installations carried out for some private houses in Buenos Ayres by Messrs. Rufino Varela (hijo) & Co., and found that in nearly every instance the entire installations were being made without a single joint in the wires. This, says the writer, is certainly a move in the right direction, as joints, as a rule, are the initial cause of all trouble in these installations. In many cases they are either not soldered, or else the work is scamped; then they are badly insulated; very often the wire is burnt by careless workmen, and breaks whenever any strain is placed upon it. This jointless work has, in our contemporary's opinion, a great advantage over all others, as it does away with the primary cause of outbreaks of fires, keeps up the insulation resistance, and the special fittings used for branches are strong and neat, and the work easily lends itself to inspection and revision in case of faults.

Municipal Authorities and Electric Lighting.—On Monday a conference of municipal authorities of England and Scotland, convened by the Municipal Electrical Association, was held at the Westminster Palace Hotel, to ascertain their views as to what course should be taken before the Joint Committee of the two Houses of Parliament, which is now considering the question of electrical energy, generating stations, and supply within extensive areas, and has agreed to certain clauses. Manchester, Wolverhampton, and Glasgow had already agreed to take common action, and the representatives of the other municipalities on Monday agreed to support the course that they had decided to take before the Select Committee, and that their interests should be represented by Mr. Worsley-Taylor, Q.C., Mr. Pritchard, Q.C., and Mr. Lewis Coward. After debate, the conference unanimously decided that, notwithstanding the provisions of the Electric Lighting Act, 1882, powers should be given to municipalities for acquiring land compulsorily for generating stations, and that as to liability for nuisance and notices to owners, they should be under the same statutory powers as railway companies as to their liability for compensation or damages for neglect; that compulsory powers should be given for acquiring land for generating purposes not within the area of supply; that power should be given for breaking up streets between the generating station and the boundary of the area of supply; that powers should be given for the supply of electrical energy over an area including districts of numerous local authorities, with the consent of such authorities; and that powers ought to be conferred upon promoters seeking to supply electrical energy "to other undertakings, and not directly to consumers," with the consent of the local authorities.

Röntgen on the Röntgen Rays.—Such a host of investigators have devoted themselves to the development of Prof. Röntgen's great discovery, that it would be no matter for surprise if there was nothing left for the discoverer to find out about his own discovery. Some novel properties of the X rays, however, have been described by Prof. Röntgen in a third communication on this subject to the Berlin Academy. Among these the following appear to be especially interesting. If a fluorescent screen is covered with a plate completely opaque to the X rays, a slight fluorescence can nevertheless be seen when the tube is in action. Röntgen has shown that this is due to rays proceeding from the air of the room, which emits X rays wherever it is itself exposed to their action. This fact points to the necessity of placing photographic plates in a sheath of lead when used for long exposures, to prevent them being fogged by diffused rays from the back or sides. Of the rays which are given off by the platinum plate of a focus tube, those are most effective for producing pictures which leave the platinum at as great an angle as possible, within a limit of 80°. The specific transparency of bodies is greater the thicker the body. The ratio of the thicknesses of two equally transparent plates of different material is dependent on the thickness and the material of the medium through which the rays have to pass before they reach the plates. For instance, the ratio of the thickness of platinum and aluminium plates of equal transparency will be reduced to one-half if the rays are passed through a thick glass plate before they strike the metal plates. Röntgen, like Swinton and others, has shown that the contrast between bodies of different transparencies depends on the E.M.F. used to excite the tubes. A spark gap in the secondary circuit acts in the same way as an intercalated Tesla transformer; both produce more intense and less easily absorbed rays. By the use of a Tesla transformer and wire electrodes in a narrow tube, X rays can be produced with a vacuum of 3·1 mm., the usual vacuum being, of course, about 0·0002 mm. Hard tubes, as Röntgen calls those tubes which require a very high E.M.F., can be softened, as is well known, by heating, or by re-admission of air, or, as is not so well known, by heating limetree charcoal placed in a side tube, or by sending through the tube a very powerful discharge. The composition of the rays given off by the platinum anti-cathode depends essentially on the time change of the discharge current. The quality of the rays is not affected by the change of the primary current, but their intensity is proportional to the strength of the primary current.—*Elektro-Zeit.*, 19, p. 192.

Auxiliary Wastes.—The Chicago Electric Traction Company are now alive to the saving in substituting electric motors for steam in driving auxiliary plant. Their large engines developed 217 H.P. on a water consumption of 3,903, or at the rate of 18 lbs. per I.H.P.-hour. The small engines used steam as follows:—

Economiser engine	...	38·4 lbs. per hour.
Stoker engine ...	...	36·4 „
Air and feed pumps	...	685·0 „

The total is 759·8 lbs. per hour, or nearly 20 per cent. of the consumption of the main engines. While true that the exhaust went to heat the feed, the *Street Railway Review* says this was the function of the economiser, and it is scarcely an economy after all to employ a wasteful engine as a feed heater, when unavoidably wasted furnace products are available for the purpose.

Oil Fuel.—Oil fuel has been used for several weeks past at the Chicago Elevated Power Station, one of the 2,000-H.P. units having been run six hours daily on oil fuel. Storage tanks and pumps, with duplicate pipes, are completed.

Exhibition of Acetylene Apparatus.—The Executive Council of the Imperial Institute has on foot a scheme for holding an exhibition of acetylene gas generators and illumination by acetylene gas. The generators admissible are divided into three groups, viz., (1) those in which the gas is generated by water being allowed to drip, or flow in a small stream, on to the top of the carbide; (2) those in which water rises round the carbide; (3) those in which the carbide falls into the water; these being again sub-divided into automatic and non-automatic. Forms are being sent out for applications for space; but the Council will not undertake to hold the exhibition unless, by May 2nd, there is a sufficient number of applicants to cover the actual outlay which will be involved.

Street Lighting at Buenos Ayres.—The streets of the city of Buenos Ayres are at last to be lighted by electricity, as the municipality has accepted, says a River Plate exchange, the tender presented by the Compania General de Electricidad de la Ciudad de Buenos Ayres. To commence with, 300 8-ampere lamps are to be installed in various districts. The prices are:—120 lamps, burning all night, at $27 each, $3,240; 180 lamps, burning up to 1 a.m., at $20.25 m/n $3,645. Total, $6,885 per month. The saving under this arrangement as compared with the gas bill is expected to be considerable.

Electric Motor Printing Presses.—The *Electrical Age* says that the largest printing press ever built is being driven by a Crocker-Wheeler motor. This press was constructed by R. Hoe & Co., and is an octuple, stereotype perfecting press and folder. It prints, folds, counts and delivers 96,000 eight-page newspapers in an hour. A 75 horse-power motor built by the Crocker-Wheeler Electric Company, of Ampere, N.J., and New York, has been installed under the floor for direct connection to the gigantic press above it.

Steam Engine Trials.—At the South Western Polytechnic, Chelsea, S.W., a special class in "Steam Engine Trials," intended for draughtsmen and advanced engineering students, will be conducted by Prof. Pullen, Wh.Sc., A.M.I.C.E., and Mr. H. A. Clark, Wh.Sc., A.I.E.E., on Tuesday evenings, from 7.30 to 10 p.m., commencing May 17th and terminating June 28th, 1898. Inquiries to the head of the engineering department.

Gas Producer Feeding.—The importance of even feeding of gas producers is insisted upon by Mr. Bildt in a paper to the American Institute of Mining Engineers. The familiar hopper and cone introduces large masses of fuel suddenly into the producer, generating large volumes of gas at one time, while at another the gas becomes small in quantity and there will be excess of air with formation of carbonic acid, or when the gas is used in furnaces, oxidation of the metal from excess of oxygen. The cone is, moreover, an uneven distributor, depositing more fuel on one side than on another, and variable gas results. An ideal feeding device should be continuous in action, feeding just so much coal as will yield the gas required in a given time, and it should evenly distribute the coal over the surface of the already deposited fuel so as to give an even resistance to the rising column of air in order to prevent uneven action. The author has patented a device consisting of a spiral revolving in the upper part of the producer, and receiving coal through a shoot and slide. The description of the revolving spiral and its action is not very clear. Analyses are given of two gases, one from a producer using little water, the other from a steam-blown producer, which shows a large percentage of hydrogen and a very much smaller percentage of nitrogen. One is cited as from Domnarfoet, the other from the Washburn and Moen Manufacturing Company. They are as follows:—

	Domnarfoet	Washburn.
CO	2·00	4·90
O	0·10	*nil*
CO	27·90	26·80
C_2H_4	0·10	0·40
H	2·60	18·10
CH_4	...	3·50
N	67·60	46·30
	100·00	100·00
Percentage combustible	30·60	48·80

In the steam-blown furnace some of the CO has been made from oxygen produced by decomposing the steam jet. This, of course, saves using so much air, and reduces the nitrogen, thus producing a much richer and more combustible gas, as well as utilising the heat of conversion of carbon into monoxide to dissociate the steam. If the result is a cooler gas an economy will have been effected, but there is evidently a greater production of CO_2 with the steam jet, which, however, may not be due to this.

Presentation.—On Saturday last the staff of the King's Road Central Station, St. Pancras, presented a testimonial to Mr. H. R. Burnett (who is leaving the service to take up the position of borough electrical engineer at Barrow-in-Furness), consisting of a silver stop watch with suitable inscription. The presentation was made by Mr. Sydney W. Baynes (chief electrical engineer).

Lecture.—A lecture on "Wireless Telegraphy," with experimental illustrations, will be given on Wednesday, May 4th, at 8 p.m., also on Thursday, May 5th, at 8 p.m., at the Skinners' School for Girls, Stamford Hill, by Mr. J. E. Taylor. The proceeds are to be devoted to the Hackney Technical Institute movement.

The Spiral Globe, Limited.—We understand that within a few days the public will be asked to subscribe to the capital of a company with the above title. The spiral globe is a new form of lamp reflector, consisting of a closely-wound spiral of small glass rod around the bulb of the incandescent lamp. As a means of increasing the effective illuminating power of the lamp, it has been favourably reported upon by Mr. Hugh E. Harrison, Mr. W. H. Preece, and Mr. F. J. Down, the latter of whom ventures to estimate the company's probable sales at 2 million lamps per annum, and its profits at not less than £26,000.

Obituary.—We hear with regret of the death of Mr. George Greenwood, of the well-known firm of Greenwood and Batley, of Leeds, which occurred at his London residence on 16th inst. Mr. Greenwood was 57 years of age. Ten years ago, when the business was turned into a limited company, the deceased gentleman came to London and acted here as managing director. Mr. Greenwood was a member of various institutions, including the Institution of Civil Engineers.

Early Electrical Appliances.—We understand that by request of the secretary of the Institution of Civil Engineers, Mr. Killingworth Hedges, of Emery Hill Street, Ashley Gardens, Westminster, is gathering together, for the purpose of an exhibit at the May Conversazione, a representative collection of early electric lighting appliances used from about 1876 to 1886, excluding large objects, such as dynamos. This is, we understand, in honour of the new president, Mr. W. H. Preece, C.B., &c., and if successful, we believe the exhibit may take a permanent form. Mr. Hedges will be glad to receive exhibits, and to hear from all who are able and willing to render any assistance in this matter.

Davy Davies Hoisting Gear.—The Davy Electrica Construction Company write "to thank Mr. Ernest Kilburn Scott for his good opinion of the Davy Davies patent hoisting gear" in our last issue. "The gear, as illustrated," they say, "is merely one of our methods of carrying out the invention, and we see no difficulty in applying the gear to all kinds of street and private arc lighting."

NEW COMPANIES REGISTERED.

Lancashire Electrical Engineering Company, Limited (56,992).—Registered April 19th, with capital £5,000 in £1 shares, to acquire the business carried on by J. McDermott, J. E. Taylor, and W. Barratt at Volt Works, Old Street, Ashton-under-Lyne, as "The Lancashire Electrical Engineering Company," to adopt a certain agreement, and to carry on the business of electrical engineers, electricians, millwrights, &c. The subscribers (with one share each) are:—J. McDermott, Old Street, Ashton-under-Lyne, electrical engineer; J. E. Taylor, 40, Bentwick Street, Ashton-under-Lyne, electrical engineer; W. Barratt, 175, Old Street, Ashton-under-Lyne, electrical engineer; J. J. O'Connor, 28, Rycroft Street, Ashton-under-Lyne, electrician; J. Barratt, Trafalgar Street, Ashton-under-Lyne, engineer; W. Barratt, 132, Hyde Road, Gorton; C. Wilson, 27, Egerton Street, Higher Openshaw, pattern maker. The number of directors is not to be less than two nor more than three; the subscribers are to appoint the first; qualification, 50 shares. Registered office, Volt Works, Old Street, Ashton-under-Lyne.

Electric Horse Promotion Syndicate, Limited (56,996).—Registered April 19th, with capital £5,000 in £1 shares, to adopt an agreement with J. Lambert and to promote or assist in promoting a company for the acquisition of certain undescribed patents and inventions. The subscribers (with one share each) are: E. Kaiser, 131, Earl's Court Road, Kensington, clerk; A. J. Biss, 53, Elizabeth Street, Walworth, clerk; W. C. Ponsford, 6, Upper Tollington Road, N., clerk; H. Harman, 11, Charing Cross, S.W., clerk; L. Kelsey, 101, Victoria Road, Kilburn, theatrical manager; H. Lack-Szyrma, Barkingside, Ilford, solicitor; A. Trow, 46, De Beauvoir Road, N., accountant. Registered without articles of association by Chapronière & Co., 11, Charing Cross, S.W.

Lancashire Light Railways Company, Limited. (57,018).—Registered April 21st, with capital £50,000 in £1 shares, to construct, purchase, lease, contract for or otherwise acquire, equip, maintain, and work light railways and tramways in Lancashire or elsewhere, and to carry on the business of electricians, engineers, suppliers of electricity, and electrical apparatus manufacturers. The subscribers (with one share each) are:—J. B. Atherton, Manhattan, Gateacre, Lancashire, manufacturer; F. J. Leslie, 15, Union Court, Liverpool, solicitor; W. M. M. Forwood, 15, Union Court, Liverpool, solicitor; C. O. Grindrod, 11, Knowsley Road, Rock Ferry, Cheshire, gentleman; A. E. Haptie, 5, Durham Road, Seaforth, Liverpool, cashier; A. Ruckley, 8, York Road, Seacombe, Cheshire, clerk; J. G. Setterfield, 16, Thorndale Road, Waterloo, clerk. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first; qualification, £200; remuneration as fixed by the company. Registered by F. J. Leslie and Company, 15, Union Court, Liverpool.

Sphere Lighting Company, Limited (57,040).—Registered April 22nd, with capital £12,000 in £1 shares, to adopt an agreement with F. Gallsworthy, to acquire any inventions, patents and rights, for the lighting of billiard tables and rooms by electricity or otherwise, and to carry on the business of billiard table and requisite manufacturers, electricians, electrical, mechanical, and metallurgical engineers, &c. The subscribers (with one share each) are:—F. Gallsworthy, 17, Wellington Street, Leeds, leather factor; J. Gordon, 1, Bond Street, Leeds, chartered accountant; J. M. Barwick, 24, Basinghall Street, Leeds, solicitor; A. C. Peake, 24, Basinghall Street, Leeds, solicitor; E. O. Simpson, 47, Albion Street, Leeds, solicitor; T. H. Cooper, Great Northern Hotel, Leeds, manager; G. H. Hebblethwaite, Westroyd, Mirfield, belt manufacturer. The number of directors is not to be less than three nor more than seven; the first are C. E. Bulling, F. Gallsworthy, J. Gordon, G. H. Hebblethwaite, A. C. Peake and E. O. Simpson; qualification, £100; remuneration as fixed by the company. Registered office, 47, Albion Street, Leeds.

CITY NOTES.

Huddersfield Corporation Electricity Works Accounts.

PROBABLY the best way of showing the sound and steady progress that is being made at the Huddersfield Municipal Electricity Works is to reproduce the comparative statement which is included in the abstract of accounts for the year ending December 31st, 1897. From a fairly heavy deficiency of £2,547, which was encountered at the end of the first year's work (1893), the management has been able to show a very substantial profit, after providing for interest and contribution to sinking fund.

The following table gives the cost per unit:—

	1897.	1896.
Total capital expended	£69,415	£58,117
Number of units sold	438,848	304,163
Number of lamps connected	41,702	28,983
Revenue from sale of current	£8,533	—
Net revenue	£4,964	—
Average price obtained per unit	4·66d.	—

Cost of production.	£		Per unit.	1896.
Coal	901		·49d.	—
Oil, waste, water, and engine room stores	104		·06d.	—
Salaries and wages at generating station	985		·54d.	—
Repairs and maintenance of buildings, ngines, boilers, dynamos, &c.	794	Works' cost 1 52d.	·43d.	—
Rent, rates and taxes	311		·17d.	—
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	1,001		·55d.	—
Depreciation of buildings and plant account	—		—	—
Renewal fund account	—		—	—
Total	£4,096		2·24d.	—

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	8,533	0	0	4·66d.
Meter rents, &c.	458	0	0	—
Supply of steam	—			—
Transfer fees	—			—
Other items	69	0	0	—
Total	£9,060	0	0	4·66d.

Total cost per unit (exclusive of depreciation and renewal accounts), 2·24d.; works' cost, 1·52d.

COMPARATIVE ANNUAL STATEMENT FROM THE COMMENCEMENT OF THE UNDERTAKING.

Year ended.	No. of consumers.	No. of 8-C.P. lamps connected.	B. T. units sold.	Income.	Expenditure.	Balance. Deficiency paid from borough fund.	Balance. Surplus.	Balance. Rate in £.
				£ s. d.	£ s. d.	£ s. d.	£ s. d.	d.
Dec. 31st., 1893 ..	112	9,613	43,224	1,067 3 11	3,614 11 8	2,547 0 0	...	$1\frac{9}{16}$
" 1894 ..	214	15,342	156,169	3,560 8 7	5,625 13 4	2,065 0 0	...	$1\frac{1}{3}$
" 1895 ..	280	20,889	227,753	5,351 5 0	6,724 9 0	1,373 0 0	...	$0\frac{7}{8}$
" 1896 ..	385	28,983	304,163	6,864 2 5	6,429 13 4	...	434 9 1	Transferred to depreciation and contingencies account £1,618 9 1
" 1897...	598	41,7 2	438,848	9,060 12 1	7,876 12 1	...	1,184 0 0	

Submarine Cables Trust.

THE twenty-seventh ordinary annual meeting of the certificate holders of this trust was held on Wednesday at Winchester House, Old Broad Street, the Marquis of Tweeddale presiding.

The CHAIRMAN, in moving the adoption of the report of the trustees, said, that the revenue for the past year amounted to £22,997, being an increase of £105 over the previous year. Only £3,300 of the dividend to be received from the Eastern Extension Company for the quarter ending December 31st had been brought into the present revenue account, instead of the full quarter's dividend, as in former accounts. The total dividend and bonus for that quarter would amount to £4,315 7s., as in former years, so that, had they taken credit for the whole sum, the increased revenue would have been £1,120 instead of £105. At one time the December quarter's dividend was generally received before the closing of their books on April 15th in each year, but latterly it had not been received until the end of April or the beginning of May, in consequence of the half-yearly meeting of the Extension Company being held somewhat later than it used to be. It was hoped, however, that next year they might be able to pay the two coupons in full upon the due date without bringing in such a large portion of that interest, and the trustees looked forward to the time when the interest could be left out of the revenue account altogether until it was actually earned. The total expenses for the year had amounted to £1,159, which was an increase of £96 over the previous year. That was principally due to the extra cost of printing new notes for each of the existing 3,381 certificates. Notwithstanding that unavoidable expense, it would be observed that the total expenses were considerably less than was provided for by the trust deed. Coming to two principal features in the past year, the first was their return to the payment in full of each half-yearly coupon, and the second the completion of the sale of the Anglo-American Company's deferred stock, and the re-investment of the proceeds in dividend-paying securities. The reduction in the rate of the annual dividend which took place in 1885 prevented them from meeting certain coupons on their due dates. Between 1888 and 1891 they were one coupon behind, but since the latter date they had been able gradually to recover the lost ground, and for the last seven years they had paid an average of £6 8s. 7d. per cent., and therefore they had at last reverted again to the payment in full of the two last coupons on their respective due dates, which was a matter on which all connected with the trust were entitled to be congratulated. The proceeds of the sale of the Anglo-American deferred stock had amounted to £69,200, and the money had been invested in other securities of the character approved by the trust deed, and as the securities covered a wide area he thought they gave greater security to the trust. As showing the satisfactory position of the trust he might say that their investments showed an average appreciation of over 75 per cent.

Mr. J. DENISON PENDER seconded the motion, and the report was adopted.

The retiring auditors having been re-elected, the proceedings terminated with a vote of thanks to the chairman for presiding.

The Calcutta Electric Supply Corporation, Limited.

THE first report of directors, to be presented at the annual general meeting of the shareholders of the company at the City Terminus Hotel, Cannon Street, in the City of London, to-day, at 2 o'clock p.m., states that immediately upon the formation of the corporation, instructions were given to the managing agents in Calcutta to negotiate for the purchase of a site upon which to erect the generating station. After some little time a suitable site was acquired; but owing to the fact that the land was covered with native buildings, and to the necessity for the vendors in some cases taking ejectment proceedings to get rid of the occupiers, the corporation has only just recently obtained possession of the site. The question of the use of overhead wires in some of the streets of Calcutta has involved very protracted negotiations with the Government of Bengal, the Telegraph Department, and the Municipality of Calcutta. These negotiations have recently been concluded, so far as to permit of the contractors making arrangements for shipping the necessary cables. Now that the site for the generating station has been obtained, the contractors have entered into sub-contracts for the erection of the buildings and chimney; the whole of the cables and copper for the mains have been ordered, and a good portion of the generating plant is well advanced towards completion, so that shipment can be made immediately the buildings are ready to receive the plant. The question of the renewal of the company's concession at the expiration of the period for which it was originally granted, viz., 21 years, for a further like period, has been the subject of negotiation with the Government, and the directors have no reason to doubt that the assurance, given to the company before the issue of the prospectus, will be carried out. The auditors, Messrs. J. H. Duncan & Co., appointed by the board in the first instance, offer themselves for re-election.

The Oriental Telephone and Electric Company.

THE fourth ordinary general meeting of this company was held at Cannon Street Hotel on Wednesday, Mr. William Addison presiding.

The CHAIRMAN said that the net profits exceeded those of the previous year by £1,000. The expenditure had increased by the removal of the exchange to a more central position, and providing a new switchboard. They might expect similar expenses to arise. The rate of exchange had been more favourable to them than it had been for the past seven years. Business all round had been making steady progress, and the electric lighting had turned the corner. They were hopeful that the business already secured would show a fair profit. They would remember that the board had built up a reserve fund of £12,000, which was still intact, but owing to reconstruction could not be touched. They now suggested that a new reserve fund should be made to meet contingencies, repairs, and extending buildings and plans.

The report was then adopted.

Sir Auckland Colvin was re-elected a director in the place of Mr. Frost, a retired director, who did not seek re-election.

Stock Exchange Notices.—The Stock Exchange Committee have (1) appointed special settling days as under:—Thursday, May 5th.—Babcock & Wilcox, Limited—further issue of 8,000 ordinary shares of £10 each, fully paid, Nos. 14,001 to 22,000; South London Electric Supply Corporation, Limited—further issue of 9,159 shares of £5 each, £2 paid, Nos. 55,842 to 65,000. And (2) ordered the undermentioned securities to be quoted in the Official List:—Babcock & Wilcox, Limited—4,666 vendors' ordinary shares, Nos. 1 to 4,666, 3,333 vendors' 6 per cent. cumulative preference shares, Nos. 1 to 3,333, and a further issue of 8,000 ordinary shares, Nos. 14,001 to 22,000; Chelsea Electricity Supply Company, Limited—further issue of 8,000 ordinary shares, Nos. 32,501 to 40,500; House-to-House Electric Light Supply Company, Limited—further issue of 5,661 ordinary shares, Nos. 10,101 to 15,761; South London Electric Supply Corporation, Limited—further issue of 12,500 ordinary shares of £5 each, £2 paid, Nos. 43,342 to 55,841, and a further issue of 9,159 shares of £5 each, £2 paid, Nos. 55,842 to 65,000.

Eastern Extension Telegraph Company.—Subject to confirmation by the shareholders, the directors have declared a dividend for the quarter ended December 31st last of 2s. 6d. per share, together with a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the year 1897. The dividend and bonus will be paid on May 12th.

West India and Panama Telegraph Company, Limited.—The directors recommend a dividend for the six months ended December 31st of 6d. per share on the ordinary shares.

The City of London Electric Lighting Company, Limited.—Mr. George Herring has been elected a director of this company in place of the late Lord Suffolk.

TRAFFIC RECEIPTS.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending April 22nd, 1898, were £2,609 13s. 8d.; corresponding period (Easter week), 1897, £2,963 9s. 10d.; decrease, £353 16s. 2d.

The City and South London Railway Company.—The receipts for the week ending April 24th, 1898, were £998; week ending April 25th, 1897, £928; increase, £70; total receipts for half-year, 1898, £17,769; corresponding period, 1897, £17,612; increase, £157.

The Dover Corporation Electric Tramways.—The receipts for the week ending April 23rd, 1898, £125 18s.; total receipts to April 23rd, 1898, £1,821 2s. 2d.

The Dublin Southern District (Electric) Tramways Company.—The receipts for week ending Friday, April 22nd, 1898, were £576 13s.; corresponding week last year, £883 0s. 7d.; decrease, £306 7s. 7d.; passengers carried, 92,160; corresponding week last year, 117,731; aggregate to date, £6,892 1s. 5d.; aggregate to date last year, £7,117 5s. 8d.; decrease to date, £225 3s. 10d.; mileage open, 8 miles.

The Liverpool Overhead Railway Company.—The receipts for the week ending April 24th, 1898, amounted to £1,452; corresponding week last year, £1,770; decrease, £318. 1897, includes Easter Monday.

The Western and Brazilian Telegraph Company, Limited.—The receipts for the week ending April 22nd, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company Limited, were £2,964.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, April 20th	Closing Quotation, April 27th.	Business done during week ended April 27th, 1898. Highest.	Lowest
137,400*l*	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	...	...	100 —104	100 104	...	...
25,800	Amazon Telegraph, Limited, shares...	10	...	...	...	7 — 8	7 — 8	...	...
125,000	Do. do. 5% Debs. Red.	100	...	...	...	93 — 96	93 — 96	...	...
923,960*l*	Anglo-American Teleg., Ltd.	Stock	£2 9s.	£2 13s.	3 %	59 — 62xd	59 — 62	60	59
3,038,020*l*	Do. do. 6 % Pref.	Stock	£4 18s.	£5 6s.	6 %	109½ 110½xd	109 - 110	109⅝	108½
3,038,020*l*	Do. do. Defd.	Stock	...	...	...	12 — 12½	12½ - 13	12½	11⅞
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	7 %	7 %	16 — 16½	15¾ 16½	16	15⅝
75,800*l*	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	...	...	112 - 116	112 116	...	...
44,000	Chili Teleg., Ltd., Nos. 1 to 44,000	5	4 %	4 %	...	3 — 3½	3 — 3½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	8 %	...	175 —185	155 —165	...	...
918,297*l*	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	104 —106	104 —106	104½	103½
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	2 %	...	$\frac{1}{16}$ — $\frac{3}{16}$	$\frac{1}{16}$ — $\frac{3}{16}$	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	7 %	6½— 7½	6 — 7	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	14½ - 15½	14 — 15	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 11	10 — 11	...	...
30,000*l*	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	4½ %	103 —106%	103 —106%	...	...
60,710	Direct United States Cable, Ltd.	20	2½%	2½%	...	10½ - 10⅞xd	10 — 10½	10$\frac{5}{16}$	10
120,000	Direct West India Cable 4½ % Reg. Deb	100	...	...	...	99 —102	98 —101	100	99
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	...	17½ - 17⅞xd	16⅞ 17½	17½	16⅞
70,000	Do. 6 % Cum. Pref.	10	6	6%	...	8 19 xd	18 — 19	18½	18
89,900	Do 5 % Debs., repay. August, 1899	100	5 %	5%	...	100 103	100 103	...	...
1,302,615	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4%	...	127 130	125 -129	125	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7%	7 %	18½ 18⅞	17¾ - 18½	18⅝	17⅞
25,200*l*	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5%	5 % 5 %	99 103	99 103	...	...
100,500*l*	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5%	...	100 —103	100 —103	...	...
320,000*l*	Do. 4 % Deb. Stock	Stock	4 %	4%	4 %	127 - 130	127 —130	...	...
35,100	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5%	... ...	99 —102	100 103	...	...
46,500	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5%	...	100 —103	100 —103	...	...
300,000*l*	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1906	100	4 %	4%	...	102 —105	102 —105	...	...
200,000*l*	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4%	...	107 —110%	107 -110 %	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	...	11½ - 12	11½ - 11⅞	11$\frac{13}{16}$	11
180,042	Do. do. 6 % Pref.	10	6 %	6%	...	17½ - 17⅞	16⅞ - 17½	17½	16⅞
150,000	Great Northern Teleg. Company of Copenhagen	10	10 %	10%	10 %	29½ - 30½	29 — 30	...	...
160,000*l*	Do. do. do. 5 % Debs.	100	5 %	5%	5 %	100 - 103	100 —103	...	...
97,000	Halifax and Bermuda Cable Co., Ltd., 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	95 —100	95 —100	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10%	...	52 — 55	52 — 55	...	...
100,000*l*	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6%	...	106 - 109	106 —109	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	4 %	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5½%	5½%	6 %	5½— 6	5 — 5½	5⅝	5½
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 - 18	15 — 17	16⅛	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5½ - 6	5 — 5½	5⅝	5½
1,529,471*l*	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½ %	100 —105	100 —105	...	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	⅝ ⅞	⅝ - ⅞	$\frac{11}{16}$	...
100,000*l*	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	...	105 - 108	105 -108	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	8 - 9	8 — 9	...	...
3,381	Submarine Cables Trust	Cert.	...	..	...	136 141xd	136 — 141	...	..
58,000	United River Plate Teleph., Ltd.	5	4 %	5 %	...	4 — 4½	4 — 4½	..	...
146,733*l*	Do. do. 5 % Debs.	Stock	5 %	...	...	105 —108	103 - 108	107	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	*nil*	...	3½ - 4½	3½ - 4½	...	...
213,400*l*	Do. do. do. 5 % Debs.	100	5 %	5 %	...	99 —102	99 -102	100½	...
64,269	Western and Brazilian Teleg., Ltd.	15	3 %	2 %	...	11⅞ — 12½	11½ — 12	11$\frac{9}{16}$	11½
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	...	7½ - 8	7½ — 8	7½	...
33,129	Do. do. do. Def. Ord	7½	1 %	*nil*	...	4½— 4⅞	4½— 4⅞	4⅝	...
389,521	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	106 —109	106 —109	108	...
88,321	West India and Panama Teleg., Ltd.	10	½%	1 %	...	½— ¾	½— ¾	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	7½— 7¾	7 — 7½	7½	7$\frac{1}{16}$
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	5 — 7	5 — 7	...	...
80,000*l*	Do. do. 5 % Debs. No. 1 to 1,600 ...	100	5 %	5 %	...	105 —108	105 —108	...	...
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7%	...	105 —110	105 —110	...	...
160,100*l*	Do. do. 6 % Ster. Bonds.	100	6 %	6%	...	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	1895.	1896.	1897.	Closing Quotation, April 20th	Closing Quotation, April 27th.	Highest.	Lowest
30,000	Charing Cross and Strand Electy. Supply	5	5 %	6 %	7 %	13½ — 14½	13 — 14	...	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	6	...
20,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 19,277 ...	5	5 %	5 %	6 %	10 — 11	9½— 10½	10	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	4½%	4½%	4½%	115 —117	115 —117	...	...
50,000	City of London Elec.Lightg. Co., Ltd., Ord. 40,001— 90,000	10	5 %	7 %	10 %	26 — 27	25½ - 26½	26½	25⅝
10,000	Do. do. Prov. Certs. Nos. 90,001 to 100,000 £5.	10	...	...	...	19 — 20	17½— 18½	18	17½
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17½ — 18½	17½— 18½	...	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	129 —134	129 —134	...	...
30,000	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—30,000	10	*nil*	*nil*	*nil*	14½— 15	14 — 15	14⅞	14½
10,000	Do. do. do. Nos. 30,001 to 40,000 £4 pd.	10	...	...	...	... ...	8½— 9	...	...
20,000	Do. do. do. 6% Pref., 40,001—60,000 ...	10	6 %	6 %	6 %	15½— 16	15 — 16	15⅞	15$\frac{13}{16}$
17,400	Edmundsons Elec. Corp., Ld., ord. shares 1—17,400 £4 pd.	5	...	...	...	3½— 3⅞	4 — 4½	4	...
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5			4 %	10 — 11	10 — 11	...	...
10,000	Do. do. 7 % Cum. Pref. ...	5	7 %	7 %	7 %	11 — 12	11 — 12	...	...
62,400	*Metropolitan Electric Supply, Ltd., 101 to 62,500 ...	10	4 %	5 %	6 %	18 — 19	17½ — 18½	18½	17⅞
220,000*l*	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½%	117 — 121	117 —121	117	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	2 %	4 %	6 %	19½— 20½	19 — 20	19⅞	19½
31,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord.	5	7½%	10½%	14½%	17½— 18½	17½— 18½	18	17⅝
20,000	Do. do. 7 % Pref., 20,001 to 40,000	5	7 %	7 %	7 %	10 — 11	10 — 11	...	..
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	4 %	107 —110	107 —110	...	...
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2½— 2⅞	2½— 2⅞	2⅝	2⅞
79,900	Westminster Electric Supply Corp., Ord., 101 to 80,000 ...	5	7 %	9 %	12 %	16½— 17½	16⅞— 17½	16⅞	...

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, April 20th.	Closing Quotation April 27th.	Business done during week ended April 27th, 1898. Highest.	Lowest
30,000	British Electric Traction	10	..	...	...	15½— 16½	15½— 16½	...	...
10,000	Do. do. 6 % Cum. Pref. 30,001—40,000 (issued at £2 10s. prem. all paid)	10	...	...	...	......	7½— 8½	...	...
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	2½%	*nil*	*nil*	1⅝— 1⅞	1½— 1¾	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	*nil*	4 %	2¼— 2½	2⅛— 2⅜	2 5/16	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	110 —114	110 —114	114	...
50,000	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	102 —105	102 —105	...	...
19,894	Central London Railway, Ord. Shares	10	...	...	...	10¼— 10⅝	10 — 10½	10⅜	10⅛
129,179	Do. do. do. £6 paid	10	...	...	...	6¼— 6¾	6¼— 6¾	...	...
59,254	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1½— 2	1½— 2	...	...
67,680	Do. do. Def. do. £5 pd. ...	...	...	...	...	4⅝— 4⅞	4½— 4¾	4¾	...
630,000*l*	City and South London Railway	Stock	1 3/16%	1 3/16%	1⅞%	68 — 70	67 — 69	68½	68
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	...	...	2 — 2½	2 — 2¼	...	...
99,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 99,261	5	5 %	5½%	...	2¼— 2¾	2¼— 2¾	2 11/16	2⅝
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5½%	...	4 — 5	4 — 5	4½	...
194,023	Do. do. do. 4% Deb. stock Red. ...	100	...	...	...	103 —105	103 —105	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	5 %	6 %	...	2⅝— 2⅞	2⅝— 2⅞	2¾	2⅝
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343	2	7 %	7 %	...	3⅛— 3⅜	3⅛— 3⅜	3⅛	...
111,100	Do. do. 4% Perpetual 1st Mort. Deb. Stock	Stock	...	...	...	106 —108	106 —108	107	...
91,196	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,863	2	...	...	...	½— ¾	½— ¾	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	...	...	...	⅜— ⅝	⅜— ⅝	...	...
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	10½%	7 %	7 %	9 — 11	9 — 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	8 %	10 %	12 %	21½— 22½	21½— 22½	...	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½— 19½	18½— 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½%	110 —115	110 —115	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	21 — 22	21 — 22	21½	21
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	102 —106	102 —106	104½	...
37,500	†Liverpool Overhead Railway, Ord.	10	2⅞%	2⅞%	3¼%	10 1/16— 10 3/16	10 1/16— 10 3/16	...	...
18,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15¾— 16¼	15¾— 16¼	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	15 %	15 %	35 — 38	35 — 38	36	...
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	...	...	135 —138	133 —136	136	134

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

* Birmingham Electric Supply Company, Ordinary £5 (fully paid) 10⅝.

House-to-House Company, 4½% Debentures of £100, 108—110.

Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 16—17; 1st Preference Cumulative 6 %, £5 (fully paid), 8—8½. Debentures, 107—110. Dividend, 1897, on Ordinary Shares 10 %.

* From Birmingham Share List.

London Electric Supply Corporation, £5 Ordinary, 3½—4.

* T. Parker, Ltd., £10 (fully paid), 15½.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8—8½. Dividend for 1896—6 %.

Bank rate of discount 4 per cent. (April 7th, 1898).

MARGINS FOR ECONOMY.

We referred some time ago to the very large margins for economy which existed everywhere in this country, and which, if taken in hand, would go a long way to the routing of foreign competition, which has become formidable from not having these wasteful margins. We might instance an example which came recently under our notice, and which serves to illustrate our meaning. In passing through a boiler shop we noted a locomotive type boiler in course of being stayed. Two men were at work upon it. They were tapping the holes for the stud stays, using the customary long tap which passes through both plates, and which in our young days was laboriously turned through by hand labour.

When flexible shafts were introduced they formed a very valuable and rapid auxiliary, and put the taps through the plates in very much less time than was possible by hand. On the boiler which came under our notice there were two men at work. One of these men was armed with a flexible shaft, but the other man was putting his tap through at about treble the speed effected by the flexible shaft. He was using a little compressed air three-cylinder engine contained in a small cylindrical box, and coupled up by a flexible India-rubber tube to an air compressor. At the rate he was doing the work he would save, as compared with his fellow workman, about, shall we say, only 10s. a week. It would be more. This would soon pay for a new apparatus to replace the old flexible shaft, which, in its turn, had replaced the hand work. But it occurred to us that if the shaft were changed for a small motor, the new tool would put to shame the rapid air tool we so much admired, and very soon the air tool also would be displaced by an electrical tapper.

We would not quarrel with the use of compressed air in the workshop. For some purposes it is better than electricity. For example, we think air is better than electricity for operating small direct lift cranes, such as are employed to lift work from the floor to a lathe. These small cranes are direct acting and easily controlled; they might as well be water-worked, except that water has the freezing objection to contend with, and there is more or less risk of leakage. They may not be very efficient, but they are cheaper than a small electric crane would be. But for portable drills, reamers, tappers, &c., electricity is certainly more easily applied, and more efficient than compressed air. For this class of work, involving the reaming or tapping of hundreds of holes, the element of speed is important and in electricity we find an agent which is peculiarly suited to small high-speed tools.

Great as is the economy to be derived from electric driving in large workshops, it is as nothing compared with the saving to be secured by its use in small shops. We mean such little shops as are run with a small vertical boiler and a little wasteful steam engine. In a recent investigation by the writer of the conditions of one of these small workshops, it transpired that the only regular work to be done every day was the driving of a fan using about a third of a horse-power during not more than half the day. To drive this fan required the engine and boiler, and if the boiler fire did not keep alight all night, it would happen that work could not start in the morning for an hour after starting time. This delay alone must often have cost from £2 to £4 per week. Then the boiler required either the constant attention of one man, or the partial attention of a striker, which meant delay. Fuel cost about £1. The total expense for power was thus quite £4 to £6 one week with another, or more than sufficient in a year to have applied an electric motor to each machine, and paid for current for a few years also.

But conservatism and ignorance stood in the way of the new motive power, and, so far, has prevented its adoption. Few realise how very partial is the running of machine tools. Often they do not work, even when busy, half the time. There is stoppage for tool grinding, resetting, calipering work, changing work, &c. Yet all this waste time the shafting is going round, and fuel is consumed. Few people are aware of the extent of small industries in large towns, and especially in London, nor of the enormous waste of power involved in turning round the shafting.

One such shop lately seen by us was driven by a gas engine placed quite 100 feet from the work. To do work of only a quarter horse-power pretty well loaded up a 6-horse gas engine. In fact, loaded or unloaded, the engine seemed to record about the same number of explosions. The gas engine might have driven a dynamo, and all the shafting might have been abolished. It is all very well to say that if shafting is kept in order it will absorb much less power than is usually the case. But in practice it is the small shop which is worst off for shafting, because there is not the staff to look after it, and in every respect the small shop is at a very great disadvantage, both in respect of the fuel consumption for the energy output of the engine and in respect of the mechanical efficiency of the organs of transmission. The dead load bears so large a ratio to the live load, and moreover, the dead load is run 10 hours a day, where the live load is run from two to six hours only. Gas engines pay in small shops as compared with steam, but gas engines do not enable us to dispense with shafts and belts, and they also must run all day. It is very much in the time not worked that such large economies are possible with electricity.

Even where steam is employed the attempts to economise it are very half-hearted. We have seen live steam used for heating where exhaust steam would have done as well. We have seen a drying stove heated by the steam pipes to the engine, which were left bare on purpose to help the stove. The owners would not listen to any explanation that the resulting wet steam was very prejudicial to the economy of the engine, and there was no water separator. This sort of economy—for the owners believed that in thus using the engine steam pipes they were saving a set of pipes, and also so much non-conducting covering is really very common. Moreover, these same pipes had nine bends where two only were necessary. Had this pipe been made direct and covered the lengths of pipe saved would have been sufficient to have made up the stove heat, for the steam pipes were not wholly on the stove. Some of them were out in the open air and bare in places to the rain.

And people talk of hard times. All the examples cited have come under the writer's direct attention; they are but samples of thousands more or less parallel instances of waste, and we are bound to say that in many similar cases pressure to remedy has come from below—from the man at a few shillings a week, and has been blocked by the man above, whose refusal was usually that he did not see why such or such an action would save fuel. Electrical driving, even when it comes from outside generated power, appeals to such men when they happen to get it because they are keen to reduce a metered charge. These same men will go on paying for coal in excess because they have not the knowledge to teach them how to estimate where the losses come in. We have known them pay for expert advice, and refuse to follow it because they could not understand "*why it was so.*"

COMMERCIAL FORMS OF ELECTRICAL RESISTANCES FOR LIGHTING AND POWER PURPOSES.*

By Ll. B. ATKINSON.

The functions of a resistance being primarily to regulate or determine the amount of the current, which it does by its resistance, its second function is to dissipate the heat produced by the electric power expended on the resistance. This becomes a matter of cooling surface, and leads to a wide range of possible designs.

Speaking generally, then, in considering electrical resistances, the points to be considered are the (1) material of which the electrical resisting circuit is composed, (2) the nature of the support for such circuits, and (3) the material for insulating the circuit from the support, and, in addition, the nature of the switching mechanism for varying the amount of resistance in circuit.

(1) Material of which the Electrical Resistance Circuit is Composed.

Since all conductors offer resistance to the passage of the electric current, any conductor may be used as a resistance. The following table shows the resistance of 1 centimetre in length of various metals and alloys, carbon, and liquids, the cross-sectional area of the specimen being 1 square centimetre and the temperature 0° C.

Table of Specific Resistances.

Table I.

	Resistance per cubic centimetre.	Percentage variation per degree Centigrade.
Silver	1·504 microhms	·377
Copper	1·598 "	·388
Iron	9·716 "	·453
"German silver" ...	20 93 "	·03
Platinoid	51·0 "	...
"Manganin" ...	52·0 "	practically *nil*
"Eureka"	60 0 "	"
"Rheostene" ...	100·0 "	"
Carbon	4,200-40,000 "	—·2
"Relugite"	3·2 to 3,200 ohms	—·2
Solution of soda (10 per cent. solution)	11·5 ohms	...
Solution of zinc sulphate (density 1·405)	28 3 "	...
H_2SO_4 (density 1·10)	1·37 "	—1·7

This table is only to be used as a guide, since, except with pure silver and copper, as all the other materials are of somewhat undefined composition, and the resistance of alloys and carbon varies greatly with their chemical and physical condition. It will be observed that several of the materials used are special alloys, for the most part of nickel and manganese, which, in addition to having a very high resistance, have a very small temperature coefficient, which is important, as resistances are often worked to a temperature of 200° C., causing a very considerable variation of resistance.

* Abstract of paper read before Northern Society of Electrical Engineers.

An interesting example of this is in the use of iron wire when it is approaching a red heat, in which case it will be found that the resistance rises so rapidly, that a very large increase of E.M.F. will only cause a very small increase in the current, because as the E.M.F. is raised, causing a small increase of current, this raises the temperature, so that the resistance rises almost as fast as the E.M.F.

The writer some years ago used this property for arc lamp resistances, when even if the lamp was cut out, the permanent rise in current was quite small.

The metals, solids, and liquids shown in the table are those which are most frequently used for making resistances, and with regard to these, the usual form of the metals and alloys is in the shape of wire or strip, the former generally wound into coils.

Carbon may be used either in rods, in which case the ends should be electro-coppered, and the connections clamped and soldered to the copper, or the carbon may be used in the form of flat plates piled on one another.

The material, "Relugite," shown in the list, is a new material, now being put on the market by the Electric Insulation Syndicate, of Cardiff, and having an incombustible base, such as asbestos, in which is deposited conducting carbon, and the specific resistance of which can be made as required within the limits given, and this material also may be used either in strips, the current passing from end to end, or in plates or layers, through which the current passes.

Liquids are used generally where high resistances are required, and are on the whole an unsatisfactory form of resistance, as the solutions creep and cause loss of insulation on the circuits to which they are attached, whilst the liquids also leak or evaporate, so that they have to be made good, and the composition and resistance is constantly varying.

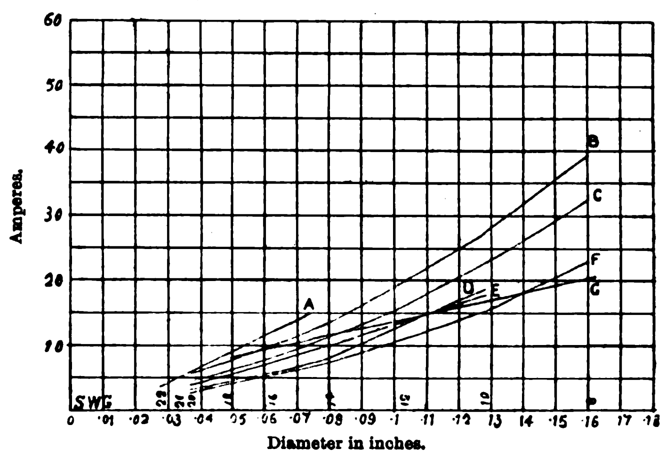
Carrying Capacity of Resistance Materials.

It is important to determine what is the carrying capacity of the wires, strips or plates, of which a resistance is composed; this being defined in relation to some particular allowable rise of temperature.

The rise of temperature to be allowed is probably the point on which the greatest difference of opinion seems to exist among manufacturers.

It is somewhat curious that the fire insurance offices who define to a nicety the insulation of the circuit and other quantities, are exceedingly vague on what is probably one of the chief fire risks that are run, most of the offices satisfying themselves by merely stating that the resistance should be constructed of, and mounted upon incombustible material, and that no combustible material should be within a foot of the resistance.

Diagram of carrying capacity of metal wires.



A, Iron wire coils on ½-inch bar, 280° C.; B, Rheostene 150° C.; C, Rheostene 100° C.; D, Iron 50° C.; E, Silver 50° C.; F, Rheostene 50° C.; G, Tinned iron maximum safe current.

Since most organic matters and fabrics char at a temperature of 200° C., the writer thinks that that limit at all events should never be passed, and probably the rule defining that the maximum temperature of the hottest part at the maximum working load should not exceed 150° C. would be a safe rule.

The principal methods of dissipating heat from resistance are by radiation, air currents, and in certain cases by circulating liquids, such as oil or water.

The amount of heat radiated at the temperatures discussed is not large, and the use of liquids for cooling is not common, so that practically speaking cooling by air or currents is the usual method.

It is obvious, therefore, that the designs should be such as to allow a free circulation of air through those parts where the heat is being produced.

Wire Resistances.

For this reason where wires are used, it is advantageous that the diameter of the wire should be small, so as to give a maximum surface for a given cross-sectional area, and to carry the requisite current a sufficient number of wires should be placed in parallel.

Again, where wires are wound into coils, these coils should be open, and there should be a space between successive turns of the coils of 2 or 3 diameters to allow an effectual passage of air.

In the case of long coils placed vertically, the upper parts of the coil become far the hottest, as the air heated by the lower coils is the only cooling medium.

It is almost impossible to give any general rule as to the carrying capacity of wires in coils.

The Diagram shows the relation between the diameter of the wire and the carrying capacity of wires stretched out straight in the air, and for certain temperatures.

If the wires are in coils drawn out so that the space between the wires is about 2 diameters, the current the wires will carry for the same temperature will be about one-third of that given by the diagram.

One of the most effective forms in which wire can be used is in the form of wire gauze, and the best class of gauze is that in which the longitudinal wires carry the current, the wires all being in parallel connection, whilst the cross threads carry away the heat, and in this case the load to be carried by a given wire is double that given in the table.

A great difficulty occurring with wire resistances, particularly where alloys, such as German silver, are used, is that the wires become brittle or rotten, and break, causing short circuits, and danger of fire.

In the case of resistances enclosed in boxes so that only the outside surface will dissipate the heat, the carrying capacity of the wires is much less than that given in the table, and the ultimate carrying capacity of the resistance will depend on the surface of the casing exposed to the air, and for a temperature of 150° C., the total external surface should be about 10″ per watt to be dissipated.

The surface for this purpose may be increased, if of metal, by casting ribs or fins upon the casing, so as to increase the surface.

Some resistances are only required for a short time at intervals, such, for instance, as resistances for starting motors, and here the element most to be considered is not the surface on which depends the power of steadily dissipating heat, but the total specific heat of the parts on which depends the rise of temperature with the given load in the time for which it is to be used, and in this case materials having a high specific resistance with large bulk may be used to advantage, or if fine wires are used, they may be imbedded in materials such as enamel or sand or asbestos, which will absorb, by conduction, the heat from the wire itself.

Carbon Resistances.

A common form of carbon resistance consists in the use of ordinary lighting pencils, with the ends coppered and connected up by clamps.

These resistances for testing purposes can be run at a very high temperature, but they dissipate heat badly, they are very liable to be broken, and are not often used for resistances which may have to be transported.

Carbon resistances made up of plates placed in a frame are often used, and they have the advantage that the resistance may be varied by screwing them up more or less tight by a clamping screw.

In this case a very large part of the resistance is due to the resistance of the surface of the contact between the layers, and due, also, to the fact that the current travels in the plane of each layer from the points of contact at the surface, of one set of plates to those of the next set; these, in most instances, not coming opposite to one another on the plates.

In other words, except when the plates are screwed up quite tight, the current is travelling by a zig-zag course through the pile of plates, and it is principally this which enables the resistance to be varied.

The material previously mentioned, viz., "Relugite," is used in the same way, and with the same results, but it has a great advantage over the carbon resistances, in that the material being flexible and elastic, a much wider range of the screw is obtained, so that the resistance can be varied more gradually, whilst the tendency with solid carbon resistances for the plates to actually break contact and so set up an arc is got over.

The chief difficulty with carbon resistances is that they present a very small cooling surface.

This difficulty has been obviated in the case of "Relugite" resistances by interposing metal plates between the plates of material, which metal plates are larger than the plates of the material, and thus serve to conduct the heat from between the plates, and to present a large surface for the air to pass through to cool them.

Liquid Resistances.

The commonest form of liquid resistance is a wooden tub filled with water in which is sulphuric acid, common salt, washing soda, or other metallic salt, to render it more or less conductive, and in which are immersed plates leading in the current.

Such resistances cannot, of course, rise above the temperature of boiling water, and they absorb a large amount of heat due to the large latent heat of steam.

Such an arrangement is, of course, a very rough one, and only used for temporary purposes.

For permanent installations iron or earthenware jars or pots are used, containing solutions, and having electros of various forms which can be moved in relation to one another.

(2) Materials for Supporting Resisting Wires or Materials.

In the early days of the use of electric power, resistance wires or coils were usually strung in wooden frames, and the writer believes he was the first to introduce into the market standard patterns of resistances, in which the supports were wholly composed of incombustible material, that is to say—iron frames carrying slate or porcelain insulating parts, to which were attached the resisting wires.

These resistances may be, and usually are, provided with a switch having a number of contacts, which enables, more or less, the resisting wire to be included in the circuit.

A class of support previously mentioned is the use of enamel on a base of iron. In this case the iron is first enamelled, to give it an insulating coating; the wires, which are very fine, are then placed on the enamel, and covered with thick coating of enamel, which is then fused, so that the wires are firmly imbedded in it.

The resistances known as the Carpenter resistances, and the resistances in most heating and cooking apparatus, are arranged in this manner. In this case the enamel carries the heat from the wire to the iron supports, which then distributes it, and forms the cooling surface.

In the case of the "Relugite" resistance material, this is carried in iron frames, generally on pillars or bolts passing through it, the insulation being enamel, and in certain cases mica or asbestos sheets are used where flat surfaces are to be insulated.

In a form of liquid resistance which the writer has used, the current enters at the bottom of one tube and leaves at the bottom of the next tube, a wire fork or bridge being raised or lowered in the tubes.

A curious phenomenon occurs with such an arrangement, the complete explanation of which the writer is unable to give, viz.: That using lead plates at the bottom of the tubes and a copper or iron bridging piece, the resistance and heating effect is not equally divided between the tubes, but is largely concentrated in one of them.

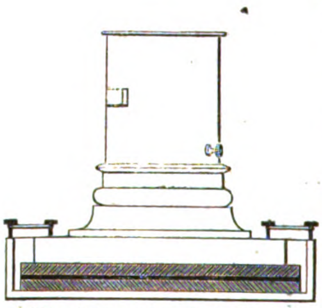
(To be continued.)

TRIAL OF THE SULLIVAN UNIVERSAL GALVANOMETER ON A TORPEDO BOAT.

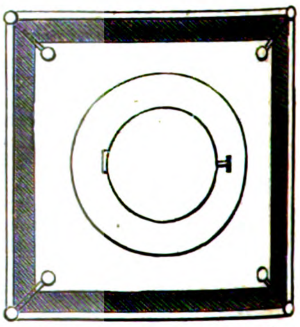
The Sullivan Universal Galvanometer has recently been tried in the English Channel on an Admiralty torpedo boat steaming at various rates of speed. The object of the trials was to determine the effect on the working of the instrument of the excessive vibration experienced on those vessels. Throughout the observations the galvanometer was mounted in a cabin aft almost immediately over the propeller, with the instrument facing towards the bow, and in the first instance was screwed to the cabin table in the usual way without a cushion of India-rubber or other vibration absorbing material interposed between instrument and table. Thus the vibration of the boat was communicated direct from table to galvanometer. The distance between mirror and scale was 42 inches. The following is a record of the behaviour of the galvanometer under these conditions:—

The boat was found to be most vibratory at 300 to 350 revolutions of the engines per minute (about two-thirds full speed). The observations noted below were all made at that speed.

So severe was the vibration then experienced that a glass of water placed in a receptacle on the table was in a few minutes more than half emptied. Nevertheless, the instrument behaved very well.



Side of tray removed showing the hair felt pad.



Showing galvanometer in tray and rubber stays at four corners.

Only an occasional movement of 30 to 50 scale divisions was noticeable. In every case this disturbance was of the nature of a sharp throw, the spot of light immediately returning to zero without oscillating or passing that point. At all other times there was no perceptible unsteadiness.

The galvanometer was then mounted as follows, and a further series of observations made:—A thin wooden tray was screwed down to the table, and inside were laid two thicknesses of hair felt, each of them ·8 inch thick, together making a pad or bed about 1·5 inch thick when not compressed and 1 inch thick when the galvanometer was on it. The internal dimensions of the tray were 12 inches by 12 inches by 3 inches deep, thickness of sides ½ inch, and bottom ½ inch. The flat portion of the wooden base of the galvanometer stood just below the top edge of the tray. At each corner of the galvanometer base (and in its screw holes) and at each corner of the tray was a screw, an India-rubber band connecting each pair of screws, so that at each corner there was an elastic stay sufficiently strong to keep the galvanometer in position when the boat rolled and pitched heavily, and yet the India-rubber bands did not transmit vibration from the tray to the instrument.

With this arrangement and the propeller doing its worst the galvanometer disturbance was reduced to an occasional throw of five divisions only, increasing at odd intervals to about 20 divisions.

Apparently this occasional and slight increase of unsteadiness coincided with sudden changes of the helm which combined with the ceaseless vibration from the propeller produced a severe jarring effect. At other times the spot again was absolutely steady, and in all cases the coil immediately resumed the zero position without oscillation.

Hitherto the galvanometer had been on open circuit. It was now short-circuited. The result was to still further reduce the maximum and occasional throws which had been noticeable upon changes of the helm from 20 to 10 divisions.

Some measurements then were made over the full range of the scale with perfect ease, the coil when deflected being as steady as when in the zero or resting position either on open or closed circuit.

During one part of the trials a short and choppy sea was encountered causing the boat to be very "lively" with sudden irregular movements, but, notwithstanding this effect and the excessive vibration of the propeller, the galvanometer, as before, preserved its equilibrium. It should be mentioned that the delicately suspended coil was in perfect balance.

An ordinary and less sensitive iron-clad marine galvanometer set up alongside the Sullivan, and in the same way, vibrated to such an extent that the spot of light continually left the scale on either side and was often invisible, observations of any kind with it being cut of the question.

In view of the great galvanometer disturbance which mechanical vibration, apart from rolling and pitching, so frequently sets up on board ship, preventing any reliable observations being made, these trials may be considered interesting as showing the steadiness of the new galvanometer under the severest test to which any such instrument could possibly be subjected, and Mr. Sullivan is to be heartily congratulated on having achieved such perfect control over one of the most delicate of electrical measuring apparatus.

The Sullivan Universal Galvanometer, mounted on a cradle board to imitate the rolling and pitching of a vessel, may be seen in operation at the offices of Mr. H. W. Sullivan, 19, Great Winchester Street, E.C., the inventor and sole maker.

SUBMARINE CABLES IN TIME OF WAR.*

TRADE AND TELEGRAPHS.

America, it is stated, has claimed the right to cut cables connecting Cuba with the islands of Jamaica and Bermuda, and Spain has objected on the ground that the Telegraphic Convention protects these lines. Already the electric communications between Key West and Havana have been seized by the Americans. The whole question of transmission of cablegrams through neutral territory and along wires owned by neutral shareholders bristles with delicate questions and interesting points. In the course of inquiry into the subject, which not only concerns the belligerent Powers, but intimately affects our own trading and commercial relations with the Western hemisphere, a representative interviewed a gentleman whose position and experience entitle him to express an authoritative opinion upon the manner in which hostilities may interfere with the working of the submarine channels of communication between the Old World and the New.

"The Americans," he said, "I have no doubt, were within their rights in taking control of the cables between Key West and Havana. They belong to an American company, and the Government of any country granting a license to land cables invariably reserves to itself the right to enter into possession and to work them, accounting to the shareholders for the receipts meanwhile. The proprietary company of the Key West cables is the International Ocean Telegraphic, which is leased to the Western Union, the great company of America. But when you speak of the Americans cutting the cables which connect Cuba with the British island of Jamaica a different question is raised, as the line from Batabano to Cienfuegos, and the double line thence to Santiago de Cuba, on the southern coast of the island, are both British property, for they are owned by the Cuba Submarine Company, which has its offices in London. It is an English concern. From Santiago de Cuba to Holland Bay, in Jamaica, another British company—the West India and Panama—owns the cables."

"Is there any provision in the Convention to protect this property?"

"Cables are not neutral in time of war. The Submarine Telegraph Act of 1885 scheduled an international Convention, which authorised and made it legal. This Convention between the civilised States of the world was for the protection of submarine cables against wilful damage, &c., but there was this express provision in it: 'It is understood that the stipulations of the present Convention do not in any way restrict the action of belligerents.' I imagine, therefore, that there is nothing to prevent any belligerent cutting cables, but if he wilfully does so, in the case of a cable belonging to a neutral country, that country, or the company owning the line, would have a claim against the offending Power for the destruction of property. But still, the countries of the world could not complain diplomatically of such damage, as they would be justified in doing supposing that a belligerent fired upon the Geneva Cross. Let us take it that we were at war with Russia. Russia would be at liberty to cut any of our cables without raising an international outcry, but if Russia, at war with us, were to cut the cables of an American company, my impression is that the aggrieved party would have a claim against the Russian Government for damages. But it is a legal question."

"If the United States and Spain both recognise the principle, as they now do, that the neutral flag covers enemy's goods, except contraband of war, and that neutral merchandise, except contraband of war, is not seizable under the enemy's flag, why should not the same protection be afforded to cables?"

"Well, it may be argued that a cable is an effective engine of destruction, ordering troops and fleets to move, and so forth, as any other appliance used in war, which Spain has declared contraband."

"How do the two belligerents stand in regard to cables?"

"Should the United States cut cables in the West Indies, Spain may retort by grappling up cables, say, three miles off the Irish coasts—*i.e.*, outside our territorial limit. The Western Union Company have two cables across the Atlantic, and the Commercial have three, from Waterville in Ireland, to Canso in Nova Scotia. I should say that Spain could break these lines without breach of international agreement. It would be equivalent to a gun fired upon American property."

"But supposing Spain should not only grapple the American-owned cables—those of the Western Union and Commercial—but also cut the lines belonging to the English or French companies, what would happen?"

"I should think that such wilful damage to neutral property would be resented by the proprietary companies, backed up by the British Government."

"How can Spain communicate with Havana and Puerto Rico?"

"She can do so by using lines that run through British territory throughout; for, as far as I know, there is no intimation of telegraphic interruption with Puerto Rico. The route for a Spanish message would, therefore, be by one of the English companies to Halifax, Nova Scotia, and thence to Bermuda. The British have now a cable from the Bermudas to Jamaica, calling at Turk's Island, and between Jamaica and Puerto Rico there are, as I have said, two cables. So that Spain could have communication with both of her colonial possessions in the West Indies without touching American territory."

"But she would be entirely dependent upon the good offices of England. Has she no alternative route?"

"She can cable direct from Cadiz to Teneriffe; but from Teneriffe to St. Louis (Senegal) the cable is French, and from St. Louis to Pernambuco, crossing the Equator diagonally, the cable is British. England is placed in rather a singular position. To reach the Windward Islands we must enter Spanish territory at Puerto Rico. I can conceive it would be a wise measure to divert one of the cables from Jamaica, at present landing at Ponce, in Puerto Rico, to the Danish island of Santa Cruz direct, and thence to Trinidad and Demerara; and that plan, I should say, would be adopted. It would still leave Puerto Rico with one cable, landing at San Juan, from Jamaica. The French can, on the other hand, reach their coaling station at Martinique without touching Spanish territory. They have lines which go from Brest to Cape Cod, near to Boston, and they have recently laid a cable from New York to Hayti, which lies midway between Puerto Rico and Cuba, and thence to Martinique and to Cayenne. The French have also a cable from Santiago de Cuba to Hayti."

"Is it not possible to reach Jamaica and Cuba by way of South America?"

"Yes, by a roundabout route, traversing the Continent. Our Admiralty would probably direct the movement of ships in the Pacific by sending messages through lines owned by Englishmen and worked by Englishmen, first to Lisbon, and thence to Pernambuco, in Brazil, the cable being the property of the Brazilian Submarine—a British company—thence to Monte Video (Western and Brazilian Company, also British), then to Buenos Ayres (nominally Argentine, but actually British), thence to Mendoza, and so on to Valparaiso (Chili), and along the West Coast of South America to Chorillas, in Peru, hugging the land, whilst a competitive American Company takes a seaward curve to the same place. From Chorillas there are two lines—one to St. Helena, and the other to Payta, and one of them going on to Buenaventura, and then to Panama, across the isthmus of which, at Colon, a cable, which is British, connects with Jamaica, and thus completes the circuit. But you will notice that the Spaniards would be reluctant to use this route, as the links from Chorillas to St. Helena and Payta are owned by Americans. Similarly, though the map shows a possible communication *viâ* the North-East Coast of South America from Pernambuco to Cayenne, the section between Para and Cayenne is invariably broken, so no telegraphic communication with the West Indies by that route is possible."

* *Daily Telegraph.*

SUGGESTIONS FOR IMPROVEMENTS IN POWER PLANTS.

The recent attention drawn to the wastefulness of the auxiliary engines of certain ships of the American Navy, and also of our own ships, notably the *Diadem*, has its counterpart in similar attention to the wasteful items of stationary plant. The subject is discussed by Mr. Bennett in *Cassier's Magazine*, the author's conclusions pointing to the use of electric motors in place of small engines and direct acting pumps. The main engines are always fairly efficient and, less the small loss of transmission, this same efficiency ought to be obtained in auxiliary plant also, whereas auxiliary plant is almost invariably very wasteful. As a railway or a light plant must always have one unit at work, or there will be a storage battery to draw upon, there need be no fear of the auxiliaries being too dependent or liable to interruption. Where the main engines are of condensing type the steam of auxiliary engines has been very much used for feed-water heating, and it is this apparent utilisation of the exhaust which has strengthened the hold of the simple small steam driven apparatus by a false assumption of economy. As a matter of fact, if flue feed heaters were applied to use the waste gas temperature there would be no field for using the exhaust of wasteful small steam auxiliaries, and their place would be seen to be better filled by electrical motors. We need not follow our author into his recommendations of the flue feed heater or economiser, for though comparatively new to America it is old in England, at least in the north where fuel is cheap, though much less common in the south, where its economy would be so very much more marked.

The economiser is as necessary a step in steam production as is the second cylinder of the compound engine in steam using. It represents the principle of stage heating or counter currents, and in large plants may well be divided into two or more divisions in series so as to leave to the boiler proper little else to do than to give the latent heat necessary to turn hot water into steam. By this means alone can the waste gases be reduced to a temperature sufficiently low to fully justify a mechanical draught. If the waste gases are sent away very hot they may just as well assist to produce draught by a chimney, and it is not of much use adopting a power driven fan unless at the same time the waste gases are correspondingly reduced which can only be done by stage heating of the water, which is finally boiled off.

Moreover, where electricity is available there is no great need of a wasteful steam engine to drive the draught fan. Economisers are somewhat of a check upon a good draught, and are desirably associated with a fan which will revolve for less heat expenditure than a chimney will perform the duty, but as said above, if the chimney is to be abolished there must be a properly low temperature of the escaping gases.

THE SOCIÉTÉ INTERNATIONALE DES ELECTRICIENS.

Sitting of April 6th, 1898.

The annual general meeting took place on April 6th, with Dr. D'Arsonval in the chair. The general secretary was absent through illness, his place being filled by M. J. Laffargue, secretary. After the report had been read, the names of some candidates for admission were presented, and also some books. The voting list was then closed and tellers were appointed.

M. Armengaud read the report of the Committee of Accounts, which was received with approval.

M J. Laffargue then read a paper on "The Distribution of Electrical Energy in Germany."

He mentioned that last January he had the pleasure of accompanying on some professional business in Germany, M. Charles Bos, municipal councillor of Paris, and reporter on various electrical questions. He had occasion to visit a large number of distributions of electrical energy, and he wished to bring before the notice of the society some of his observations, confining himself, however, to technical matters.

Installations in Germany are on a large scale and very numerous, both for distribution properly so-called and for traction.

Sometimes these installations are combined, and a single central station effects both distributions. We have already given the statistics of the central stations of Germany. To these must be added since September 1st, 1897, 56 towns provided with 957 kilometres of electrical tramways, absorbing a power of 21,465 kilowatts; part of this power is furnished by the central stations used for both distribution and traction, of which we have spoken above.

The distribution stations are large, spacious, well managed, and very clean. In most cases they are situated near railway stations or near rivers, and sidings are always arranged to bring the coal up to the station. The boiler rooms are high and well ventilated; the boilers have a clear space between them and are easily accessible. The engine rooms are large and are capable of being enlarged still further. One can walk about freely amongst the engines, and approach all the parts. The distribution boards can be seen well from all parts of the room and the regulation is easy. For street canalisation only armoured lead-covered cables are used in Germany, made either by Siemens & Halske, or by Felten & Guilleaume. Under the pavements they are generally laid directly in the earth; under the roads they are sometimes protected in iron tubes, or in iron cases made specially. The wires intended for traction are nearly always overhead, at least as far as distribution wires are concerned. At various places, in order to prevent the falling of the telephone wires, iron wires are stretched across which add still more to the unsightly appearance of the overhead wires at cross-roads.

The indoor installations of the consumers are very bad in Germany. Notwithstanding the very strict regulations that we read of in various journals, we meet with few good installations. We see wires laid right against the walls, and merely held in place by hooks. Installations on porcelain insulators are numerous. The fitting up is often defective, metal covers scarcely fixed at all being used. Installations used both for gas and electricity are very numerous, and the wires are laid over the gas appliances without any precautions being taken. Several engineers told us that this state of affairs was now going to be looked into and altered.

We then examined some of the installations in the principal distribution stations.

At Frankfort we found a municipal central station under State management for the last two years. It was installed and is still worked by the Brown and Boveri Company of Baden. The engine room contains four compound tandem horizontal steam engines of 750 H.P. at 70 revolutions a minute, each driving directly four alternators of 500 kilowatts at 3,000 volts; a fifth engine of 1,500 H.P. is in course of erection.

The distribution board is in the centre of the room placed at a certain height; in the basement are the appliances for condensation.

The mains are formed of Felten & Guilleaume concentric cables; the transformers are placed at certain centres of distribution. At the end of the season of 1897, the installation included 40,825 incandescence lamps, 624 arc lamps, and 133 motors of 1,063 H.P. The public lighting included 100 arc lamps of 10 amperes and 800 incandescence lamps. Amongst the various installations of motive power, we particularly admired that of the *Frankfort Gazette* where three motors of 30 H.P. drive printing presses, and where there are a series of smaller ones for passenger and luggage lifts.

The cost of supplying the electrical energy is ·15 franc the kilowatt-hour for lighting and ·15 franc for motive power. At Frankfort, experiments are now being made in traction by accumulators, and are being carried on by the Pollak Accumulator Company.

This company has extensive works where the manufacture is being developed considerably. Besides Messrs. Pollak's special commutators, which serve for the formation and the charging of the accumulators made at the works, there are rotary transformers and motors driving dynamos. Cables connected to a post placed not far from the works enable the charging to be effected with a constant difference of potential of the accumulators placed in cars under the seats. The car passes under movable contacts and the charging at once commences automatically. In four minutes the charging is concluded.

We also visited while at Frankfort the works of the old firm of Lahmeyer, and of Hartmann & Braun; we found everywhere extensive works with electric transmissions and driving gear, and also fresh buildings in course of construction for extending the installations.

At Cologne there has been a municipal electrical station since 1891, established under the best possible conditions, luxuriously even. The distribution is effected by alternating currents at 2,000 volts, with transformation at the consumers' houses to 72 or 110 volts. The engine room, which is elegantly fitted up, contains four Sulzer compound engines of 650 H.P. at 85 revolutions per minute, working directly four Helios alternators of 450 kilowatts, and exciters of 110 volts and 300 amperes. The alternators are coupled in parallel with auxiliary resistances. The distribution board is placed in the middle of the room against the wall at a certain height. The arrival and departure wires are placed for each machine on a special board. On the fore-part is a switchboard, which, by the aid of levers, enables the chains to be manipulated that work the interrupters, and the circuit-breakers of the high tension circuit and of the exciting circuit. The circuit-breaking interrupters, the starting point of the high tension feeders, and also the charging resistances, are, in fact, placed in a special closed room, situated below and behind the distribution board.

The mains are in the form of concentric armoured lead-covered cables, placed in wooden cases. The central station has undertaken the lighting of the streets in certain quarters, and the feeding of some motors; sub-stations for transformation into continuous currents for traction are going to be supplied.

At Hamburg, the new station in the Carolinens-Strasse supplies three sub-stations of accumulators placed within the town, and furnishes the tramways with the necessary electrical energy. This station has a large boiler room containing 16 boilers, each with 250 square metres of surface, and an engine room of 17 metres by 50, in which are installed six triple expansion vertical steam engines of 1,200 H.P. at 100 revolutions per minute. Two of these engines each work two Schuckert dynamos of 500 kilowatts at 300 volts, three each work three similar dynamos at 600 volts, and the sixth engine drives a dynamo of 1,000 kilowatts at 600 volts. The distribution board is very well arranged; on the wooden part are placed all the arrival wires of the engines, and on the sides are the departure wires of the circuits.

There is also at Berlin the Post-strasse station, situated within the town, and containing five compound vertical steam engines of 500 H.P. at 120 revolutions a minute. These engines work five Schuckert dynamos of 400 kilowatts at 250 volts, which effect a special distribution.

The first electric station was established at Berlin in 1885. The distribution is effected by three wires at 220 volts. There are now four large stations and one sub-station, all connected with one another and feeding the same system of distribution. The station of the Markgrafenstrasse contains six compound vertical steam engines of 300 H.P. at 82 revolutions per minute, working dynamos with internal poles and also three rotary transformers of 400 kilowatts. The primary of these transformers is fed by the triphased currents coming from the station of Schiffbauerdamm. The secondary circuit is formed by a dynamo of 250 volts. The station of Mauerstrasse contains two steam engines of 300 H.P. at 82 revolutions per minute, four engines of 1,000 H.P., and two engines of 1,500 H.P. Amongst the dynamos are two of 238 kilowatts, four of 364 kilowatts, and four new dynamos of 650 kilowatts. In the station of the Spandauerstrasse are three steam engines of 1,000 H.P. and four of 1,500 H.P., and also six dynamos of 364 kilowatts and eight of 650 kilowatts. The station of Schiffbauerdamm contains three engines of 1,000 H.P., two of 1,500 H.P. working respectively six dynamos of 364 kilowatts and two triphased alternators.

The sub-station of Königin Augusta Strasse is fitted with two batteries of 138 accumulators of a capacity of 12,000 ampere-hours.

There is now in course of installation at Oberspree a large station of 50,000 H.P. which is to effect the distribution of electrical energy in the suburbs of Berlin. Up to the present the electrical tramways in Berlin have been worked partly by overhead wires and partly by underground cables, the energy being supplied by the station of Mauerstrasse, from Behrenstrasse to Treptow, and from Treptow to Dönhoffsplatz. Experiments in traction have also been made with accumulators on the line from Berlin to Charlottenburg. At Berlin we also visited the works of the Allgemeine Elektricitäts Gesellschaft, and at Charlottenburg, the workshops of the firm of Siemens and Halske. The central station of Leipsig is situated outside the town; it comprises a system of distribution by continuous currents which supplies consumers living near, and a transmission by triphased currents to a sub-station situated within the town. A rotary transformer works a continuous current dynamo of 350 kilowatts at 250 volts, and also three *survolteurs* for Tudor accumulators. The whole of this installation was provided by the Siemens & Halske Company. At Leipsig there are two different traction companies working different systems, one running 80 cars and the other 185.

The town of Munich has up to the present only undertaken public lighting and experiments in traction. The distribution is effected at 660 volts and feeds about 850 arc lamps. The station of Muffatwerk contains at present a turbine of 200 H.P., working by transmission two Schuckert machines of 66 kilowatts at 330 volts, and three similar machines of 26 kilowatts; this same transmission is also driven by a steam engine of 300 H.P. Two other engines of 350 H.P. have also just been installed, and one of 700 H.P., and one of 1,000 H.P. is now in course of installation. M. F. Uppenborn, engineer-in-chief to the municipality, explained to us the projects that will shortly be put into execution, and which include three central stations using triphased currents with sub-stations using continuous currents, the whole comprising a power of 21,000 H.P.

At Nuremberg, there is a municipal central station which possesses four alternators of 450 H.P. at 2,200 volts, and one of 1,000 H.P. In the town a special system of traction by trolley is used. But what is most worthy of notice is the large establishment of the Elektricitäts Aktien-Gesellschaft, where at every step we meet with electric transmissions, machinery, experimenting rooms, foundries, and erecting rooms. The company is erecting by the side of the *first* establishment a second, which will perhaps be still further developed.

At Strasburg, the central station supplies electrical energy for distribution, properly so-called, and for traction. The steam engines, five in number, are compound vertical engines supplied by the Société Alsacienne, two of 200 H.P. driving at the same time a triphased current alternator of 80 kilowatts, a continuous current dynamo of 125 kilowatts at 500 volts, and three engines of 300 H.P., each driving a triphased current alternator of 280 kilowatts. It will be interesting to give a few particulars as to the cost price and the selling price. Generally speaking, the cost of coal is from 12 to 18 francs the ton, and we reckon about 3 kilogrammes per kilowatt-hour produced.

At Frankfort the cost price of the kilowatt-hour is ·305 fr., including interest and sinking fund. At Cologne and at Düsseldorf the cost prices are respectively ·192 and ·126 fr., including interest and sinking fund. The selling prices vary from ·08 to ·1 fr. the hectowatt-hour for lighting, and from ·025 to ·035 fr. for motive power, with reductions amounting to 40 and 50 per cent. We will conclude by saying that in March, 1897, Germany possessed 1,025,785 incandescence lamps of 50 watts, 25,024 arc lamps of 10 amperes, and a power of 21,800 H.P. for engines installed. At Berlin, at the end of the season 1896-97, there were 196,076 incandescence lamps, 9,173 arc lamps, 357 apparatus of various kinds, and 2,056 motors of 7,475 H.P. It must be remembered that in 1888-89 there were 17 motors of 60 H.P., in 1892-93 about 232 motors of 785 H.P., and in 1895-96 about 347 motors of 4,813 H.P.

M. R. Picou asked M. Laffargue if the prices named include both *the expenses of the sinking fund and the expenses of administration*; he also said that it is not possible to establish any comparison as to cost price with distributions possessing only a concession of short duration in order to ensure the sinking fund.

M. Laffargue replied that these particulars are given; it is quite evident that no comparison is possible between concessions whose respective durations are 40 and 18 years.

The President then read out the results of the elections. The candidates elected were as follows:—

President (1899—1900), M. Violle; vice-presidents, Messrs. Olérac and Monnier; secretaries, Messrs. Abraham and Grosselin; treasurer, M. L. Violet; Members of the Committee: Messrs. Blondel, Blondin, Bouchard, Chammat, Desrosiers, Ebel, Gaiffe, Gauthier-Villars, Ch. Ed. Guillaume, Cl. Krebs, P. Laporte, A. Larnande, Margaine, Poincaré, Radiguet, De Romilly, G. Lautter, J. Voisedat; Members of the Committee of Accounts: Messrs. Armengaud, jun., A. Berthon and G. Masson.

Dr. D'Arsonval then thanked the Society for the honour that had been conferred upon him by electing him president, and he invited M. R. V. Picou to succeed him.

M. Picou asked permission to postpone until the next sitting the customary speech, and the meeting then broke up.

ELECTRICITY IN WARFARE.

The establishment of the Electrical Engineers Volunteers Corps in this country has led to steps being made in the same direction by the United States. A year or so ago when there seemed some likelihood of our being brought face to face with the army or navy of some other nation, the idea of the English electrical corps was born. Since then there has been much organisation work to be done, but though this is in an advanced state we should question whether the corps would be ready for the field within a few weeks if required. Now, however, that America is in a state of actual warfare with Spain, and requires, we suppose, all her forces to be ready within a very short space of time, there is a somewhat similar movement on foot in that country. Over seven years ago the attention of the U.S. was forcibly drawn to the advisability of forming such a corps, and if advantage had been then taken of the warning, the States would probably by this time have possessed a well-equipped body ready for all emergencies. There is no doubt that the Hispano-United States conflict will teach many lessons in warfare to both countries, though what the result of the affair may be it is unwise to attempt to conjecture. But in the matter of electrical engineer volunteers, the States may perhaps regret that steps were not taken earlier instead of waiting for us to set the example. However, at past the eleventh hour, Captain Eugene Griffin, U.S.A. retired, the first vice-president of the General Electric Company, has organised an auxiliary corps of electricians and electrical machinists, which will serve in the army or navy, or both. The engineer corps of the army has been short of electrical experts, whose services have been in great demand in the preparation and planning of submarine mines and torpedoes. Captain Griffin recognised this deficiency of skilled workers, and, with the permission of the Secretary of War, formed his plans, and has carried them out to success. He has, according to our New York namesake, obtained the names and the day and night addresses of a large number of skilled workmen in the employ of the General Electric, Westinghouse, and other electrical concerns in New York and the New England States. This information was sent direct to General John M. Wilson, U.S.A., chief of the engineer corps, who now has it on file. A number of these volunteers have already been at work in New York Harbour, Boston, and Philadelphia. Later news says that in less than a week Captain Griffin enrolled over 1,000 men.

Our contemporary, in a recent editorial, remarked that ultimate success in both land and sea practice depends very largely upon the electric current in one form or another. The preparations being made by electrical engineers and manufacturers are briefly mentioned.

In the first place the government has purchased thousands of miles of submarine and underground cable and other kinds of wire. These conductors are to be used for connecting and operating submarine mines and torpedoes, for establishing means of communication between the coast defence fortifications, and for feeders to supply current to the searchlights located at advantageous points along the coast. Nearly all the large wire manufacturing companies were at the beginning of April working their plants day and night, and the orders of many of their regular customers had to be side-tracked on the patriotic understanding that the government's needs at such a time must take precedence. One wire company was ordered to manufacture all the cable of a certain type it could turn out by a specified date some months in the future.

There was great activity in the manufacture of searchlights, large orders being received. In this connection, it is interesting to note that central stations located near the Long Island coast, such as the Edison Company in Brooklyn, have arranged to supply all the current required to operate searchlights on the fortifications in their vicinity. Electricians familiar with setting and connecting submarine mines were in great demand. The army engineer officer in charge of the fortifications in the vicinity of New Orleans has made a request for as many experts as can be spared. The General Electric Company furnished a party of 20 experts to be placed at the service of the government for torpedo work and connecting up searchlights. The Western Union and the Postal Telegraph companies have formed two corps of expert telegraphers composed of 50 men each, equipped with pocket kits of tools.

The telephone companies along the coast have also made arrangements to assist the government in every possible way.

The later technical journals to hand by this week's mail are, of course, well stocked with news regarding electrical work in connection with the war.

Mr. Frank J. Sprague, of the Sprague Electric Company, is organising an emergency corps of electricians and electrical engineers to work in conjunction with the State Naval Reserve.

The Westinghouse Electric Manufacturing Company is shipping large quantities of generators, motors, dynamos and wires to the Brooklyn Navy Yard, for use in the installation of electric power and lighting plants on board the merchantmen, old monitors and coasting steamers being equipped by the government.

President McKinley has issued an executive order establishing the ratings of chief electrician, electrician first class and electrician second class, to be taken from civil life for service in the Navy. They will be required to pass a physical and professional examination at the New York Navy Yard.

Prof. Elisha Gray has been describing in the *Times-Herald*, of Chicago, a very ingenious arrangement by which the telautograph could be adapted in coast and harbour defences for locating the exact position of an enemy's vessel. By means of suitable electrical connections the device could serve as a range finder.

The government is, of course, giving special attention to telegraphic communication along the coast, and to and in the West Indies. The *Western Electrician* says that it has arranged for the establishment in one day's time of its own telegraphic system for secret service along the entire Atlantic coast. The whole coast will be divided into districts. The government intends to build houses on the beach, where naval reserve officers will be stationed with telescopes to keep watch and report to headquarters in the city all ships sighted at sea. The system will have connection with the Western Union telegraph wires and the long-distance telephone. Three operators will be stationed in the main office in Savannah, which will be in full charge of the office and the signal corps. The Savannah office will be in direct communication with the Navy Department at Washington.

In New York, Boston, and other harbours, the work of connecting the coast defences for electrical communication is proceeding with energy. As a result of representations made by Capt. James Allen, signal officer stationed at Governor's Island, to General A. W. Greely, chief signal officer, of the absolute necessity of the expenditure of more than $25,000 in the telephonic and telegraphic connections between the fortifications in New York harbour, New York will get $25,000 more to complete this work according to the original plans. Boston will get about $10,000, Philadelphia about $5,000, and Washington, Baltimore, Newport, and Portland, Me., will also get increased appropriations. The total increase for the Department of the East is $96,000. This increased appropriation will make it possible to do an especially important work. All coast fortifications are provided with range finders for the purpose of determining the distance from the fortification of an enemy's vessel. These, if they are to be used effectively, must be supplemented by telegraphic apparatus, to enable the man in the tower to telegraph to the gun pits the range of the approaching vessel. The majority of the range finders in the fortifications are now so equipped. Every one will be equipped within 30 days.

One serious problem is the possible interruption of cable service in the West Indies. An arrangement was recently made by which the United States and France will co-operate through their ministers at Denmark in the establishment of a public cable station on the Danish island of St. Thomas. The cable is owned by a French company, but its use has become of vital importance to the United States Government, owing to the possible base of naval operations in the Leeward Islands Secretary Long was particularly desirous of having this cable arrangement effected. As a result of conferences a dispatch was sent to the United States minister at Copenhagen asking him to secure the consent of the Danish Government, and at the same time the French authorities arranged to have their minister at Copenhagen exert similar influences. With the Leeward Islands, of which St. Thomas is a centre, as the probable centre of any naval operations which may result from the present crisis, it is recognised as of vital importance to secure cable facilities not controlled by Spain. At present the cable line touching at Puerto Rico, and subject to Spanish control, is the only means of communicating with these islands. The French cable lands at St. Thomas, but the station is merely for testing purposes, and messages are not received or delivered. It is now proposed to have this station turned into a regular bureau, in which case the government could be brought into close cable communication with any naval rendezvous there.

It is stated that the Western Union and the Postal Telegraph Companies have begun to organise corps of skilled electricians, whose services are to be offered to the government. The Postal Telegraph Company has already organised three companies of 50 men each in New York and an equal number in Boston for this service. The particular work expected of the men is the laying of submarine cables and connecting them with submarine mines and torpedoes. Every man in each company has been provided with a kit of tools, which, under orders, he carries with him day and night. The men have been informed of the service expected of them, and they have been informed that they will draw their salaries from the company as well as their pay from the government.

Lynde Bradley, of Milwaukee, has devised plans for the use of the X ray on board of war vessels and on the field. Mr. Bradley says that while it would be a simple matter to bring the X ray into use on a warship, considerable difficulty would be attached to the introduction of the apparatus on the field. A small outfit would have to be mounted on wheels for field use. The apparatus would, however, be much lighter and more portable than may be imagined, and his field apparatus could be finished in a week. The great help that the X ray would be to surgeons lies in the quick method of locating a bullet or splinter in a man's body, a fracture of a bone or other serious injury.

It is said that the government has practically closed a contract with the General Electric Company for eight 400,000 (projected) candle-power searchlights with dynamos, to be set up in the fortifications in New York harbour. This order will be supplemented in a short time by one for several more to be placed elsewhere.

The largest searchlight that had a place on the top of the manufactures building at the World's Fair has been brought from Sandy Hook to Fort Monroe, Va. It will illuminate Hampton Roads from shore line to shore line.

HIGH RESISTANCE INSULATION.*

By REGINALD A. FESSENDEN.

In laboratory apparatus in many cases, for instance, with electrometers and resistance boxes, we need as high ohmic resistance as it is possible to get. Here, however, we are met by the fact that the two substances most commonly used, *i.e.*, hard rubber and glass, are among the poorest insulators known for this class of work.

Rubber is very objectionable from the fact that whilst it presents a nice bright appearance when new, it contains sulphur and is very easily oxidised, especially when exposed to light. A film of sulphuric acid is thus formed on the surface, and if the tongue be applied to a piece of rubber which has been in use for some time the taste of the acid is very strong. I have seen the top of a Wheatstone bridge, supposed to be capable of measuring accurately to one part in 5,000, in which the total length exposed to leakage, divided by the average distance between which leakage could take place and the average voltage was only ·008, with the top so acid that the tongue could hardly be allowed to touch it.

As a rule it is very hard to remedy this; rubbing the surface does no good as the acid extends in to some distance. Rubbing with cigar ashes is advocated by some, but I should fancy it would be almost impossible to remove the last traces of alkali. The method used by the writer is to steep the rubber in warm 10 per cent. caustic soda, then in warm distilled water, frequently renewed, then drying in the dark quickly and rubbing with pure paraffin, treated as described under paraffin, then polished while warm. This does good for a time, until the paraffin takes up dust.

For rods, a good way is to treat as above and coat half an inch thick with paraffin; then run over the rod with a wooden die and cut a thread in the paraffin. Run over the thread about once a month, and good results will be obtained.

With bridges, however, it is impossible to remove the top, and the only thing which can be done is to keep them covered up from light.

Rubber has also one other disadvantage, in that it does not show dirt, and where rubber comes in contact with copper it is apt to rot.

Glass is very bad because the alkali in it has a great affinity for moisture. The alkali is slightly soluble, and hence it is the custom with analytical chemists to boil all beakers used in exact work for several days before using, so as to get the soluble alkali and silica out of them. When possible this should be done with the glass of electrical apparatus. Another very serious trouble is that the angle of contact between water and glass is zero, so that when a drop of water is placed in the middle of a pane of clean glass it immediately spreads all over it in a thin film. This method is used by chemists to determine when a glass is clean. Nothing much can be done with glass but to keep it dry. Sulphuric acid is generally used, but it sometimes, if allowed to get dust in it, gives off vapours which condense on the sides of the apparatus. This, however, does not often happen.

Evidently we need some substance of high ohmic resistance, and one which water will not wet. Boys, who has earned the thanks of electricians for his happy discovery of an almost perfectly elastic fibre, has given us also, as he himself has pointed out, such an insulator in quartz. Dip a thread of glass in water and lay it between the knob of a charged electrometer and the ground, and the leaves close almost at once, the whole fibre being covered with a film of water. Treat a quartz fibre similarly and the water slides off it, or remains in little drops, each separate from its fellow, and the insulator is apparently as good as the air itself.

Quartz should, therefore, be used as much as possible in electrical instrument work. It can be melted in a powerful gas flame furnace, and though it can never be melted down free from small bubbles, these make no difference except in appearance. It is, however, possible to obtain glass which contains no alkali, and resembles quartz in that is not wet by water. Such a substance is Faraday's borate of lead glass, as he himself points out. This is, however, too brittle for most work, but by an admixture with silica a glass could no doubt be made which would be perfectly satisfactory. If some glass manufacturers would take up this question and furnish us such a material for electrical instruments, the greater part of the present annoyance met with in making delicate experiments would vanish. It would not leak, would show dirt, could be readily cleaned, and would be free from one of the great disadvantages of rubber, *i.e.*, a large coefficient of expansion, which is always making trouble by bending terminals of resistance coils, thus changing their value and sometimes opening the circuit.

It is also probable that a fine grade of porcelain would be a great benefit to the electrical profession, if coated with a good non-alkaline glaze.

For insulating the coils of resistances it is doubtful if we

* Extract from a paper read before the American Institute of Electrical Engineers. From an incomplete advance proof.

have any good solid material. For paraffin cannot be used, as its expansion and contraction are so great that large pressures are put upon the wire and the resultant strains change the resistance. It might be easy enough to prevent the strain on the first solidification in a way similar to that devised by Rowland for cementing flat mirrors without buckling them, *i.e.*, by mixing a little glycerine with the beeswax; the glycerine not dissolving in the beeswax makes it act like a viscous fluid, *i.e.*, deform under the action of infinitesimal forces in time. The glycerine, however, finally works its way out like zinc in a resistance alloy (as first pointed out by Mr. Weston), and if a similar method were used with the coils, it would still be subjected to strains on change of temperature. Another objection which has been made in England is that paraffin absorbs moisture. It is possible that this is due to the dissimilar methods of producing American and English paraffin, as I have never had to complain of this, except, of course, when cold paraffin was placed in saturated moist air. The insulation resistance of paraffin seems, however, to be markedly increased by the treatment mentioned below. The great objection to paraffin is its tendency to collect dust. Shellac has been recommended, and since the coils are in the dark, the material will oxidise but slowly, and if care be taken to use pure alcohol for a solvent, and not denaturised spirit (which sometimes contains conducting impurities), has a very high resistance when dry. Some forms of Japan lac seem to remain flexible permanently, as, for instance, the sample *a* (composition unknown), which is 10 years old.

Oil is sometimes used for resistance coils, and this is without doubt the best method, since the great point in the use of resistance coils is to know their temperature. The writer's experience with manganin and constantin, as practical laboratory standards, has been unfortunate, and he has hence decided to use only standards of pure lead run into glass tubes, and kept in water. The reason is that, other things being equal, the most sensitive Wheatstone bridge is that which takes the greatest current without appreciable heating, and in the ordinary form of resistance coil, a very small current will heat the interior up to such a temperature, as to alter the value. Moreover, if the coil is of a material not affected by such changes of temperature, it (with our present alloys) will have a larger temperature coefficient, and as the temperature of the interior of the coil is not known, this introduces another uncertainty. With the oil mounting, however, this is all done away with, and pure oil has a very high resistance for low voltages.

For condensers and induction coils it is not only necessary to have materials of great ohmic resistance and of great dielectric strength; they must also be perfectly pure, and free from admixture. For the first two properties there is nothing so good as paraffin, when properly used, all compositions such as beeswax (cerotic acid), &c., being quite inferior in both respects. Paraffin, and what is practically the same thing, pure ozokerite, will stand, according to the tests of Mr. Chesney, which I had the pleasure of witnessing, at the rate of 500,000 volts per inch. This I have confirmed up to 600,000 volts alternating. Most substances, such, for instance, as glass, are at once cut out from consideration, from the fact that they have too much electrical absorption, and heat when subjected to a fluctuating voltage.

We must have an electrically homogenous dielectric, *i.e.*, one of the same specific inductive capacity all through. This

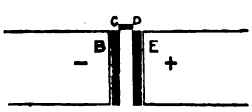


Fig. 5.

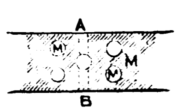


Fig. 6.

is for two reasons. First, because if we have a dielectric, A, between two charged conductors, the introduction of a dielectric of greater specific inductive capacity, even if of infinite dielectric strength and ohmic resistance, will cause A to break down. To take a numerical case—suppose we have two plates, 1 cm. apart, and attached to the terminals of a 10,000 volt A.C. dynamo (fig. 5). Suppose the dielectric, air, to support 50 per cent. more than this pressure. Introduce two plates of glass of $K = 8$, each $\frac{1}{4}$ cm. in thickness. Since the voltage divides itself up inversely to the capacitance, we will now have 8,889 volts between C and D. This being at the rate of 17,778 volts per cm., and as it only supports 15,000, we will get a spark between C and D at every reversal of the voltage, which will quickly heat the glass and make it conduct. The full potential of 10,000 will then be between C and D, and a regular arc will form. Thus we see that the introduction of a good insulator will, in all cases where an intermittent or alternating voltage is used, have the paradoxical effect of weakening the insulation, unless the whole space is filled up with the material. This weakening is not generally apparent at once, as the spark takes some time to eat its way back, and this explains why many induction coils only last for a few years of operation.

Another cause is that treated of by Poisson, Clausius and Maxwell.* This is, that layers of dielectrics of different

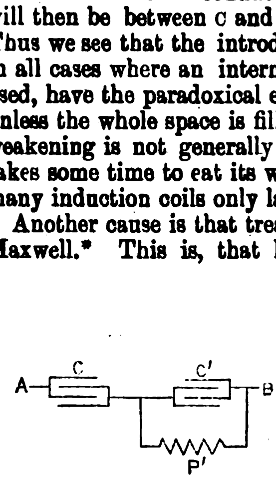


Fig. 7.

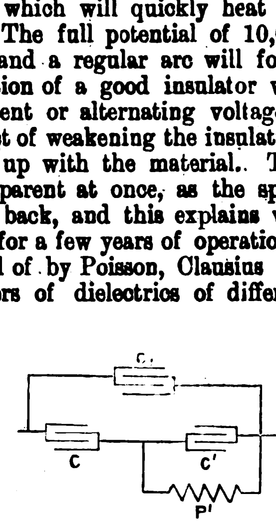


Fig. 8.

capacities and resistances show electrical absorption, and this theory has been proven experimentally by Muraoka, who showed that by taking two fluids, neither of which showed absorption, a layer of one on top of the other did do so. Maxwell treated the general case. It has, however, been treated in a more specialised way in *La Lumiere Elec.*, in 1891. In this paper are brought out the following points:—

1. A dielectric, as in fig. 6, containing conducting particles of water, for instance, may be considered as an arrangement of condensers and resistances in series and shunt with each other. Two cases, shown in figs. 7 and 8,

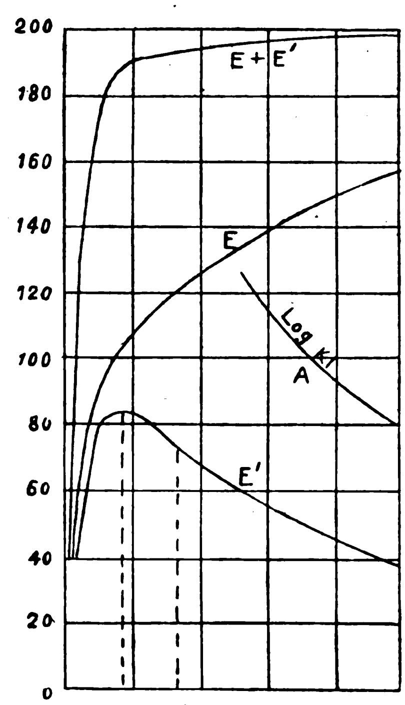


Fig. 9.

are worked out, and fig. 9 gives the curve of charge in the cases of fig. 7; E is the voltage on the condenser part, and E′ that on the condenser and resistance.

2. A condenser can show large residual charge, though its true ohmic resistance is infinite.

3. With dielectrics showing absorption, there will be found some discharge time at which the amount of discharge will be constant at all temperatures.

* "Elec. and Mag.," Vol. I, Chapter X.

4. Why in some tests insulation seems to be lower with higher voltages.
5. Why the presence of conducting particles increases apparent capacity.
6. That to get true ohmic resistance of most dielectrics, voltage must be kept on for a long time, even for days.
7. Why Siemens's method of taking the rate of loss of charge by electrometer does not give correct results.
8. That specific inductive capacity of such dielectrics can only be determined by rapidly alternating currents. This possibly explains an effect noticed by the writer many years ago, *i.e.*, that an A.C. static wattmeter immersed in water did not give anything like the torque it should have if the true value of K for water were 80.
9. The importance of getting out the last traces of water in gutta-percha and paper when used for cables.

(*To be continued.*)

A NEW INTERRUPTER FOR INDUCTION COILS.*

By V. CREMIEU.

In consequence of the working of the interrupters used in Ruhmkorff coils, the induced electromotive forces, of opposite nature, are not equal in absolute value; they may be represented by the curve (fig. 1) in which *e r* shows the electromotive force induced on the breakage of the primary

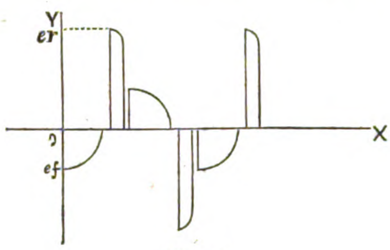


Fig. 1.

circuit and *e f* that which is induced on the closing of the circuit. This difference, which is considerable, is productive of much inconvenience in the use of induction coils.

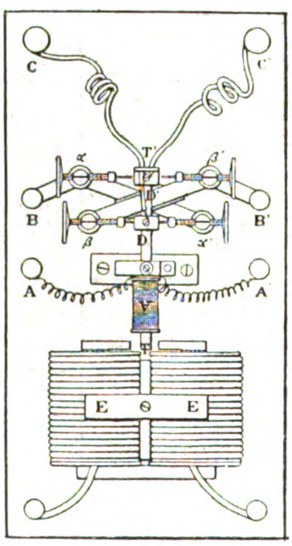


Fig. 2.

By sending into the electro-magnet an alternating current, we can, for low voltages, overcome this inconvenience; but this method cannot be used when we wish to obtain sparks several centimetres long.

I have solved the question by means of the little apparatus I am about to describe.

An electro-magnet E E′ is excited by an alternating current (fig. 2). Between its two poles oscillates the end of a rod T T′, movable at O, on an axis perpendicular to the plane of the figure. The part O T is of soft iron and the part O T′ of ebonite or some other insulating material. On the part O T is wound a little bobbin, V, traversed by a continuous current. From it we get at T a determinate magnetic pole. When the alternating current traverses E E′, an oscillatory movement is imparted to the rod T, the period of which is equal to that of the alternating current. On the part, O T′, of the oscillating rod are fixed two platinum plates, D D′, connected by two flexible wires with the terminals, C C′.

During the movement the two plates, D D′, come successively in contact with the terminals, α β, α' β'; these are connected two by two with the arrival terminals, B B′, of the inductive current; the arrangement of the apparatus shows therefore that if, for instance, the + pole of the current is at B, and the − pole at B′, the current which circulates between C and C′, in consequence of the successive closings of the current due to the movement of the rod, will go alternately from C to C′, and from C′ to C; the nature of the current between these two terminals will be reversed between two successive breaks. We see, therefore, that the induced electromotive forces of opposite nature (fig. 3) will,

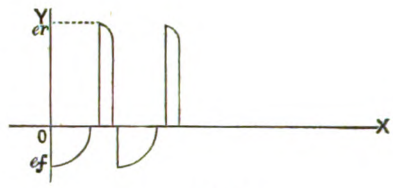


Fig. 3.

at each movement, be the sum of two quantities that are always the same, and of the same sign. They will therefore be equal in absolute value.

The apparatus works very well. For an intense inductive current, the contacts, α α' and β β', and the part O T′ of the rod should be immersed in some suitable liquid.

The only drawback which can, however, easily be provided against, is a somewhat considerable loss of energy; in order to obtain sparks of the same length, it is necessary to send into this interrupter a current of double the electromotive force required with a Foucault interrupter. The apparatus is, moreover, reversible, *i.e.*, if we connect the terminals C C′ with the two poles of the alternating current, a derivation

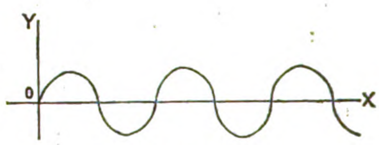


Fig. 4.

of which excites the magnet, E E′, we get between the terminals, B B′, a reversed alternating current. If the current arriving at C C′ is represented by the curve shown in fig. 4, that received between B B′ will be represented by the curve shown in fig. 5.

But we must avoid producing the successive breaks at the

Fig. 5.

moment when the periodic electromotive force has its maximum value, or even a large fraction of this value.

A very simple arrangement enables us to produce the breaks at the moment when this electromotive force is *nil*: the screws of the contact terminals, α α', β β', are hollowed out in the direction of their axis, with a cylindrical cavity (fig. 6). At the bottom of this cavity is a very flexible spiral spring and a cylindrical piece of platinum, T P,

* Note presented to the Académie des Sciences, February 17th, 1898, and reproduced from *L'Electricien.*

in the form of a plunger, the rod of which, T, would slip into a brass screw cap, C, screwing on to the end of the screw.

The rod T T′ being at rest (fig 2), the four screws are regulated so that they touch, without pressing, the contacts

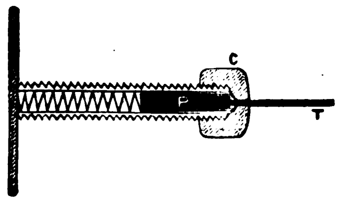


Fig. 6.

D D′, the end T being equidistant from the two poles of the magnet E E′.

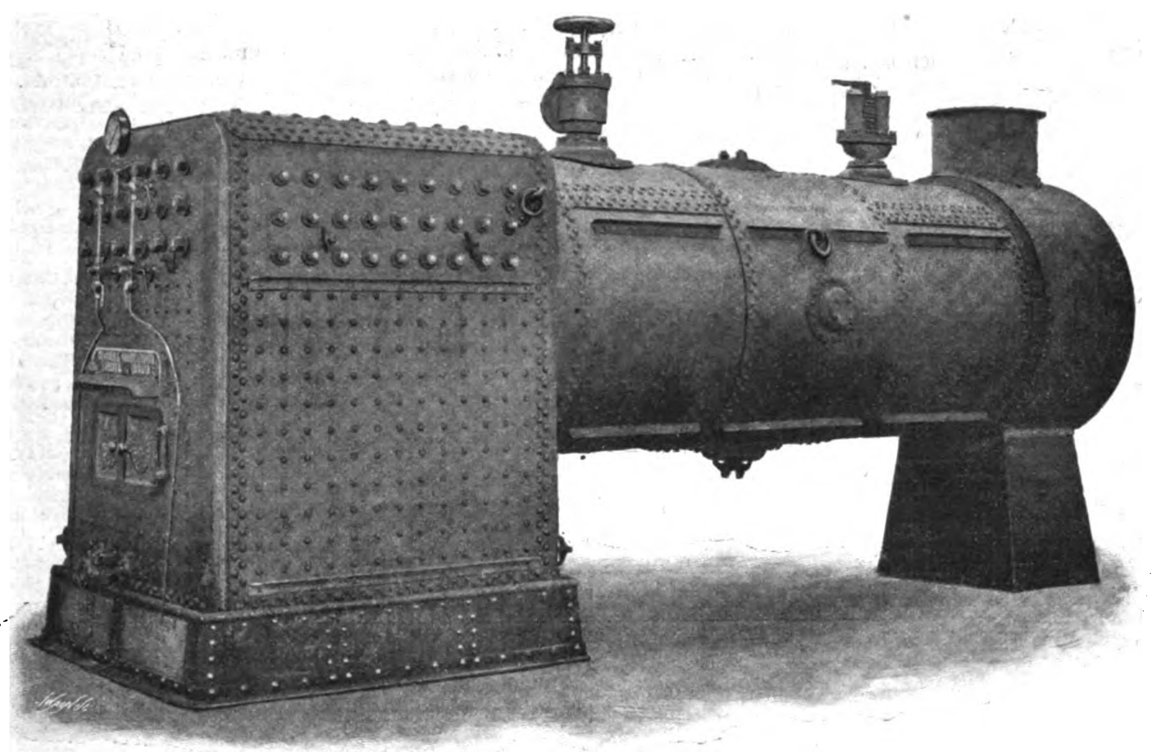
As soon as the rod T T′ oscillates, the contacts D D′ are drawn right and left, alternately repelling the plungers α β on leaving α' β', and then repelling α' β' on leaving α β.

If we observe, moreover, that the rod T T′ passes through its position of non-acceleration just at the moment when the electromotive force of the alternating current which excites E E′ is also *nil*, and that the breaks are made at this very moment, we see that there will be no break spark at α α, β' β'.

In practice, very feeble sparks are produced. The loss of energy does not exceed a quarter of the original energy.

BOILERS FOR CAPE TOWN ELECTRICITY WORKS.

Messrs. Clayton & Shuttleworth, of Lincoln, have supplied two large locomotive type boilers for the electricity works at Cape Town. These are of the type shown in the photograph and known as the "Belpaire." The boiler is constructed of mild steel throughout, and the fire-box plates are of a special quality in order to withstand high temperatures. The Belpaire type of boiler is claimed to offer great advantages in respect of the staying of the fire-box crown, as through stays can be used, which for large fire-boxes and high working pressures are thought to be better than girder stays, because they leave the top of the fire-box comparatively clear for cleaning purposes. There is also said to be a saving in weight. The scantlings on plates and stays are to suit the Board of Trade requirements for a working pressure of 150 lbs. per square inch. The extreme length of the boiler is 22 feet 6 inches, its width 6 feet, and the height, exclusive of ashpan and fittings, 7 feet 9 inches. The longitudinal seams are fitted with double butt strips, and all rivet holes are drilled in position. The main diameter of the barrel is 5 feet 6 inches. The barrel plates are $\frac{9}{16}$ inch thick. Front plate, throat plate, and fire-box casing $\frac{9}{16}$ inch. Tube plates $\frac{3}{4}$ inch, and the fire-box plates $\frac{9}{16}$ inch. The inside dimensions of fire-box are: Length, 6 feet $0\frac{9}{16}$ inch; width at top, 5 feet; width at bottom, 5 feet $3\frac{3}{4}$ inches; total depth, 5 feet $2\frac{1}{2}$ inches; depth to fire-bars, 4 feet $6\frac{1}{4}$ inches. There are 98 steel tubes in the boiler, each of 3 inches external diameter, 10 S.W.G. thick, and 12 feet $1\frac{1}{2}$ inch long between the tube plates. This includes six stay tubes, with nuts on each side of the tube plates. The total heating surface is 1,080 square feet, and the grate area 32·2 square feet. The guaranteed evaporative performance is 5,360 lbs. of water per hour. The manufacturers subjected the boiler to a hydraulic test pressure of 280 lbs. per square inch, and a steam pressure of 150 lbs. per square inch without any sign of leakage or any weakness.



AMERICAN TRACTION PLANT.

The *Street Railway Review* is grieved because an esteemed English contemporary expressed the opinion that there was a good field for British made electric traction plant in America. To send electric plant to America would savour of sending coals to Newcastle, says the *Street Railway Review* in its wrath, and it proceeds to give advice to Englishmen as to learning from American experience. We are not ourselves disposed to question the fact that American experience is very great in traction supplies manufacture. At the same time, we doubt altogether the conclusions drawn from the sale of American plant in England. In the first place, while Americans are busily engaged in cutting each others throats, or rather prices, we observe that they all, with one accord, keep an eye on the topmost brick of the high tariff wall they have built around the domestic cockpit. Americans can beat the world: they declare this to be their conviction. At the same time, all the world can see they have not got the courage of their convictions, and whether they could do so or not, they dare not face the world except from behind the high wall. Wisely or unwisely, business on this side is conducted with some idea of profit, and either because of this or because we are too slow in adopting cheapening devices and machinery, we cannot afford to sell the equipment of a car, including two 25 H.P. motors and all accessories, for £140, which is, we believe, the price at which American plant is sold to England. We are not informed as to whether American manufacturers can make a profit on these rates, nor are we told whether these low prices are available for American purchasers. Wherever we have investigated the relative prices of American goods at home and in England we have invariably found that the prices for identical goods were very much less in England, and the conviction has forced itself on us that England has the chance of buying a good deal of stuff at less than it can be bought behind the tariff wall. All Queen Victoria Street speaks to this conclusion. Protective tariffs always produce these results. Another instance is that English sugar users pay less for sugar than its makers in France or Germany. It may be that the overflow of American manufactures is alone sold here at such low figures. Whatever the cause, it is certain that American goods are not able to compete in the open market, whereby we mean not the neutral market alone, but the home market also. Americans themselves do not yet believe in their ability to compete on fair terms, or they would knock a brick or two off their 50 per cent. wall of tariffs—or is it 75 per cent.? a few per cent. makes no difference, however—and come out into the open. While we English are certainly likely to purchase a good deal of bounty-fed sugar and tariff-cheapened machinery for some time, we cannot agree with the *Street Railway Review*, that American factories can give us as good and enduring apparatus as we are likely to evolve at home. It is not as our contemporary supposes, a question of conditions, nor is it that English engineers decry American experience.

With an equal amount of experience, we venture to say that English traction plant will surpass that of American make. At present we have not the experience, and Americans take very good care that we shall not gain that experience by manufacturing for them. Our contemporary would retort that they know better than buy from such inexperienced people. We anticipate the retort, and would reply that they dare not give us the chance of selling, nor dare they offer their own public the chance of buying.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1898.

Compiled expressly for this journal by W. P. Thompson & Co., *Electrical Patent Agents,* 322, *High Holborn, London, W.C., to whom all inquiries should be addressed.*]

8,489. "Improvements relating to the electro-deposition of metal." H. W. Wright. Dated April 12th.

8,495. "Improvements in electric switches and fuses." J. McFarlane and Holland House Electrical Manufacturing Company, Limited. Dated April 12th.

8,528. "Process and apparatus for concentrating magnetic iron ores and bricking the same for market." B. J. B. Mills. (T. A. Edison, United States) Dated April 12th. (*Complete.*)

8,539. "Improvements in and relating to electric heaters." E. F. Porter. Dated April 12th. (*Complete.*)

8,550. "Improvements in automatic magnetic circuit breakers." W. M. Scott. Dated April 12th. (*Complete.*)

8,584. "An automatic switch for electric cooking utensils." F. J. Down and J. Eck. Dated April 13th.

8,602. "Barriers for the outside entrance of tramway, electric tramway and railway carriages." C. Lindner. Dated April 13th.

8,603. "Waterproof contact apparatus for electric railways with underground conductor." G. Ihle. Dated April 13th. (*Complete.*)

8,638. "Improvements in electric furnaces for the manufacture of carbide of calcium or other electro-chemical or electro-metallurgical products of the like kind." P. Determes. Dated April 13th.

8,645. "Improvements in telephone directories." J. D. Browning. Dated April 13th. (*Complete.*)

8,710. "Improvements in and relating to electrical incandescence lamps." J. R. Quain. Dated April 14th.

8,713. "Improvements in and connected with generators for electrical igniters in gas or like engines." B. McInnerney. Dated April 14th. (*Complete.*)

8,718. "Improvements in telephonic apparatus." M. Freudenberg. Dated April 14th.

8,735. "Improvements in telegraphic transmission over long submarine cables by Wheatstone's automatic apparatus." S. Roos and P. Biraghi. Dated April 14th.

8,823. "Improvements in or connected with drum apparatus for electric generators and motors." V. A. Fynn. Dated April 15th.

8,829. "An improved apparatus for counting telephonic conversations." F. Graf. Dated April 15th.

8,832. "Improvements in electricity meters." C. E. O'Keenan. Dated April 15th.

8,848. "Improvements in the method of and means for the electrical propulsion of railway, tramway and other similar vehicles." W. G. Heys. (J. J. Heilmann, France.) Dated April 16th. (*Complete.*)

8,856. "An improved method of intercepting dust arising from the commutator of dynamos." J. McLaren. Dated April 16th.

8,864. "Improvements in electric devices for theatrical purposes." M. Sanson. Dated April 16th. (*Complete.*)

8,901. "Improvements in or relating to electrostatic machines." L. S. A. Cohendet & Co., and P. Arohat. Dated April 16th. (Date applied for under Patents, &c., Act, 1883, Sec. 103, March 5th being date of application in France).

8,913. "A method of and means for transmitting electric currents through musical instruments to players or performers." H. B. Knoblauch. Dated April 16th.

8,920. "Improvements in trolley poles and standards for electric traction." Siemens Brothers & Co., Ltd., and F. Ayton. Dated April 16th.

8,927. "Improvements in electrical apparatus for gas lighting and other purposes." J. F. Bennett and W. Appleyard. Dated April 16th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free,* 9d. (*in stamps*).]

1897.

5,136. "Improved electric tan bark bath and apparatus therefor." J. J. Stanger. Dated October 9th, 1897. This relates to an improved tan bath for use against rheumatism, gout, &c. There is a bath filled with tannin solution, to which the electric current is supplied, so that the main conductor is in connection with the electrodes. These electrodes are carbon and do not contaminate the tannin solution. They are inserted in slotted wood frames placed in bath, and are easily removable. Upon a plate there are placed a rheostat, a reversing switch, a current meter, and a bell in such a manner that these apparatuses which control the current at will are easily accessible from the bath. 3 claims.

4,183. "Improvements in electric incandescent lamps." C. S. Dolley, R. Hawkins, T. M. Lightfoot, H. P. Goodwin. Dated October 16th, 1897. This consists of an electric lamp, which has an incandescent filament compressed between two non-conducting plates of mica one or both of them being transparent. The air has been exhausted from between these plates, which are set in a hermetically sealed boundary frame. The carbon conductor is furnished with platinum wire connections. 3 claims.

9,173. "An electro-therapeutical lamp." R. I. Mayer. Dated October 16th, 1897. This consists of a handle, on end of which there is filled an incandescence lamp within a suitably arranged reflector, through the core of the handle pass the conductors. 1 claim.

19,035. "Improvements in electrolytic apparatus." H. Sefton-Jones. (A communication from E. Balbach.) Dated October 16th, 1897. This consists of a cathode case composed of a trough having its bottom divided in two portions, one of which is horizontal. The other portion sloping down and connecting the horizontal portion throughout its length. It is provided with a cathode plate and an anode suspended therein, arranged to cover the horizontal portion of the bottom only. The anode case is composed of an exterior frame which has a grated bottom, and an inner frame fitting into the exterior case, with a filter cloth bottom. Instead of one anode case there may be a series, arranged transversely side by side. 5 claims.

20,041 "Improvements in metal for telegraph and other poles." G. W. Glazier. Dated October 16th, 1897. This consists of a pole to the end of which is secured segmental metal base sections by means of bolts; the lower ends of these sections are made outwardly flaring, and are provided with a series of perforations through which the earth is rammed after these sections have been placed in a cavity in the ground. On the outside of these sections are strengthening ribs which, besides serving to increase the strength, also in a measure conceal and protect the heads and nuts of the fastening bolts. 2 claims.

THE

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ELECTRICAL DEVELOPMENT.

WE notice in the columns of an American contemporary * an admirable little homily addressed by Mr. W. D. Weaver to those terribly optimistic people who, unsatisfied with all that modern electrical science has done for them, are ever anticipating new discoveries of transcendental magnitude, and accept with all the credulity of profound ignorance those scientific fairy tales with which the non-technical press is ever ready to supply them. This attitude arises in part, as Mr. Weaver points out, from the air of mystery with which in the popular mind all things electrical are specially enshrouded. The achieved results of electrical science have struck the popular imagination, and ignorant of the bounds set by the nature of electrical energy, it runs riot in the region of the impossible. To-day the public hears with respectful admiration that one of the Grand Lamas of the electrical cult is ready, nay, it is whispered, anxious, to annihilate whole battalions *en bloc* with the aid of an electrified squirt; to-morrow, that the electric fluid has at last been tracked down and bottled, and can be supplied in various colours, and at the most reasonable prices, for the cure of diseases of diverse kinds. The public finds no difficulty about the reception of these stupendous yarns, and like the young gentleman in fiction, asks for more! Of the unknown and the mysterious, it argues, all things may reasonably be expected.

As a matter of fact, however, the theory of electricity is as firmly established now as are the theories of light and heat, and far more so than that of gravitation, the most familiar of all the forces of nature, and at the same time the most incomprehensible. The time is yet to come when anything even approaching a satisfactory explanation can be given of the fact that a stone released from the hand falls to the ground. We are not, however, always anticipating revolutionary discoveries in thermo-dynamics, optics, or mechanics; we have a distinct and practical idea of the limits of probable development in those sciences, of the boundary between the possible and the impossible.

Moreover, there are limits which we can discern even in the absence of a perfect knowledge of the ultimate nature of electricity. We make our dynamos and transformers now with an efficiency of about 95 per cent., leaving small room for improvement when theory goes still deeper into the nature of the medium we work with. The uncertainty we may feel on such subjects as the dissociation of electrolytes and the migration of ions is not incompatible with a practical working knowledge of electro-chemical equivalents, the corresponding thermo-chemical equations, and armed with this knowledge we are able to turn a deaf ear to the wiles of the primary battery promoter in the certainty, much to be regretted, that apart from the solution of the great problem of the direct conversion of the energy of carbon into electrical

* *American Electrician*, reprinted from the *Annual Journal* of the Brotherhood of Electrical Workers.

energy, no revolutionary change in the cost of production of the latter can be expected. The solution of this problem means an extension of the life of our coalfields of many centuries, revolutionary changes in scores of established industries, the disappearance of such evil-smelling anachronisms and architectural monstrosities as gas works, and incidentally, the enriching of its discoverer beyond the dreams of avarice; but it may well be that our coalfields will be exhausted, and, perhaps, our spendthrift race with them, before the realisation of that great idea.

Mr. Weaver discusses two other attractive problems to which it has been thought that electricity might furnish a solution—the production of light without heat, and the transmission of energy across space without the use of a conducting wire. Much was hoped from Tesla's work on the former subject, but little practical result has been achieved. There is no prospect of the direct production of currents having a frequency of even 4×10^{14} periods per second, the radiation from which would be just visible to the eye as dull red light. The smallest wave length reached even in the oscillatory discharge of microscopic condensers is measured in centimetres instead of in their hundred-thousandth part, and it is only by molecular impact, as in a vacuum tube, that vibrations of a sufficiently rapid order, unaccompanied by heat, have been obtained.

The problem of the transmission of energy across space has recently been brought vividly before the mind in connection with the Marconi system of telegraphy. There is something singularly fascinating in the idea of the Morse key ticking away its message in the room at Bournemouth,* and the printing instrument over at the Needles recording the words just as certainly as though a cable linked the instruments together. But it is a far cry from this achievement to the transmission of energy for power purposes across space. Even the small amount of energy required for the printing instrument is not transmitted, only the infinitesimal quantity required to operate the coherer, which serves as an almost incredibly sensitive relay. The energy from the transmitter is scattered in all directions through space, and the waves can only be gathered into a parallel beam with difficulty and with considerable loss. As yet, moreover, we have no means of generating this particular form of wave energy in sufficient amount to serve any practical purpose, quite apart from the difficulty of transmitting it when obtained. It seems likely, therefore, that we shall have to put up with copper mains, and the C^2 R losses contingent thereon, for some time to come, in spite of the advantages that wave motion in the ether seems to offer as a practically wasteless mode of transmission.

The American Iron Trade Prospects.

The *Scientific American* states that from four of the Lake Superior iron mines, viz., the Marquette opened in 1856, Menominee opened in 1880, Gogebic opened in 1884, and the Mesabi opened in 1892, there have been produced over 98 million tons of ore. The last mine alone produced in five years over 8 millions of tons, one half of which ore is of over 60 per cent. iron, and contains only 0·06 per cent. of phosphorous. In this mine there is in sight or indicated some 400 million tons, or sufficient at present production for 50 years. As all the above mines must continue at present rates if the present rate of iron manufacture is to be maintained, there will need to be a vast further body of ore if America is to keep the lead for an indefinite period. There appears good reason to endorse Mr. Jeans's prediction that the centre of iron production may yet shift to other countries, as, for example, Australia. But for many years to come the continent of North America is likely to increase its output of iron. It is still considerably behind the production of the equal area of the European Continent; indeed, has only just exceeded the production of England, a small section of Europe, about half the size of a moderate American State. The advantages of the Lake Superior ores generally are their great accessibility, being often surface mined and well placed for cheap working; they are very rich in iron and low in phosphorous, and so are eminently Bessemer ores, and the ore beds are of great extent. Some samples assay over 67 per cent. iron, and out of nine grades of ore in the Vermilion ranges none went less than 60 per cent. Phosphorous is very rarely over 0·1 per cent. On the Mesabi range a steam shovel can load 500 tons per hour at 7½d. per ton on the cars, and at times it is claimed cars have been loaded for 5d. per ton. Evidently there will be no scarcity of iron in the lifetime of anyone living to-day.

Economy of Hot Feed.

Mr. MacFarlane Gray has again drawn attention to what Mr. Kirkaldy first discovered, that it pays to heat feed water with live steam drawn from the same boiler into which the feed is being put. Mr. Gray only attempts to explain it by increased mobility of water. Our contemporary, the *Electrician*, attempts a more scientific explanation, that the economy due to this live steam feed heating is due to the better thermo-dynamic efficiency of heat transmission from fire to hot water than from fire to cold water. The larger temperature drop in the case of cold water is useless. Heat ought to be transferred as near the maximum temperature as possible. If this feed-heating question can be explained thermo-dynamically, what a chance the men have missed who, like Mr. Gray, are thermo-dynamicians and yet have failed to fit the practice to theory. Are we again to see a thermo-dynamic theory fitted to a proved practical fact, for there seems now no reason to doubt the facts. It is an unfortunate shortcoming of most scientific men that they are not possessed of the ability to foresee facts from their theoretic knowledge, though they are very ready to assert themselves in picking the flesh off the skeleton and exposing the hard dry bones beneath. Practical men would be glad of a few X rays of scientific research to show the bones in the living creature without the process of stripping off the flesh. It has been held that the only duty of the furnace ought to be to supply the latent heat to the water in a boiler. To a very large extent this has been followed in north country practice where heat of low degree, otherwise going to waste, is employed to heat the feed in the economiser or flue feed heater, and this may account to some extent for the good evaporative results obtained there from plain boilers.

Institution of Electrical Engineers.—Last night at the ordinary (extra) general meeting, held at the Society of Arts, a paper was read on "The Prevention of Interruptions to Electricity Supply," by Mr. Leonard Andrews, Associate.

* Electrical Review, Vol. xlii., p. 538.

CARBON BRUSH-HOLDERS.

By ERNEST KILBURN SCOTT.

Part I.

(*Concluded from page 564.*)

The other more widely known but, perhaps, little understood method, is by the use of a solid carbon block, or, better still, by a multi-section carbon brush. Fig. 4 shows such a

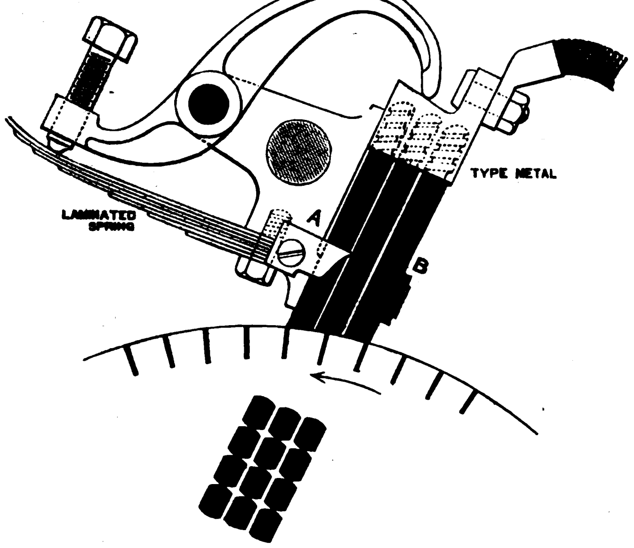


Fig. 4.

brush and holder designed by the writer, from which it will be seen that the brush is made up of the scrap ends of ordinary arc lamp carbons bunched together, as shown in the section A B. Type metal is cast round them at one end, and in order to get the metal to hold properly they are spaced about $\frac{1}{16}$th inch apart, thus giving the multi-section brush. When the carbons are worn away the type metal can be melted off and used over again. In connection with this holder it should be noted that the tangential pressure keeping the brush firmly against the holder casting, can only be fully utilised when the armature is revolving in the direction of the arrow.

The immediate effect of increasing the resistance in the circuit of the short-circuited coils may be explained as follows: When working at full load the coil under short circuit must be in a field of considerable strength, in order that the current may be properly reversed. It follows, therefore, that if the load is allowed to fall off without the lead being proportionately reduced, the field will naturally tend to cause an excessive flow of current through the short-circuited coils. This is where the above-mentioned extra resistance comes in, as a check against the rush of current and consequent arcing and waste of heat.

Another point in connection with the design of brushes and commutator is, that the interval of short circuit, or, in other words, the width of a brush, has a marked effect upon sparking. On a given dynamo, with single-wound armatures, for example, commutation can be more easily effected in a strong field if the brushes cover several segments instead of only one. One may therefore argue that a high induction density in the armature is not only a good feature because it reduces the weight of copper and iron per kilowatt output, but that it also allows of a thick brush being used, or, in other words, it shortens up the commutator. Where currents running into thousands of amperes have to be dealt with, the advantage of this is obvious, for even with double or quadruple wound armatures the cost of the commutator is a heavy item in large output machines.

When a commutator appears to work well at first, but afterwards becomes badly scored, it will generally be found that it is caused by the proportions being such that the contact surface between the metal brush and the receding segment of the commutator decreases more rapidly than the current which is flowing; the result of this being that too big an amperage is crowded into the surface of the brush, causing it to fuse and stick. It is this fusing of the metal (shown when it is very pronounced by yellowish sparks) that scores the commutator, the small bluish sparks which spit off from the outer edge of the brush being comparatively harmless. Carbon brushes being infusible prevent this trouble.

Part II.

As the designs of brush-holders are very numerous, it will be necessary to confine the purely descriptive part of this article to a few typical types. Most brush-holders intended for metal brushes have the one great fault of not allowing the brush to be automatically set up by a parallel feed. On many holders, for example, it will be noticed that as

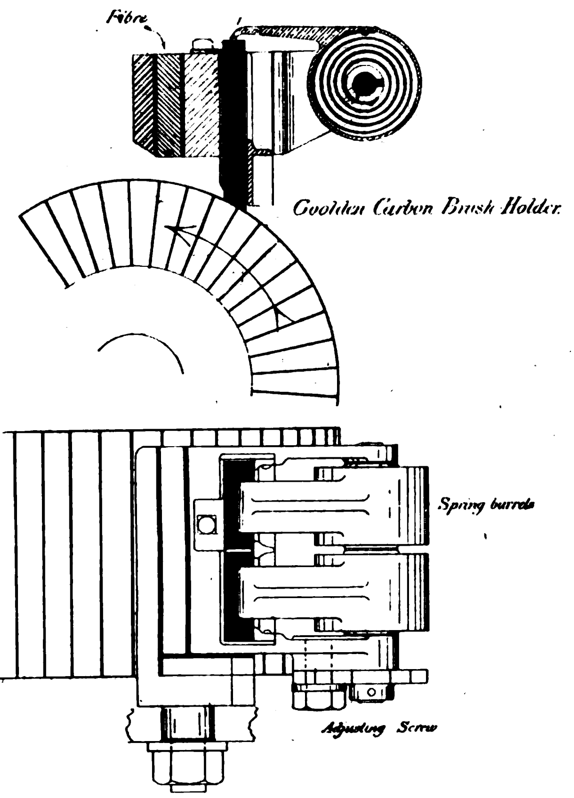


Fig. 5.

the brushes are worn down, the wearing end gradually drops away from its proper position, until (if left without adjustment for a long enough period) it becomes almost square across, and causes sparking by reducing the lead.

Designers of carbon brush-holders appear to have borne this in mind, with the result that in most types the brush remains in the same position relatively to the commutator.

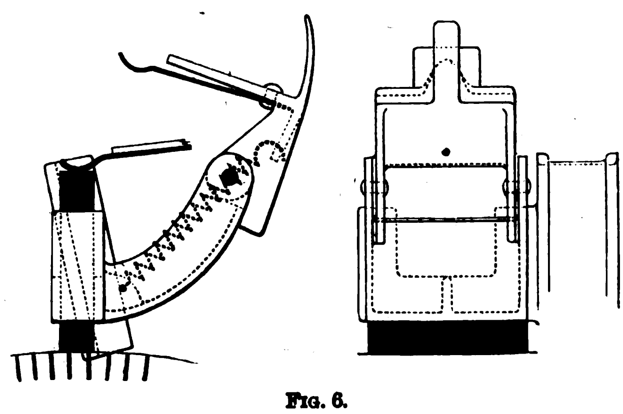


Fig. 6.

It has also, no doubt, been partly due to the fact that carbon wears perfectly with a square end; in fact, reversing motors must of necessity have the carbon in the radial position.

Fig. 5 shows a type of brush-holder which was designed for the earlier Goolden motors for use in colliery work, hauling, coal cutting, &c. It was one of the first to take advantage of the tangential action of the commutator to prevent chattering, a point of considerable importance not only on account of the noise and sparking at the commutator, but also because it is liable to set up sparking between the carbon and its holder.

The barrel with its concentrically coiled spring, shown in sectional elevation in the figure, makes a very neat arrangement, but in the event of the spring breaking or loosing its temper, it is a trifle awkward to replace. The carbon blocks were $2\frac{1}{2}$ inches long × $1\frac{1}{4}$ inches × $\frac{3}{8}$ inch thick, and were covered with a layer of electro-deposited copper.

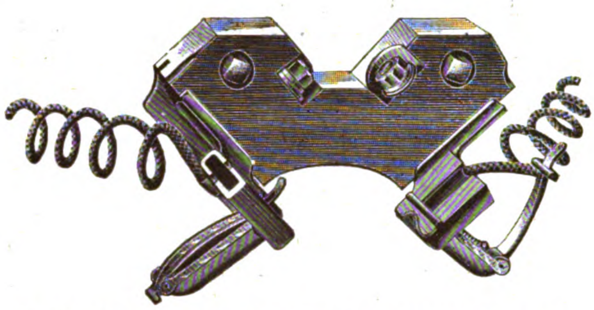


Fig. 7.—Brush-Holder of the Steel Motor Company, Johnstown, U.S.A.

Fig. 6 shows a side and end view of the brush-holder of a Thomson-Houston tramcar motor as made by the General Electric Company of America. The finger or hammer lever is shown in the raised position with the spiral spring just below the centre of the pivot. The end of the finger is also shown dotted resting on the top of the carbon

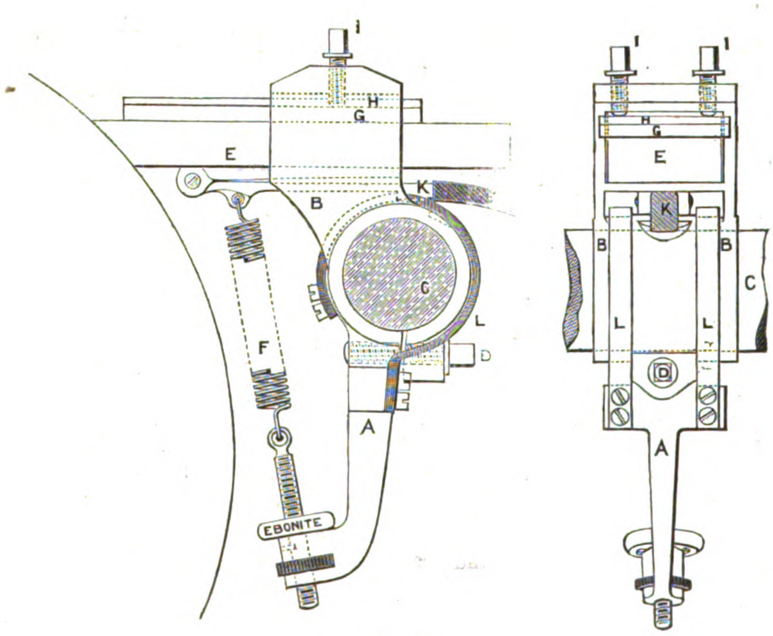


Fig. 10.

block as it would be in actual work. When new, the carbon is $3\frac{1}{2}$ inches long and has a bearing surface on the commutator of $2\frac{1}{2}$ inches by $\frac{1}{2}$ inch. The slot in the brush-holder casting is deep enough to allow the carbon wearing down to $1\frac{1}{2}$ inches long, the pressure due to the spring being about the same during the whole of the travel.

Fig. 7 is taken from a photograph of a pair of carbon brush-holders made by the Steel Motor Company, of Johnstown, U.S.A. The carbons are removed, and the right-hand holder is shown with the hammer lever caught back ready for a carbon to be put into position. The brush-holder yoke is fastened to the top half of the motor frame, and it can be removed along with the brush-holders without disturbing the adjustment, this removal being affected through a malleable iron cover on the top casting of the motor.

The Walker Manufacturing Company, of America, makes the type of holder shown in fig. 8, which allows the carbon block to adjust itself to a bearing, whilst at the same time advantage is taken of the rotation of the commutator to keep the carbon firmly pressed against the metal part of the holder. The current does not therefore have to pass through bearing surfaces or springs, and the type is on this account very suitable for large currents. The facility with which the old carbons can be removed and a new set put in, is a very noticeable feature, and it will also be noticed that chattering is entirely prevented.

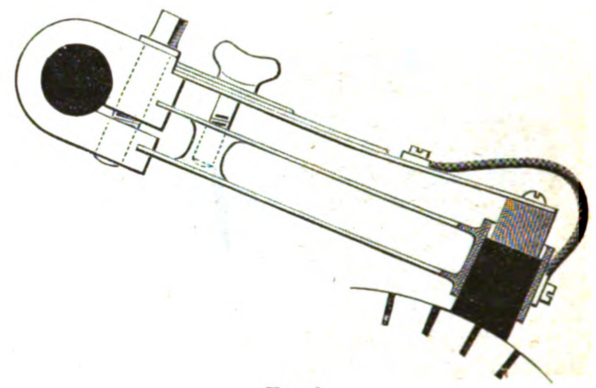


Fig. 9.

Spiral or coiled springs are always more or less a nuisance, and attempts have therefore been made from time to time to use flat laminated springs for the purpose. Fig. 9 shows a brush-holder with a spring of this type similar to those used on the motor-generators at the Electric

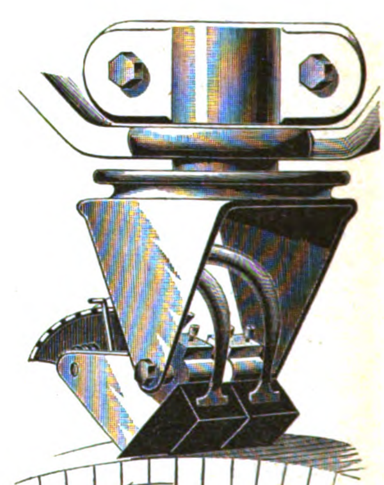


Fig. 8.

Cab Company's charging station, Lambeth. The design is somewhat crude, but judging by the appearance of the commutator it seems to answer its purpose very well.

Fig. 10 shows a well designed brush-holder made by Siemens Bros. & Co., of Charlton, and fitted by them to the large dynamos for the new Waterloo and City Railway. The carbon block is 7 inches long, 2 inches wide, and 1 inch thick, and in order to make it bed more easily it is held in place by an ordinary copper gauze brush as shown in the figure. The action of the holder is as follows:—Casting B moves round the fixed spindle, C, whilst the casting, A, may be firmly clamped to C in any required position by the screw, D. The main part of the current is conveyed from the brush casting, B, to the spindle, through the flexible copper strips, L, and the carbon block, E, can be lifted and held off the commutator by means of the spring catch, K, which is fitted with an insulated end. The brush is drawn back into position when this catch is released by means of the spring, F, which also allows the pressure of the carbon on the commutator to be regulated.

Fig. 11 shows a carbon brush-holder suitable for a small machine. As will be seen it is very simple in construction, and, of course, it could only be used for small currents.

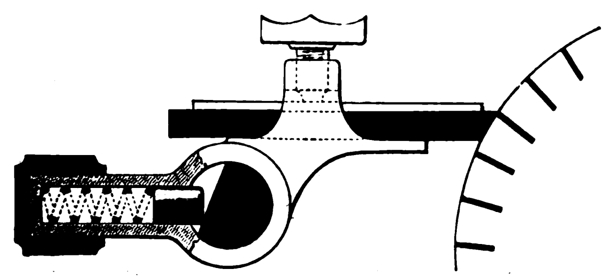


Fig. 11.

The following tabulated particulars of brush gear, &c., may be found useful to designers and others:—Assuming the amperes per square inch of contact for carbon brushes at about a quarter of that allowed for metal gauze brushes, and taking the usual standard sizes of machines and for brushes, the following particulars will hold good.

Amperes.	Metal gauze brushes.		Carbon brushes.	
	Number.	Size.	Number.	Size.
20	1	7 × 2 × ¼	1	3½ × 2 × ½
45	2	7 × 2 × ¼	2	3½ × 2 × ½
75	2	7 × 2 × ¼	3	3½ × 2 × ½
115	3	7 × 2 × ¼	3	3½ × 2 × ½
165	3	7 × 2 × ¼	4	5 × 2 × ¾
225	4	7 × 2 × ¼	4	5 × 2 × ¾
300	4	7 × 2 × ¼	5	5 × 2 × ¾
450	5	7 × 2 × ¼	5	7 × 2 × 1
600	6	7 × 2 × ¼	6	7 × 2 × 1

The sizes of brush flexibles may be taken as given in the following table, which is based on a current density of about 2,000 amperes per square inch.

Diameter of copper in inches.	Area in square inches.	Maximum safe current in amperes.
⅛	·009	20
3/16	·021	45
¼	·037	75
5/16	·058	115
⅜	·083	165
7/16	·112	225
½	·150	300
Two 7/16	·224	450
Two ½	·3	600
Three ½	·45	900
Four ½	·6	1,200
Five ½	·75	1,500

The widths of commutators vary a good deal, but they are all based more or less of the standard 7 inches × 2 inches × ¼ inch brush, as follows:—

Number of brushes side by side.	Width of commutator in inches.	Diameter of rocker spindle.
Two 1" or one 2"	2⅝	⅝"
Three 1½" or two 2"	5¼	¾"
Four 1½" or three 2"	7⅛	⅞"
Four 2"	9⅝	⅞"
Five 2"	12	1"
Six 2"	14½	1"
Seven 2"	16⅛	1¼"
Eight 2"	18½	1¼"

THE UTILISATION OF BLAST FURNACE GASES FOR ELECTRICAL POWER TRANSMISSION.

By W. H. BOOTH.

(Concluded from page 532.)

From a careful consideration of results obtained, it would appear that the amount of power that may regularly and continuously be obtained from a blast furnace is 10 horsepower per ton of coal per week. Thus a furnace burning 1,000 tons per week would yield 10,000 horse-power continuously under correct conditions of work, including the driving of the blast by gas power and sundry other economies into which it is not necessary more fully to enter. The foregoing figures will probably be sufficient to show that there is a calculable saving of enormous extent to be made. My tests of the actual plant more than confirm the figures, and it is beyond cavil that the system is a success, commercially as well as mechanically. Several other plants of utilisation are either at work or projected, including one at the Frodingham Ironworks, one at Barrow, and an entirely new plant, including a new furnace in France; but of more than special interest is one to be put up at the Wigan Iron Company's works in Lancashire, the special interest attaching to this being that a length of 1½ miles of canal has been selected on which to make a trial of electrical traction as

Table I.

	Blast furnace gas.		A gas producer.
	Wishaw.	Frodingham.	
Carbonic acid	5·75	6·0	6·6
Carbonic oxide	24·75	27·3	19·6
Hydrogen	2·33	1·5	6·4
Marsh gas	0·75	...	1·3
Nitrogen	66·42	65·2	66·1
	100·0	100·0	100·0
Heat units per cubic foot ...	97·8	96·7	98·0
Calculated cubic feet per I.H.P.	79·44	80·34	79·27
Percentage combustible ...	27·83	28·8	27·3

applied to canal barges. In this installation a gas engine of about 30 H.P. will be employed, generating electricity for three separate purposes. One of these is the lighting of the ironworks as is being done at Wishaw; the second is the purification of the blast furnace gas itself by electrification, the gas passing through a highly charged field, and depositing its load of dust which aggregates and coalesces and drops by gravity out of the gas stream. The third use of the current is, as stated, for canal barge traction by means of small motors running upon a lattice-framed rail carried on posts along the towing path. There is, perhaps, nothing in the mere transmission of electricity along a short length of canal, but the matter has nevertheless considerable interest as being the first use of electric current generated by furnace gases for power purposes outside the premises on which the waste gas is manufactured. Electrical transmission of power is common, and the problem of the wasteful blast furnace only waits the application of this solution to be at once recognised as a source of power of almost unlimited extent.

If about 10 million tons of fuel are used annually in English and Scotch blast furnaces, then about 2 million horse-power is running to waste. Unlike huge water powers, or even small ones, the utilisation of blast furnace gas does not involve a great capital expenditure on works of preparation such as dams, tunnels, pipe lines, aqueducts, &c., as required where a water power is sought to be developed. Seeing that this 2 million horse-power is located at about a score of centres all over the land, there is an average of

D

about a hundred thousand horse-power to distribute from each. Electrical transmission alone is possible in this matter. It would be sheer waste of time to consider any other system of transmission than that afforded by electricity. The only cost is that of gas engines and cheap light holders, scrubbers, and pipes. To what use can all this current be applied?

The whole of the cotton mills in the country would not, if properly driven, absorb a fourth of the supply. The most obvious use, apart from factories, is that of transportation and light. Between them none of the gas produced in the country need go to waste. Electrical traction may be looked on as the next coming industry, the application to which of the new power involves no rejection of old plant, no change in existing conditions, and no subversion of established ideas. The obvious power for most new tramways is electricity, and it is bound also to be applied to most old lines, if these are to live in competition with new ones.

The application of electricity to main line service may well wait until the tramway system of the country has been modernised and extended. No engineer who had the means at his command need hesitate to undertake the supply of ample power to the London underground railway from the demand exceeds the rate of supply, the addition of a holder will tide over the peak of the demand "curve." Further growth in demand can be met by further storage. The question of storage will not be of immediate urgency. So much power is going to waste that it will be a long time before unbelief is overcome sufficiently to absorb all the power available. In no industry, however, has the production of a large and apparently useless waste been allowed to proceed indefinitely. In the production of the ordinary illuminating gas, the bye-products, once so difficult to dispose of, have become almost the primary profits, and gas has become, in a sense, the bye-product. In the Scotch blast furnaces using raw coal the tar and ammonia recovery has added a very welcome margin to the profits of pig-iron production; and so in many other industries. Yet in none is there so huge a waste as that represented by the gases, still practically thrown away, of the blast furnace, and only capable of employment to their full capacity by the combined agency of the internal combustion engine and the dynamo, with its attendant long-distance transmission.

The recent articles of Mr. J. S. Jeans dealing with the subject of supremacy in iron manufacture have a very close and special relation to this question of waste utilisation.

TABLE II.

Gas.	Per cent. Volumes.	Weight per cubic foot.	Weight per 100 cubic feet of mixed gas.	Ratio of constituents.	Actual weights of elements per 100 cubic feet of gas.			
					C.	O.	H.	N.
Carbonic oxide = CO	24·75	0·0784	1·9404	3 : 4	0·8316	1·1088	...	...
Hydrogen = H	2·33	0·0056	0·0130	...	...	...	0·0130	...
Marsh gas = CH_4	0·75	0·0448	0·0336	3 : 1	0·0252	...	0·0084	...
Nitrogen = N	66·42	0·0784	5·2073	...	...	...	...	5·2073
Carbonic acid = CO_2	5·75	0·1234	0·7095	3 : 8	0·1935	0·5160	...	...
Cubic feet =	100·00	0·079038	7·9038	Total	1·0503	1·6248	0·0214	5·2073
					7·9038			

iron furnaces of Northamptonshire. Some of the furnaces are at rest. With a very moderate payment for the gas now sent to waste, the profitable joint production of iron and gas would keep these furnaces alight. To Wellingboro' is only 63 miles from London, and the Wellingboro' furnaces are probably the nearest to London. A transmission of 60 miles is nothing to be afraid of. Greater distances are now finished or in hand in America on water-power transmissions. Hence it is perfectly possible and practicable to transmit power to London from Wellingboro' for railroad purposes, adding at one stroke to the prosperity of the decaying iron industry, and rendering the sulphurous underground tolerable. The question of electric traction seems to turn so much on the constant expense of fuel that where this can be had for a fraction of its normal cost there would be great inducement to undertake the building of the transmission line.

It must not be overlooked that the production of blast furnace gas is continuous; furnaces do not stop, but work on for years under blast. The volume of gas produced is enormous, and from one furnace may be a million feet per hour. It is thus essential that, in order to avoid blowing gas to waste, there must either be an immense storage system or the use of the gas must be as uniform and continuous as it is possible to make it. For power purposes of manufacturing establishments there is a fairly constant load over 12 hours of the day, and there is the night load for lighting purposes, but there is rarely much of a load for any purpose beyond street lighting between 12 p.m. and 6 a.m. Assuming that a given furnace is capable of yielding a continuous 6,000 H.P., the possession of sufficient storage capacity to absorb the production of the six night hours would increase the power capacity during the 18 hours to 8,000 H.P., and similarly very much more than 8,000 H.P. would be possible at the hours of maximum demand, such as from 9 a.m. to noon, or the evening overlap of large power and light demand which occurs between 4 and 6 p.m. in winter, where a system of storage is adopted. The storage resolves itself into a question of demand. As soon as the maximum rate of By its means the production of iron in a small country of short distances is placed in a better competitive position than is the case with the furnaces of a large country more sparsely populated and less able to absorb the power production of a furnace within a reasonable radius. This consideration is of great importance to the British iron trade, and, indeed, to the country at large, which is placed in the same advantageous position that is now occupied by countries of large water powers—Switzerland, Scandinavia, or America. Given also increased powers of electrical transmission, and the injustice to Ireland which she has suffered in the denudation of her carboniferous strata may be considerably ameliorated in the not far distant future. These are, however, mere speculations; the solid fact remains that a new power source, of at present unlimited extent, is ready to our hands, and comparatively small expense is needed to utilise it for every purpose of light, power, and even of warmth.

It has been argued that the waste gas might be utilised for similar power purposes by burning them under steam boilers, as now done for the purpose of raising steam for the blowing engines. This argument overlooks the fact that the heating power of all these producer gases and their congeners is very poor. One pound of carbon produces about 7 lbs. of gases, and the minimum air supply is another 6 lbs., so that at the very least a pound of carbon results in the production of 13 lbs. of products of combustion. The carbon has only a calorific value of, say, 10,000 units, one-thirteenth of which, or 770 units, is apportioned to each pound of the products which have a specific heat of about 0·23, so that the maximum possible temperature attainable beyond the initial is only 3,350°, and this is liable, indeed certain, to be very much reduced by the excess of air always present. The flame of carbonic oxide is not a suitable flame for boiler heating purposes, being too transparent, and therefore devoid of radiating capacity. On the other hand these poor gases are very suitable for gas power purposes, and lend themselves readily to the peculiarities of the gas engine, especially in respect of that still unavoidable water-jacket. Rich gases must be diluted, and the poor gas is already dilute and only requires that a slight variation be made in the ordinary proportions of the air and gas inlets and in the piston base for purposes of greater compression. There is no difficulty in igniting these poor gases, in the cylinder of a gas engine, under compression. Gases almost too dilute to burn in the open will readily ignite when compressed.

THE EFFECTS OF ALTERNATING CURRENTS ON THE HUMAN BODY.

By Dr. W. S. HEDLEY.

THERE have lately been recorded (*Electrotechnische Zeitschrift*) a series of experiments undertaken by Prof. Weber, of Zurich, to determine the effects upon the living body of alternating currents at different voltages. Two metallic conductors at opposite potentials were held, one in each hand. With the hands damp, an effective electromotive force of 30 volts, and 50 alternations a second, the whole arm seemed paralysed; extended, it could not be flexed; flexed, it could not be extended. At the same time, the pain was so severe, that it could not be borne for more than five or six seconds. It was not without effort that the hands could be detached from the electrodes. When the voltage was raised to 50, fixation occurred; that is to say, the hands could not by any voluntary effort be released from the electrodes, and the pain was not supportable for more than two or three seconds. With the voltage raised to 80, even with the hands dry, all the above phenomena were accentuated.

Other experiments followed to observe the effect of a current passing to earth through the body; thus, standing on a damp macadamised road, but with dry shoes, a person touching with his hand a conductor at a potential of 1,000 volts experienced a marked burning sensation, and when the conductor was grasped with the whole hand a violent tremor occurred, with complete fixation.

In the same journal M. Emile Kolben gives a case of an accidental contact of several minutes' duration, where the body was placed in the path of a current passing from hand to hand at 200 volts. In our present ignorance of the exact conditions which make electric currents dangerous, experiments of this kind are of great interest and value, and it is desirable that all such cases be assiduously recorded. But it is altogether premature to conclude, because the voltage of electric lighting currents may but little exceed that used in some of these experiments, that therefore such lighting currents are free from danger, or that a person with dry shoes, standing to earth on moist ground, need never be afraid of an alternating current whose potential does not exceed 1,000 volts. In a recent number of the ELECTRICAL REVIEW, reference is made to four fatal cases of accidental contact with live wires, in three of which the potential could not have exceeded 115 volts. Data must for a long time be accumulated, and a great deal more learnt about the human body as an electrical conductor before the line can be drawn beyond which electrical currents begin to be dangerous to life.

BALANCING OF ENGINES.

THE recent paper by Mr. Whitcher, read before the Manchester Association of Engineers, deals with engine balancing on the lines, lately come into fashion, of the bob-weight, a method so obviously correct in theory as to need no demonstration, and, indeed, a method which has been often attempted approximately. As the author points out, the balancing of an engine is an endeavour to hold fast its centre of gravity. Slow moving engines having small energy of motion in any part are sufficiently balanced if they will remain at rest in any position in which they are placed. Such are the old beam engines which can be balanced by a weight in a fly-wheel. In such engines we can neglect the twisting moments about a vertical axis, due to revolution of balanced parts, and their balances in different planes. More quickly moving engines can be balanced by tail cranks and fly-wheel weights, the weight being in the same angle as the crank and the tail opposite, a method very efficient for long stroke engines up to 900 feet piston speed. But these methods do not really balance the piston and other parts which move in right lines; they introduce a vertical disturbing force in horizontal engines, or a lateral force in vertical engines, which have to be dealt with by the absorbing power of more or less heavy foundations.

The conviction of most engineers that a steam engine with two cranks must have these cranks at right angles, has prevented a good deal of excellent work being done. With a three-cylinder engine very good balancing can be effected by keeping the middle crank opposite the two outer cranks and of equal weight to the sum of the two.

Mr. Whitcher considers one of the most important effects of balance to be the effect on bearing surfaces, and he shows how alternating stresses on bearings which produce knock may be converted into rotary stresses free from knock. A revolving counterweight does this at the cost of introducing a general vertical want of balance. He describes briefly various methods, and regrets that the three-cylinder engine with cylinders at 120° on one crank is so inconvenient a machine, being perfectly balanced by a single weight opposite the crank. He criticises the six-cylinder Willans idea, considering the four-cylinder idea of Messrs. Schlick, Yarrow and Tweedy to be superior and simpler where the cranks are placed nearly 90° apart, but so far different from 90° as to correct the irregularity due to angularity of rods. He recommends his hearers to attack the problem from this point.

For two-crank engines, nothing, of course, can be better than a crank angle of 180°, with cylinders as near as possible to each other to suppress twisting moments. With three cylinders there is a fair balance possible. Four cylinders are better. For single engines there is the bob-weight system, and the author questions if it be not better always to treat every cylinder alone, and give up the attempt to balance moments by means of multi-cylinder schemes.

One of the author's methods is to lengthen the connecting rod beyond the crank-pin, and put a bob end to it, so as to balance the transverse component introduced by the rotary crank tail. The same effect is shown by a system of linkage which will obviate stresses otherwise brought on the cross-head slides by the previous system.

Mr. Whitcher makes a severe dig at locomotive engineers who of all men, with unbalanced vertical components in a heavy machine, set to run over rails supported at intervals only, and over costly bridges easily damaged by vibration and its cumulative effects, ought to seriously consider balance. He suggests how locomotives ought to be balanced. The present writer would balance locomotives by giving them three or four cylinders with the cranks of the outer cylinders 180° from the inside crank or cranks, and with equal mass moments. But locomotive engineers apparently dare not depart from their antiquated ideas of cranks at 90° so as to be able to start from any position.

They will not accept the little turning engine, so easy to be applied, nor will they try the above system with the cranks slightly off the 180° position, which would generally secure a start, and yet would so greatly reduce the present vertical component so destructive of rail joints, bridge floors, and girders.

Mr. Whitcher's paper is deserving of study and attention, because balancing, though really a simple matter, is by no means always so simple in practice as in theory. Its difficulties arise with frequent reciprocation of parts, and disappear altogether in electric motor work and steam turbines.

ELECTRICAL ALLOYS.

By ROLLO APPLEYARD.

(*Concluded from page* 537.)

II.—NEW ALLOYS.

It was thought that some further diminution in temperature coefficients could be obtained, for it was found that with some specimens of patent nickel examined at the

Reichsanstalt this constant had fallen to 0·00017. It appeared that this diminution resulted from increase of nickel in the constitution of the alloy. A number of experiments were therefore made with copper and nickel, or similar metals, in order to investigate the effect of the quantity of nickel upon the temperature coefficients. Alloys of copper and manganese, such as were being made by Dillenburg at the Isabell foundry for parts of machinery, were examined. The Reichsanstalt were encouraged to pursue this investigation by the success of the patent alloys of Weston, of Newark (American patents Nos. 381,304 and 381,305), which were described as having negative temperature coefficients. Twelve nickel-copper alloys, with different quantities

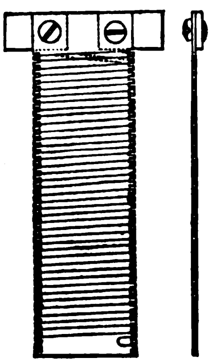


Fig. 1.

Variation of the resistance of alloys of manganese and copper with temperature.

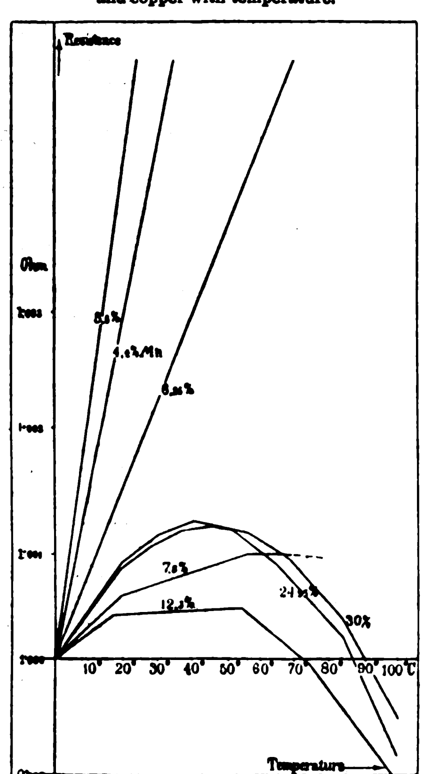


Fig. 4.

Temperature coefficient α, specific resistance ρ and thermo-electric force (against copper) ϑ the constitution of the alloy of nickel and copper.

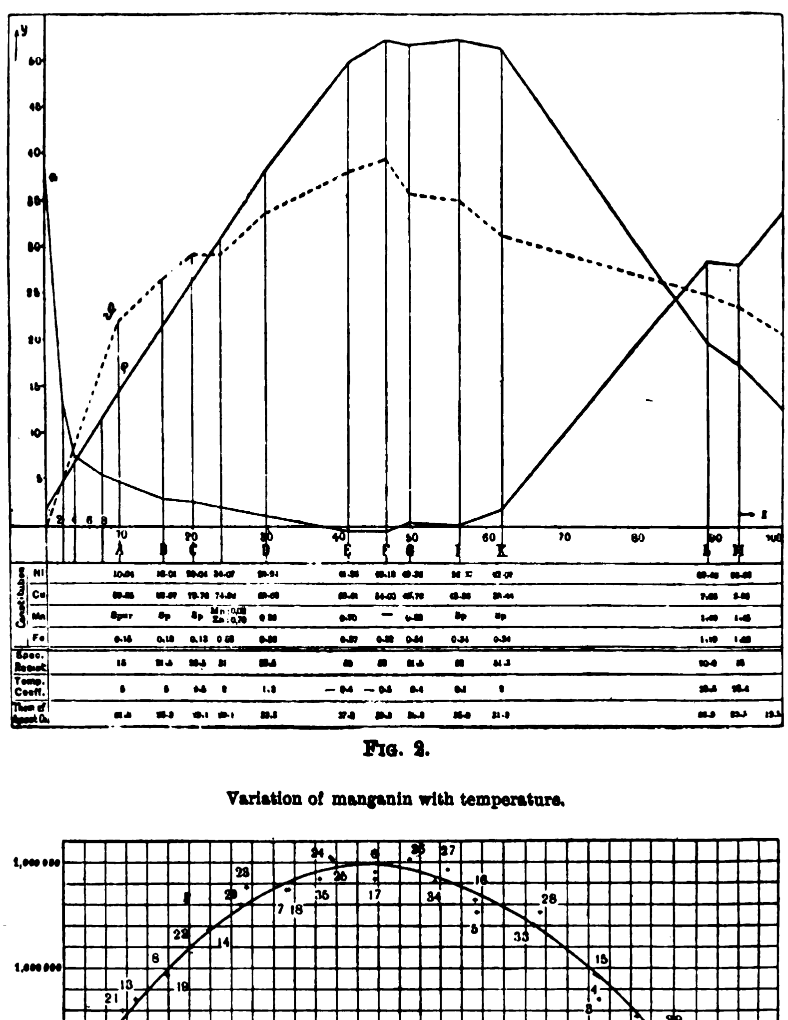


Fig. 2.

Variation of manganin with temperature.

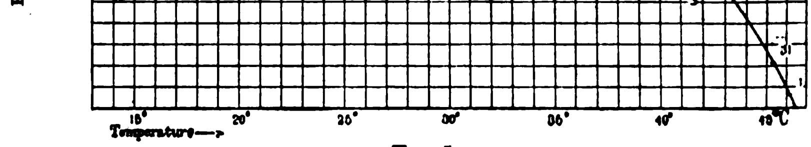


Fig. 5.

of nickel, were therefore specially manufactured for them by Basse and Selve, in Altena, Westphalia. The specific resistances and temperature coefficients were determined from wires of 0·5 mm. diameter and about 2 m. long, soldered to copper contact pieces, and, after their diameter and length had been measured, wound double upon a strip of mica, as represented in fig. 1. Afterwards these wires were kept in a thermostat at 120° C. in a dry heat for 24 hours. The wire was then put into an oil bath, and its resistance was measured at different temperatures. The results corresponding to both groups of alloys are given in curves in figs. 2 and 3. Abscissæ in fig. 2 represent different alloys of nickel, the ordinates marked ρ represent the specific resistance in micro-ohms per cc.; those marked α represent the temperature coefficients, giving the significant figures after four decimal places. The ordinates drawn to meet the curves represent the observed values. Fig. 3 sets forth the same data for manganese alloys. Fig. 4 shows the variation of resistance with temperature for various alloys of manganese and copper. These alloys can only be examined up to 30 per cent. of manganese, as alloys beyond that limit cannot be worked.

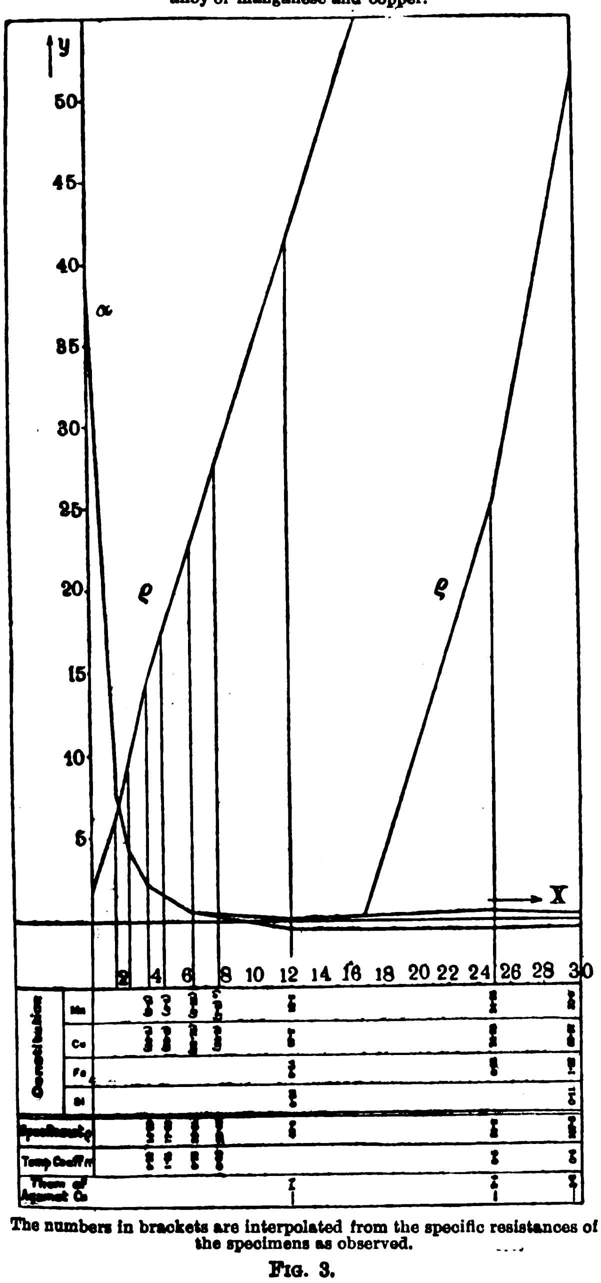
Both with copper-manganese and copper-nickel alloys, the specific resistance increases in proportion to the added manganese or nickel; up to this 30 per cent. value, the resistance of copper-manganese increases about 2·5 times as rapidly as copper-nickel. With the latter alloy, the resistance then diminishes up to 46 per cent. of nickel, and then remains fairly constant up to 62 per cent.; after that, it falls steadily until the metal is all nickel.

With manganese-copper, the temperature coefficient diminishes at first very rapidly, then gradually slower, until at 7 per cent. of manganese it becomes *nil*. Beyond that point, increasing the quantity of manganese produces an alloy which at 0° C. has a small positive temperature coefficient; this vanishes at from 40° C. to 50° C., and beyond that temperature assumes increasing negative values. In fig. 4 the ordinates of the seven curves show these various results, each represents the change in resistance experienced by a wire of 1 ohm when its temperature is varied from 0° C. to 100° C.

With nickel-copper the diminution of temperature coefficients as the nickel is added, is slower than the change noticed when manganese is added to manganese-copper; it is slower in the same proportion as the increase of specific resistance is less. Close to the zero-line there is a bend to the curve of alteration of temperature coefficients, the second part of the curve is not horizontal, but has a slight upward inclination, and then falls somewhat rapidly towards the zero line at 46 per cent. of nickel. This alloy gives the least temperature coefficient. At this same 46 per cent. value the specific resistance also attains its maximum.

The alloy represented by F (fig. 2) has approximately the chemical formula Ni Cu. In these alloys it may be supposed that the combination of one molecule of nickel with one of copper is mixed with different quantities of copper and nickel, and that these possess high specific resistances and negative temperature coefficients. The practical result of this investigation is to show that it is possible to obtain two kinds of alloys with vanishing temperature coefficients. With manganese-copper only 7 per cent. of manganese is required to produce an alloy of infinitesimal temperature coefficient. In practice, 12 parts by weight of manganese, 2 of nickel, and

Temperature coefficient α, specific resistance ρ the constitution of the alloy of manganese and copper.



The numbers in brackets are interpolated from the specific resistances of the specimens as observed.

Fig. 3.

86 of copper are adopted. Nickel has the effect of raising the thermo-electric force against copper, besides delaying the bend of the curve of resistance variation with temperature by about 20° C. (see fig. 4). This alloy has received the name of manganin. It is specially made at the Isabell Foundry for standard resistance coils. Fig. 5 shows the change in resistance of a 1-ohm coil of manganin at various temperatures; the observation-points on the curve are numbered for purposes of reference.

From the curve given in fig. 3 it appears that there are only two alloys of nickel and copper for which the temperature coefficient vanishes. The relative merits of these two alloys remain to be studied. Messrs. Basse & Selve, of Altena, who have made all the sample alloys for the Reichsanstalt throughout this investigation, make an alloy with 40 per cent. of nickel, corresponding to the first coincidence of the curve with the abscissæ axis, and they have given this alloy the trade name of "constantan."

Important as is the production of an alloy possessed of a vanishing temperature coefficient, such an alloy cannot be adopted for standard coils until the permanence of the specific resistance has been firmly established. Experiment seems to have proved that manganin and constantan are, in this regard, as suitable as patent nickel. In considering other properties, the thermo-electric power against copper comes first under notice. The table given below fig. 3 shows that manganese-copper has only small negative values for this power; this can be got rid of altogether by adding a trace of nickel to the alloy. On the other hand, nickel-copper, and especially constantan, have high thermo-electric power against copper; these are given in micro-volts in fig. 2, for different proportions of nickel.

The recorded values were determined by soldering the ends of the specimen wires to copper wires that were connected to a galvanometer. All the wires were contained in an oil bath kept at constant temperature by a heating spiral and a stirring wheel. The thermo-electric power disturbed the resistance measurements, especially when low resistances and strong currents were employed. It is true that these defects can generally be eliminated by care in the construction of the apparatus, but for resistance measurements of great precision, it is almost essential to have a material such as manganin, for which the thermo-electric power against copper is *nil*.

Manganin is rather easily oxidised; this, no doubt, is due to the affinity between the manganese and the oxygen of the air. At 100° C. the wire soon tarnishes, and during annealing, the surface manganese is perceptibly oxidised out of the alloy, leaving a surface of copper beneath the oxide. As might be expected, the electrical qualities suffer in consequence. The surface of copper can be removed by "dipping" in nitric acid, after which the good qualities of the manganin are restored.

Surrounding the manganin with powdered charcoal during heating does not sufficiently preserve it against oxidation. Moreover, dipping in acid is impracticable with the finer wires. At first this question of rapid oxidation at annealing temperatures presented a great difficulty to manufacturers of manganin wire, but the wire drawers have now learnt how to draw manganin cold, even to very fine gauges, so that the trouble is very much lessened. By varnishing the finished coils with shellac, it is found that the wire is rendered proof against oxidation, at any rate up to 150° C.

Constantan, on the other hand, resists oxidation. It can be heated with impunity up to 300° C. On account of its strength and flexibility it can be drawn into fine wires or rolled into strips. For many electrical purposes—for instance, where considerable heating is to be expected—the qualities of constantan are of great value; but for standards of resistance manganin takes preference, chiefly because of its small thermo-electric power against copper. In jointing manganin wires to the copper connecting pieces for standard resistances, tinman's solder was previously used, applied with a soldering iron. But this method is found to be detrimental; it produces in the course of time very perceptible changes in the resistance. The soft solder causes fissures, and generally alters the structure and properties of the manganin. The present method employed is to solder the wires with silver solder to copper lugs that are screwed under the contact pieces, so that they can be removed if necessary. All coils, after varnishing several times with shellac, are dried for some hours at 140° C. In winding, the insulated wire is not touched by the hand, but is passed through a clean dry cloth. The bobbins are made of as large diameter as possible, and other precautions are taken to avoid bending of the wire. It is often found better to use several thinner wires in parallel than a single thick one.

CENTRAL STATION PLANT ON BOARD SHIP.

In connection with the, of late, frequent reference to the extravagances of auxiliary plant, we note the remarks of Mr. W. S. Aldrich in a recent paper read to the American Society of Naval Engineers. On board ship the distances are so small that line losses are negligible. They are not, however, negligible in the case of steam. Compressed air is perhaps the best means of storing energy on board ship. Hydraulic accumulators as well as secondary batteries are dismissed as quite unsuitable. Electricity alone seems altogether suitable to economically transmit power from a central point where engines of economical type can be installed near to the source of steam. The power plant should consist of a number of similar self-contained units. The range of power will be less on any one unit than on the several steam engines used to drive scattered auxiliaries. On board ship there can also be arranged very steady loads, and the plant may run day and night at nearly uniform load, the light by night being set off during the day by additional motor loads, while certain pumping machinery can be operated at any time to compensate for unavoidable load variations. The one in charge of such a plant could, in fact, so work it as to secure a load curve the envy of a shore station manager. Quoting from *Transactions American Institution Electrical Engineers*, Vol. xiv., it is shown from Mr. Foster's paper that plants above 200 H.P. show a remarkable uniformity in the fixed charges of interest, depreciation, taxes, and insurance. Operating expenses gradually decrease in plants from 200 to 1,000 H.P., above which they remain very uniform and irrespective of load variations. Large stations supplying many smaller industries are scarcely affected by the instantaneous load changes. On board ship the mains can be safely and securely run through watertight bulkheads, and generally the system is, like the cables, most flexible. Only distribution losses on branch circuits need to be considered in detail. Main line losses are too small for consideration. Direct current in all cases is to be used. Distant motors can be controlled with known certainty from the central point. The author states that there is not a single auxiliary which cannot be electrically operated with certainty, efficiency, and economy, and he enumerates all fans, pumps, blowers, hoists, shifting and steering gear, turret gear, and gun mounts as daily reaching towards the system of electrical operation, also the air compressors for refrigeration purposes.

JOINT TEST: AN ACCUMULATION NULL METHOD.

By E. RAYMOND-BARKER.

In all joint tests hitherto employed two operations are necessary. Whether in Clark's *accumulation*, the *discharge*, or the *electrometer* methods, the main feature of the test lies in the comparison of two deflections.

These deflections are proportional to the amount of current which, in a given time, has leaked into or out of a condenser or into an electrometer, through the respective dielectrics of joint and standard core.

In practice, indeed, frequently three operations are gone through, viz., testing loss on (1) trough; (2) trough and joint; (3) trough and standard core.

It is quite possible, especially in work at sea, for atmospheric conditions accompanying the two main operations of a joint test to be not perfectly constant. Brine laden squalls, intermittent with sunshine, will cause variation of leakage, which scouring of ebonite would seem, at times, powerless to wholly get rid of.

For these reasons a test in which both joint and standard core are tested simultaneously, would appear to have points in its favour. It was under the influence of this idea that—some two years ago—the writer devised the subjoined test.

The accompanying diagram shows the connections of this test which is practically an *accumulation null method.* T is a double trough of ebonite. The usual precautions are taken as regards good insulation, and to prevent leakage between the two trough compartments.

The core with the joint, and an equal length of similar and perfect core, are laid in their respective compartments and are immersed in salt water. The joint will previously have been hardened in ice or freezing mixture.

P_1 and P_2 are copper plates for effecting connection between the water in the respective trough divisions, and the instruments.

C_1 and C_2 are two mica condensers of equal capacity, each, say, one microfarad.

K_1 K_2 is a Price mixing key (shown as a Lambert for ease of illustration).

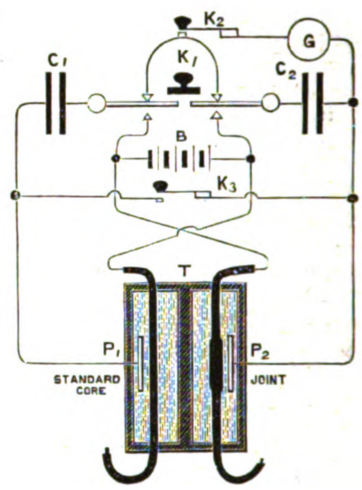
K_3 is an ordinary make-and-break key.

G is a sensitive mirror galvanometer.

B is a battery of high voltage.

For the test, K_1 is depressed during a certain fixed time, say, for one minute. The current leaks through core and joint respectively into C_1 and C_2 in which charges of opposite polarity accumulate.

K_1 is then raised, allowing the accumulated opposite charges in C_1 and C_2 to mix and tend to neutralise. K_2 and K_3 are at once depressed, thus discharging through G any



residue of unneutralised charge. The consequent deflection throw will be to the one side or the other of scale zero, according as joint or standard core has the higher insulation. If the two are equal the deflection will be *nil*.

The side of scale zero indicating that the joint has the higher resistance can be decided once and for all with any given arrangement of instruments, by simple experiment with two lengths of core or leading wire of known inequality of insulation; or, again, by testing for loss on the trough with an artificial leak on one side of the same.

For the joint test proper, when a considerable length of cable may be in circuit with the joint, C_1 and C_2 ought each to be short-circuited until K_1 has been depressed. C_1 and C_2 are then simultaneously unplugged, this operation determining the moment from which the time of charge is to be noted.

By the use of slides or of two high resistances, one being adjustable, this test may be modified so as to afford a perfect *null* method.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Two interesting papers occupied the Institution at its extra meeting on Thursday, April 28th. Mr. H. F. Parshall presented a detailed review of his practical experience of the return circuit in electric traction in his paper, "Earth Returns for Electric Tramways," while the question of return feeders was dealt with by Major Cardew and Mr. A. P. Trotter in a joint paper entitled, "Notes on Electric Tramways."

After the papers had been read, Mr. Gadsby opened the discussion by referring to Mr. Parshall's statement that, where lead-sheathed cables run parallel to earth returns of tramways, the results have been entirely unsatisfactory, since, in the absence of bonding, the lead sheathing is rapidly eaten away. The serious difficulties which arise with such cables makes them unsatisfactory indeed; holes as large as a shilling are sometimes eaten out by the return currents; in tropical climates, where the soil is dry for the greater part of the year, it is found that when rain does fall, and these places are exposed to wet, the cable breaks down. Mr. Gadsby thinks that track welding will be adopted for all tramway work in the next few years; where cast-welded bonding is adopted, good results might be obtained by permitting the metal to overflow or run out at the other side, so as to raise the temperature of the rails sufficiently, but it is a mistake to try and get the weld on so as to have an extremely small amount of clearance. Where rails are laid on white oak sleepers on broken stone, as is the practice in the United States, the conditions are different from what is customary in the country, where a concrete foundation is put in, and there is not much likelihood of trouble with the latter system.

Mr. Gadsby has designed a rail with a separate tread, with the idea of renewing that part of the rail which is subject to wear, and of making the tread of the most durable grade of steel. By stepping and breaking the joints the rail can be made to bond the tread and the tread the rail. With reference to the apparatus and method used in measuring the resistance or joints and rails in position, Mr. Parshall has not stated if or how the resistance of the shunt or parallel path provided by the earth between the test points has been allowed for.

Coming to Major Cardew's paper, Mr. Gadsby considered that it would be impossible to apply the "different voltage" arrangement to a complicated tramway system, but there seem to be some cases in actual practice where the use of feeders of different resistances might be of use.

A certain tramway, not 100 miles from London, exhibits certain interesting features. The tests taken as set forth by Board of Trade Regulations give for the drop in the rails a figure not more than 1 volt, but the leakage to the earth-plate shows 10 per cent. of the total current, the explanation of this being that the generating station is over 300 yards from the line, and an insulated feeder runs from the station or power house to the line terminus. On this feeder there is a drop of from 5 to 6 volts, with the result that the whole of the rail system is some 4 or 5 volts above the earth.

Another speaker referring to the cast-welded joint, thought that it should be bonded electrically, otherwise it does not prove at all a successful system; while Mr. Heaviside described an experiment he had made showing that rails must be insulated completely if it is desired to prevent currents flowing through the earth.

Mr. A. J. Lawson thought that Mr. Gadsby did not recognise the effects of pipes in the subsoil, and the circumstances he had mentioned might be not altogether, but only partially due to the cable in the return, as water and other pipes being connected across and buried in different soils leading up to the generating station would modify the direction of current flow.

A mixed contribution, partly Prof. Ayrton and partly Prof. Perry, followed. Prof. Perry had sent his remarks in writing to Prof. Ayrton for submission in the discussion, and as the speaker and the writer did not always hold the same opinions, the result was somewhat amusing. Prof. Perry thought the most important explanation in the paper by Mr. Parshall was his experience that well-made bonds do not increase in resistance. The exposed surface of the rails is very large, some 50,000 square feet per mile, and the consequences of this should be carefully considered by electrical engineers. Again, in the interests of the companies, Prof. Perry would say that the return should be insulated; whether there should not be a rule, for example, that *all* electrical conductors should be insulated, even though it is known that the Board of Trade rules will partially protect pipes, &c., buried in the ground. New York and Boston have already insisted upon this point—the extra expense need not prove excessive. Prof. Perry ventured to disagree with Prof. Ayrton as to the degrees of importance of educational or teaching institutions being guarded against disturbance from earth currents. Magnetic observatories, however, suffered severely. The value of all records of the Washington Observatory is now destroyed, although two miles away from the source of disturbance, while those of Toronto are useless. At three-quarters of a mile the variations may amount to a half or more of the diurnal variations it is desired to record. While a laboratory may be protected, it is impossible to defend an observatory, and if Kew were interfered with, no money compensation would be commensurate with the damage inflicted. There seems to be no other way in which to obtain a knowledge of the cause of the earth's magnetism than the study of magnetic records.

Then there is the amount of harm that may be done by uninsulated returns to pipes and lines in their neighbourhood. When sewage was cast into rivers the general rights of the community suffered, and steps were taken to prevent future interference. As Prof. Ayrton has before stated, he repeated again, that the use of earth returns was an evidence of conservative feelings of the human being. As earth returns are used for telegraphy, it seems natural to some that we should bring back the current of tramway lines in the same way. There is a talk about zero pressure on the return lines (and of apparatus for effecting this). Who wants them to be at zero? Why should one interfere with the pressures at all? It is an old-fashioned idea that one must do everything by the same means. In ancient days a hole in the roof of a hut let in light and allowed smoke to escape, in later times separate provision was made.

Prof. Ayrton has mentioned on previous occasions that all the railway companies which had Bills in Parliament for the construction of underground railways near South Kensington had undertaken and did insert clauses to the effect than an entirely insulated system would be employed; all had given undertakings that whether a two or three wire were used every bit of the system should be insulated to the satisfaction of the City and Guilds of London Institute and the Science and Arts Department, and had agreed to their right to see that the undertaking was duly carried out. It was to the interest of the companies, who could then construct their lines with best consideration from a purely engineering point of view. Not only would other people not be disturbed, but an enormous benefit would be derived by the companies.

Prof. S. P. Thompson agreed that a standard laboratory should not be interfered with. It was true that Toronto can no longer make magnetic records, but a student's teaching institution is on quite a different footing, and he saw no reason for protecting a laboratory of this kind; rather let the students find out what occurred. He did not apparently favour the plastic bond, and urged the absolute inadvisability of having anything to do with quicksilver. Referring to the thermo-electric effect which interferes with resistance measurements such as Mr. Parshall had taken, he pointed out that the Peltier effects suffered reversal when the testing current was reversed. As Mr. Parshall did not find the tests unaltered by change in direction of current, this was evidence of something else that was not mentioned, as one did not have symmetry. Again with respect to "gathering" the resistance of a conductor is a minimum when the current flows equally through the cross-section, and it is obvious that the useful section diminishes close to a bond, but the professor was utterly astonished to find the "gathering" resistance was represented by 39 inches of good steel rail and hardly thought that "gathering" could be responsible for all that. He thanked Major Cardew for his clear account of how to keep down the drop by return feeders and boosters.

Prof. Thompson was aware that there had been much grumbling at the Electric Lighting Act of 1882, but it is now regarded as a blessing in disguise, as it has saved us from a great deal of abominably bad work: the Board of Trade Traction Rules are a blessing, and not this time in disguise—one need not have quarrelled with them on question of economy had they been more severe than they are.

Mr. Wordingham had come to the conclusion that there was no alternative in some cases to insulating the return. A great objection to slot and conduit systems was the length of time the highways had to be closed for laying—three weeks to a month. Insulated overhead returns had resulted in failure.

Mr. Parshall replied by urging the survival of the fittest.

The four rails of a tramway system represented 6 square inches of copper conductor. The "hole-in-the-roof" argument suited him perfectly; on his basis the hole-in-the-roof became the roof itself! He explained how some of the tests in his paper had been taken, his remarks may be of interest to those who read the paper and reply together in the *Journal*.

Major Cardew briefly replied: He thought that the disturbance at an observatory would depend very largely upon the angle subtended by the tramway at the observatory.

The meeting then adjourned, after a notice by the President that the next paper would be on "The Prevention of Interruptions to Electricity Supply," by Mr. Leonard Andrews.

CORRESPONDENCE.

Carbon Brush-holders.

With reference to the historical note in the first paragraph of Mr. Scott's article on "Carbon Brush-holders" in your issue of the 22nd ult, I may say that although carbon, as Mr. Scott says, does not appear to have been very much used on dynamo commutators until 1892, I remember it being experimented with in the early part of 1889, and largely adopted later by the West End Street Railway Company, of Boston (U.S.A.), on their street railway motors of Bentley-Knight, Sprague & Thomson-Houston constructions.

The use of this material was a decided success, and relieved those in charge of the running of a lot of anxiety owing to the small amount of attention necessary; sparking being practically overcome and wear on the commutator hardly noticeable.

The almost universal adoption of carbon brushes at the present time for street railway work provides ample proof of their superiority on all points over metal brushes, and electric traction engineers have certainly much to thank Prof. Forbes for in suggesting the use of such a satisfactory material.

It is a small detail certainly, but one that has assisted towards making electric traction the success it is.

Gus. C. Lundberg.

April 30th, 1898.

"Generation of Electricity at Gas Works."

According to the *Daily Mail*, January 26th, 1898, there are in the United Kingdom 433 private gas companies, 208 municipalised gas undertakings, the majority of which are at the present time making a considerable profit from gas and the by-products or wastes.

During the year 1897 an application for provisional protection for "Generation of Electricity at Gas Works by Utilising the Waste Gases and Heat," was passed by the Patent Office, and the applicant is of opinion that it is possible to generate 30 to 50 units of electricity as well as 9/10,000 feet of coal gas from a ton of coal as well as the usual by-products, coke, &c.

If such is possible, what will be the ultimate cost of electricity?

The capital expenditure of these gas undertakings is stated to be about £66,500,000, and the expenditure on electrical central stations is increasing so fast that the figures can hardly be correctly stated; but it is certain that a large amount expended on land and buildings, if it were possible or practicable to make gas and electricity at the same works, would be saved, besides which there would be considerable saving in the departments of distribution and collecting.

Another feature is the question of Dowson or power gas, made from cheaper coal, having less illuminating but greater motive power; and the combination of some of the systems would obviate the necessity of storing the electricity, which forms the most costly part of an electrical undertaking when "works' cost" is calculated.

The great increase of electrical traction, and the comparative low cost and advantage of electrical motor power and its distribution, and the question of "day load" may be solved by utilising gas works for the production of electrical light and power as well as illuminating and power gas.

All this hinges upon one question: Is it possible or practicable to utilise the present waste gases or heat at gas works for the generation of electricity?

Also, whether the gas companies, which for many years have supplied us with light, heat, and power, are to be superseded?

Now, as many municipalities are owners of the gas undertakings, and have applications for electric light, would it not be worth their while to consider these questions?

Gas engineers have been studying how to improve their light, and electrical engineers how to cheapen theirs, and both have overlooked the fact that it is possible to produce gas and electricity at the same time from the same coal.

What the public want is cheap and good light, heat, power, and quick transit, and the profits thereof to go to the reduction of the rates, and it may be found practicable by combining the production of gas and electricity at one and the same time at gas works.

Sam. Thos. White.

Bristol.

Free Wiring.

In an article on this subject by Mr. V. Zingler, commencing in your issue of the 22nd ult. and concluding in the current number, it is argued that it is fairer for the consumer, who has the wires and fittings put in for him free of initial cost, to pay in proportion to the actual use he gets out of them rather than for the length of time these goods are in his house. In other words, that it is an all round better arrangement for him to pay a little extra on the cost of the units for the use of the wires and fittings rather than a fixed sum per quarter per lamp put in. I cordially agree with the writer, and feel convinced that the plan which is fortunately being most generally adopted is the one which will work out best in practice, and I hear from the Midlands that a very marked improvement has now been brought forward, which I suppose was not seen when free wiring was first introduced. I refer to the charge for free wiring being made ½d. per unit after the first hour's use at 1d. on the maximum demand basis. This exactly meets the point which Mr. Zingler brings forward, when he says that it may be urged that just as it is found profitable to give the customer a rebate on the cost of electricity after a certain consumption per diem, so it would most likely also be advantageous to all parties concerned to give him a similar rebate on the excess sum per unit for wiring and fittings, the point at which this rebate should come into operation being determined by the sum representing fair interest on capital sunk required from him. Just as when you take a cab for a short trip it costs you 1s., but for a 3-mile run the fare is 1s. 6d., so with the improvement in the free wiring tariff to which I have alluded the customer is not discouraged, by the additional charge for the free wiring, from running his lamps freely and for many hours each day.

Geo. J. Somerville.

Visual Telegraphy.

We have read with mingled feelings of amusement and surprise the numerous and sensational press announcements regarding the alleged invention of Herr Szczepanik.

From interviews with him recorded in *Black and White* and the *Illustrated London News*, we observe that he claims to have originated the idea of employing vibrating mirrors in an apparatus for transmitting views or images of distant objects by electricity.

We may say, however, that as long ago as 1890 we conceived the same idea, and in letters of that date addressed to, and now in the possession of, Dr. Charlton Bastian, F.R.S., we fully described the method whereby this visual telegraphy could be accomplished provided certain mechanical difficulties in the construction of the necessary apparatus were successfully overcome.

Our experience is that the difficulty lies in mechanical construction only, and when Herr Szczepanik has solved this problem he will, indeed, have invented something new.

In the absence of proof to the contrary we must certainly claim to be the originators of the idea of using vibrating mirrors, which, however, is not of much value until some means have been invented for causing them to vibrate at a greater speed than has ever yet been attained mechanically, as in order to reproduce a picture on a screen six inches square with a single electric circuit, the mirror would have to make at least 90,000 (ninety thousand) distinct and intermittent movements in each half second of time, and even at this speed the picture would appear very blurred.

In addition the 90,000 movements of the mirror at the receiving end should be absolutely synchronous with the 90,000 movements at the transmitting end.

We foresee the possibility of reducing the above speed to as little as 300 (three hundred) distinct movements per half second, but then the difficulties of synchronising throughout the longer period of each movement become immensely increased.

It appears evident, therefore, that something more than vibrating mirrors must be thought out before "pictures of battlefields, &c., can be reproduced at a distance with all the clearness of the cinematograph" (*vide Black and White.*)

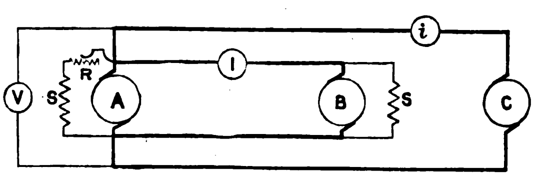
Chas. O. Bastian and A. J. Parsons.

Testing the Efficiency of Direct Current Machines.

On page 548 of your issue of April 22nd appears a reprint from *L'Eclairage Electrique*, by Mons. P. Dupuy, on a method of testing the efficiency of two similar direct current machines. Am I not correct in stating that M. Dupuy is in error in his method of calculating the efficiency? This same test is described briefly by Prof. S. P. Thompson on pp. 759 and 760 of the fifth edition of "Dynamo Electric Machinery," Mr. Kapp being given as its originator.

The formula there given to obtain the efficiency of either machine is:— $\sqrt{\frac{I}{I + i}}$, not $\frac{I - \frac{i}{2}}{I}$ as M. Dupuy has it; where I is the current in the machine running as motor, and i that supplied by the third machine.

M. Dupuy seems to have overlooked the fact that the currents in the two machines are not equal, except when mentioning the Joule effect, where, unless I misunderstand



A, Motor; B, Generator.

him, he makes the currents to be $I + i$ and $I - i$, whereas they should be $I + i$ and I, that in the motor being in excess of that in the generator by the amount supplied by the third machine.

The efficiency obtained is, I take it, that of either machine at an output situated somewhere between the arithmetic mean and the root mean square of $I + i$ and I, being nearer the latter the larger the load. With the figures instanced by M. Dupuy the efficiency should be $\sqrt{\frac{1,000}{1,160}} = \cdot 929$, instead of $\frac{1,000 - 80}{1,000} = \cdot 92$, and the difference between the two methods becomes more marked with a lower efficiency, for instance, with $I = 1,000$ amperes, as before, let $i = 300$ amperes, then the efficiency would be ·877, whereas M. Dupuy would make it ·85.

I have been using this test for some time past in the works with which I am connected, both for obtaining the efficiency and as a handy means of applying a load, and can most fully endorse M. Dupuy's statement as to its convenience. I have found, however, two objections to it, (1) the speed drops below normal; (2) the weakening of the field of the motor is conducive to sparking, especially on toothcored armatures. An easy way of lessening the latter effect is to connect the field coils of the generator (when it possesses more than one) in parallel, and to insert a resistance, cutting this out, and so strengthening its field simultaneously with the weakening of that of the motor; but this unfortunately still further reduces the speed.

M. Dupuy speaks of keeping the external resistance as low as possible, but with machines of large output and low voltage, it is almost impossible to avoid a sensible waste on the leads, switch, and ammeter, which can easily amount to 1 or 2 per cent.

A very approximately correct allowance may be made as follows:—Measure the watts, w, wasted externally, then if V be the voltage of machines, $\frac{w}{V}$ represents that part of i for which this loss is responsible, add half this amount to the generator current and subtract half from the motor current.

$$\text{Efficiency} = \sqrt{\frac{I + \frac{w}{2V}}{I + i - \frac{w}{2V}}}$$

Example:—

Generator current $I = 500$ amperes, $i = 100$ amperes.
Motor current $= I + i = 600$ amperes, $w = 1,600$ watts.

$$V = 80 \text{ volts}, \frac{w}{2V} = 10$$

$\text{Efficiency} = \sqrt{\frac{500 + 10}{600 - 10}} = \cdot 93$, instead of working out to ·913 where these losses not taken into account.

The test is as applicable to compound machines as to simple shunt, but care must be taken that the series turns on the motor as well as those on the generator, are connected cumulatively, otherwise the arrangement lacks stability.

H. B. Poynder.

THE STRATEGIC VALUE OF CABLES.

The present regrettable state of affairs between Spain and the United States, which is a matter of the gravest interest to the whole civilised world, not only on account of the immediate conditions brought day by day before our notice, conditions to which no one can be indifferent, but also on account of the consequences which must inevitably follow when the struggle is concluded, and the time comes for re-adjusting the balance. This situation brings home to us in a practical way a lesson which we should not ignore, although it is not bought by our own actual experience. There are doubtless many points of importance in the war now going on to which the attention of the strategist, naval or military, may be directed with advantage; and there are new problems in politics being evolved which will sooner or later have to be dealt with, but we wish to confine our view to what may seem comparatively a detail of the present complications; yet one which is of the greatest moment, and on which at any time the fortune of war may turn. We have on several occasions laid before our readers our views as to the conditions to which submarine cables are subject in time of war, and have given instances of the invaluable part which these are sometimes called upon to play in such circumstances.

It may, perhaps, be within the recollection of some, that on the occasion of the meeting of the "Convention for the Protection of Submarine Telegraph Cables," which took place in Paris as far back as in April, 1884, a favourable opportunity for establishing the neutrality of cables in war time was unfortunately lost. The result of this convention, at which all the great powers of the world were represented, was a common agreement which, however useful to restrain and penalise wilful damage to cable property in time of peace, did worse than nothing for their protection in time of war.

By formulating and agreeing to Clause XV. of this convention a liberty of action was proffered to belligerents, of which some of them, at least, would have hesitated to avail themselves had not this clause been generally assented to. This portion of the convention reads as follows:—

"*Article XV.*—It is understood that the stipulations of the present convention do not in any way restrict the freedom of action of the belligerents."

It has been said that in case of war cables would be cut when and where necessary, without regard to proprietorship and to after consequences, but whatever moral restraint may have existed before this convention was concluded, or whatever fear of arousing prejudice, if not of provoking actual armed intervention, may previously have existed, has been quite done away with by the *carte blanche* given in the convention. Let us examine the position as it actually stands at present. It is of the utmost importance to each of the combatants that they should have speedy and accurate news of events as they occur, relating to the position and movements of war vessels, the transport and landing of troops, and reports as to the success or failure of the various operations of war. Here Spain is heavily handicapped, as the cable routes by which information may reach the United States are none of them under Spanish control, whereas the cables which united Florida with Cuba, the property of an American Company, are under the control of the United States authorities at Key West. From this point communication with the fleet off Havana, some 90 miles away, can be easily and quickly effected; thus giving the United States a great advantage. The other cable route to the South of Cuba, *via* Bermuda and Jamaica is, we believe, still open, and the line from New York through Hayti to Santiago de Cuba, which belongs to a French company is still working; although it is doubtful if the Spaniards are likely to make use of a cable which lands at New York.

However, we gather from a recent report of proceedings in the Cortes that Spain has taken "the necessary steps to maintain communication." As far as Manilla is concerned there is a single cable from Hong Kong, which until last month was landed at Cape Bolinao and connected with the town of Manilla by a landline some 130 miles long. In consequence, however, of this landline having been cut by the insurgents, the cable was removed from Cape Bolinao and carried direct into Manilla. This cable was interrupted a few days ago, and it is rumoured that the end has been taken on board an American vessel at Manilla for the purpose of establishing direct communication between Admiral Dewey's fleet and the United States; for the truth of this rumour we do not pretend to vouch.

We have on previous occasions given instances of the part played by telegraph cables during various wars, and have shown with what facility these can be destroyed in shallow water. In April of 1882 we published a detailed account of the various occasions on which damage was done to the cables on the west coast of South America during the Peru and Chili war, and the effect thus produced in the course of that war.

We in England have not yet had much practical experience on this subject, it is true that during the bombardment of Alexandria the lines across Egypt, which form the principal link in our means of communication with India, China, and Australasia, were cut by Arabi's troops, but this was little noticed at the time, as telegrams could still be sent to the East across the landlines through Persia, or *via* those which run through Russia and Siberia. Circumstances have changed since that time; we learn that at present the Russians are displaying great activity in Northern Persia, and it is not improbable that in time of need we may find both the Persian and Siberian lines closed against us. Since the time of the bombardment of Alexandria a ring of cables has been put round Africa, which joins the submarine telegraph route to the East at Aden, thus avoiding dangers in Egypt; but these cables are notorious for the frequency with which they break down,* and could not be relied on. Some advantage might be gained by laying a series of cables to Cape Colony, *via* Ascension and St. Helena, and this course has been recommended as one having great strategical advantages. We cannot, however, lend much support to this theory, as this means of communication would be subject to the same danger which threatens all the existing cables to Africa, India, China, and Australasia, it would be liable to be destroyed at the mouth of the Channel in the vicinity of Cherbourg and Brest, where, for more than 150 miles, all these cables lie in water of a depth varying from 40 or 50 to 100 fathoms, a depth at which the cables could be cut with the greatest of ease. We have frequently pointed out the advantages which would be derived by laying a cable from Canada to Australia through the Pacific; a route far removed and naturally secured from the dangers to which the existing cables are subject in many portions of their length. Sir Charles Dilke, who is looked on as an authority in these matters, has said that British cables which followed our trade routes could be patrolled. This sounds convincing, but in time of war it is likely that the Navy will have enough on its hands without telling off a large number of vessels to sail at long intervals along the lines marked down on charts as cable routes. Apart from the lack of foresight evident in this there is an obviously false economy, as the cost of establishing independent and widely separated systems of cables would only be a fraction of that entailed by building a large number of additional cruisers to carry out a patrol duty; which, at the best, would be of little or no use as far as the protection of cables is concerned.

* There are at present interrupted no less than four of the cable sections forming portion of the route to the Cape, *via* the West Coast of Africa; these are the cables connecting Mossamedes and and Cape Town (since April 14th, Benguela-Mossamedes since April 20th, Kotanu-St. Thomé since April 27th, and San Thomé-Loanda since May 4th. Thus, with one exception, all the cables from the Gold Coast to Cape Town are now interrupted. The cable from Sierra Leone to Accra which broke down on April 9th has since been repaired. None of the cables above-mentioned are duplicated.

ELECTRIC TRACTION AT BRISTOL.

Decision of the City Council.

The Bristol City Council, since our last issue, has, at two special meetings, devoted in all no less than six hours to the discussion of its relations with the Bristol Tramway Company with regard to the directors' scheme for extending their system, and working the whole of their lines by electricity. At last matters appear to have so shaped themselves that both the company's Extensions and Electric Power Bills may proceed practically as unopposed measures, except on one point—that with regard to the fares chargeable. It may be that the Sanitary Committee and the company will come to an understanding on this subject in the next few days, but in the light of past experience this is not very likely, and the Parliamentary Committee before whom the Bills come will have, therefore, to decide between the two bodies as to what the fares shall be upon the numerous lines affected. Mr. George Pearson, the chairman of the Bristol Civic Electrical Committee, who was throughout these long debates the spokesman for the sanitary authority, maintained, and other speakers supported his view, that when carefully examined, the Tramway Company's concessions to the city, as a *quid pro quo* for the sanction to use Bristol streets, would be found more apparent than real. The reduction of the fares for general passengers to the rate of three farthings a mile made very little difference in the present arrangements, and on many important sections no difference at all. The company had the prospect, it was argued, of making an immense saving in their working expenses by the use of electric traction throughout their system, and Mr. Pearson contended that the present price of the shares in the company showed what large profits were expected from the use of electricity. With the hopes of these enhanced profits, investors were willing to pay such a price for shares, that the return to them was only £2 13s. 3d. per cent. per annum. As these profits were to be earned by the use of the public roads, it was urged that the Sanitary Committee were perfectly right in their view that there should be a wayleave paid by the company to the city, and a substantial reduction of fares. On the pro-tramway company's side Alderman Inskip was, as before, the chief spokesman, and his main point was that under 11 heads terms had been provisionally arranged between the company and the chairman of the Sanitary Committee, and that these ought to be taken as the bases of settlement rather than to risk by further demands electrical travelling facilities the citizens needed badly. The Council carried his amendment by 32 votes to 30 in the teeth of the recommendations of the Sanitary Committee, and this amendment worded as follows became the substantive resolution:—"That the Bristol Tramways Extension Bill 1898 be allowed to proceed, and the opposition of the Corporation to the Bristol Tramways Electric Power, &c., Bill, 1898, be withdrawn upon condition that the Bristol Tramways and Carriage Company insert in the Bill proper provisions for giving effect to the stipulations Nos. 1 to 11 in the report of the Sanitary Committee, and such other provisions as may be considered necessary for the protection of the public interest, and that the additional stipulations suggested by the last paragraph of the report be not adopted by the Council."

This last paragraph thus thrown aside was:—"Your Committee are of opinion that no arrangement would be satisfactory which does not reserve to the Corporation the right to veto the use of the overhead wire system in certain areas, and provide for the payment by the company of a moderate wayleave for the use of the streets and a greater reduction of fares."—The conditions, 1 to 11, referred to in the resolution, were as follows:—

1. The company are to be allowed to generate electric current and to use the overhead system upon all the existing tramways, and upon the extensions, on condition that if any other system of electric traction, which may appear to the Council to be an improvement on the overhead system, is adopted and worked at a profit of 5 per cent. or upwards on the capital employed, in five or more towns in the United Kingdom, of a population exceeding 100,000 (any district in the County of London under the control of a Vestry, being regarded for the purposes of this condition as a town), the company will adopt that system on notice from the Council, provided that the mileage of the tramways on which the improved system is adopted is approximately the same as the mileage of the company's electric tramways; and provided the Board of Trade decide that, having regard to the length of the company's unexpired period, it is equitable that the company should make the change. Any question as to the approximation of mileage to be settled, in case of difference, by the Board of Trade.

2. The posts and overhead wires are to be subject to the approval of the Corporation, without appeal, as in the Act of 1894.

3. The power of the Corporation over the execution and maintenance of works in the streets is to be the same as in the Act of 1894.

4. The company are not to supply electric current to other companies or persons within the city.

5. The Corporation are to have the right to use the company's posts for supporting public electric lamps.

6. The company are not to be entitled to require the Corporation to supply them with electricity.

7. Of the first additional capital required by the company for the construction of the works authorised by the Bills not less than £200,000, whether issued by means of shares, debentures, or debenture stock, is to be raised in such a way that the rate of interest thereon shall not exceed 4 per cent.

8. Where owners may be required to sell parts only of scheduled properties, the onus of proof that the part can be severed from the remainder without material detriment thereto, shall be on the company.

9. The fares are to be reduced to rates of about three farthings per mile for ordinary passengers, and one-third of a penny per mile for persons (men and women) of the labouring class. The hours for running labouring class tramcars are to be extended so as to include the hours at which women are employed at factories go to work.

10. The time at which the Corporation may first exercise their power of purchase is to be 17 years from May 1st, 1893, and the subsequent periods of seven years, at which the power of purchase recurs, is to be reckoned as from the expiration of the said 17 years. The purchase is to include the whole of the company's undertaking within the city at the time of purchase, whether consisting of tramways or light railways, except the Hanham Light Railway.

11. The construction of the extensions is to be obligatory on the company.

An attempt was then made by several influential members of the Council to add to these 11 conditions to which the company had already agreed, a demand for a wayleave, and it was moved as a further amendment that the company pay to the city 50 per cent. of their net profits after providing for a sinking fund and paying a dividend of 7½ per cent. on their ordinary shares. (The company pay at present partly working by horse-power and partly by electrical power 6 per cent.). This was warmly debated, but was defeated by 34 votes to 30. Then there was a suggestion that children should be charged halfprice as on railways, and this resulted in an insertion in Alderman Inskip's proposal before the words "And subject to such other provisions" of the following clause: "And subject to the scale of fares to be charged being agreed upon between the company and the Sanitary Committee, or failing such agreement to be settled by the Committee of Parliament to whom the Bill shall be referred." This was accepted by Alderman Inskip, and by the Council generally. As the Bills reach the committee stage next week, there was no time for the Sanitary Committee to report the negotiations on fares to the Council, and it was understood the effect would be a contest on the point in the Committee Room of the House of Commons. The company, in a statement, announce that the average distance a passenger is entitled to travel under their proposed fares is 1 mile, 2 furlongs, 5 chains, 76 links for 1d., or ·75d. per mile. By workmen's car the average distance would be 3 miles, 3 chains, 89 links for 1d., or ·32d. per mile. Workmen's cars are, however, run at fixed times only, and are not numerous.

MUNICIPAL ELECTRICAL ASSOCIATION.

A meeting of the Association was held at the Westminster Palace Hotel, London, on Monday, April 25th, at 9.30 a.m., to consider and report upon the clauses having the attention of a joint committee of the two Houses of Parliament. The President, in opening the meeting, expressed regret that the notice sent out had been so short, but the clauses for consideration were so important that it was absolutely necessary the matter should have immediate attention. He then called upon Alderman Higginbottom, of Manchester, who had devoted a very considerable amount of time to the subjects to be considered, and who would be able to give them, he was sure, a very clear explanation of the effect of the clauses. Alderman Higginbottom then carefully explained the clauses to the Association, and explained the course which had been taken by Manchester, Glasgow, Nottingham, Sheffield, and several other Corporations who were represented by counsel before the joint committee. The President then said he would put the clauses one by one to the meeting, and would ask them to consider the same separately.

Clause 1.—"Whether, notwithstanding the provisions of Section 12 (1) of the Electric Lighting Act, 1882, powers should be given in any case for acquiring land compulsorily for generating stations; and, if so, under what conditions as respects liability for nuisance, notices to surrounding owners, and otherwise.

Resolved, that powers for acquiring land compulsorily were desirable, and that such powers should not be coupled with special conditions as respects liability for nuisance excepting as provided for in the Railway Acts.

Clause 2.—Whether compulsory powers of acquiring land for generating stations, if proper to be given in any case, should be given where the proposed site is not within the area of supply.

Resolved, that compulsory powers of acquiring land for generating stations should not be given without the consent of all the local authorities affected.

Clause 3.—Whether, in case of a generating station, however acquired, not being situate within the area of supply, power should be given for the breaking up of streets between the generating station and the boundary of the area of supply.

Resolved, that compulsory powers for opening up streets between the generating station and the boundary of the area of supply should not be given without the consent of all the local authorities affected.

Clause 4.—Whether powers should be given in any case for the supply of electrical energy over an area including districts of numerous local authorities, involving plant of exceptional dimensions and high voltage; and, if such powers may properly be given, whether any and what conditions should be imposed.

(a) With respect to system and plant, and to the construction and location of generating stations, in view of the powers of purchase conferred upon local authorities by Sections 2 and 3 of the Electric Lighting Act, 1888.

(b) With respect to the relations of the promoters to other undertakers, and to local authorities within parts of the area.

Resolved, that no powers should be given for the supply of electrical energy over an area including districts of numerous local authorities without the consent of the local authorities affected, and that no special conditions are required, as the Board of Trade have all powers necessary.

Clause 5.—Under what conditions (if any) ought powers to be conferred upon promoters seeking to supply electrical energy to other undertakers and not directly to consumers.

Resolved, that powers should be conferred upon promoters to supply electrical energy to other undertakers by agreement.

It was further resolved that a witness be appointed to appear before the joint committee to represent the views of this Association as expressed at this meeting, such witness to be selected by the council.

Mr. Gibbings, the president of the Association was appointed by the council to represent the views expressed at the meeting.

LONDON COUNTY COUNCIL.

On Tuesday the Industrial Schools Committee reported that the cost of substituting the electric light for gas at the Feltham School would, according to the advice of the electrical engineer who had been consulted on the subject, necessitate an expenditure of £6,000. The committee did not, therefore, feel justified in recommending such a large outlay, and their suggestion that £800 should be expended on reconstructing the gas works at that school was adopted.

The Bridges Committee mentioned for the information of the Council that they had accepted an offer of Messrs. Laing, Wharton and Down, amounting to £234 14s. 3d., for wiring the brackets and removing the old lamps in connection with the alteration of the position of the lamps in the open approaches to the Blackwall tunnel. The same committee reported the receipt of tenders, a list of which is given in another column, for the lamp columns, &c., required for the electric lighting of Waterloo Bridge.

The Council, on the recommendation of the Building Act Committee, approved plans submitted on behalf of the Charing Cross and Strand Company for an extension of the generating station in Commercial Road, for the erection of a generating station in Penrose Street, Walworth, for the Vestry of Newington, and for an extension of the Bankside station of the City of London Electric Lighting Company.

The Highways Committee reported having received a reply from the Postmaster-General on the subject of the application of the Council, under the Telegraph Act, 1892, for a license to empower the Council to provide a municipal telephone service for London. The reply stated that it would not be competent for the Council, without obtaining the sanction of Parliament, to construct the necessary works and carry on telephone business at the cost of any funds over which the Council has any control. The Postmaster-General further stated that he must await the report of the Select Committee to be appointed by the Government to consider the question of empowering municipalities to undertake telephone exchange business.

The Highways Committee announced for the information of the Council that the Board of Trade had decided to grant the application of the Vestry of Marylebone for an electric lighting provisional order, and that the orders applied for by the County of London Electric Lighting Company and the Marylebone Electric Supply Company for powers in the same parish of Marylebone had been refused.

It will be remembered that towards the end of March, as mentioned in the ELECTRICAL REVIEW at the time, that the Council decided to ask the Board of Trade to insert, in each of the electric lighting provisional orders which might be granted in this or any future session, a clause for the protection of tramways already purchased or likely to be acquired at any future period. In this connection the Highways Committee reported that the Board of Trade had expressed the opinion that full protection was afforded to the Council by the provisions of the Electric Lighting Act, 1882, and the orders made thereunder, by which the Council, as owner of the tramways, would have power, subject to certain conditions, to alter the position of electric lines or works which would interfere with the lawful exercise of any powers vested in the Council, the Board pointed out that Section 15 of the Act provides that where the position of any electric lines or works is altered, compensation shall be made or secured to the owners. In these circumstances the Board regretted that it was unable to insert in provisional orders the clause suggested by the Council.

LEGAL.

WEBLYN v. SHOOLBRED & CO.

THE case of Weblyn v. Shoolbred & Co., was down for hearing in the Queen's Bench Division on Monday, May 2nd, before Mr. Justice Hawkins and a special jury. Mr. Fletcher Moulton, Q.C., Mr. Roger Wallace, and Mr. Gaskill were counsel for plaintiff, and Mr. Lawson Walton, Q.C., M.P., and Mr. Ernest Pollock for the defendants. The action was brought to recover damages for the destruction or partial destruction of a valuable picture, entitled "The Royal Harem," which was on exhibition in the Strand during the latter part of the Jubilee Year.

MR. FLETCHER MOULTON said the damage, which was by fire, was alleged to be due to the negligence of the defendants, in consequence of their having put in an installation of electric light in a defective way.

HIS LORDSHIP (alluding to a vast array of models and electric lighting apparatus in the Court) asked if the case was a patent case. Was all that electrical apparatus to be used before him and the jury? If so he thought it was hardly a fit case to go before a jury.

Mr. LAWSON WALTON said the defendants were anxious that the case should be tried before his Lordship and a jury.

HIS LORDSHIP: I don't know how you purpose to do it; for you may have experiments to make.

MR. FLETCHER MOULTON said there was no doubt it was a technical case, but he thought there would be no difficulty in making either his Lordship or the jury fully acquainted with the facts of the case on which they would have to form conclusions as to what was done in connection with the electrical installation.

Mr. FLETCHER MOULTON said that if his Lordship expressed an opinion that it was not a suitable case to be tried before him and a jury, they would communicate with their respective clients. Both sides were very anxious to have the case tried.

HIS LORDSHIP: I do not think it is a case that could be reasonably tried by a jury or by anybody who has not had some opportunity of making some experiments himself.

Mr. LAWSON WALTON said there were two issues on which a verdict was desired. The first was whether the installation was carefully and correctly done, and the second was whether the fire was caused by the defective installation or had some other origin. He thought that that would involve the calling of considerable electrical evidence.

HIS LORDSHIP suggested that it would be better for experts to make the experiments elsewhere and then give evidence. If there was any likelihood of fire being caused by the experiments he should prefer that they should not be performed in his presence.

After consultation it was agreed that Mr. Fletcher Moulton should take an order referring the matter to an official referee or arbitrator within a fortnight. The parties, with their models and apparatus, and electrical experts, of whom a large number had been subpœnaed, then left the Court.

CROSSLEY BROS. v. JOHNSON.

AT the Greenwich County Court on Friday, before his Honour Judge Addison, Q.C., Messrs. Crossley Bros. sued Mr. W. Claude Johnson, of the Dignaries, Westcombe Park Road, Blackheath, for £21 17s. The sum of £5 was paid into Court by the defendant, who urged that the balance was expenditure caused by the act of the plaintiffs' own servant. From the evidence it appeared that on May 13th, 1897, the plaintiffs sent a workman named Frank Turner to effect certain repairs to the gas engine which worked the dynamo of defendant's private electric light installation. He arrived a few minutes before the dinner hour of the defendant's workman, Suckling. The engine was working at the time, but when Suckling left for dinner he stopped it, and Turner commenced to do his work. Whilst he was removing some bolts from the gas engine it began to work, and Turner noticed sparks on the switch on the wall which turned the electricity from the dynamo either direct to the lights or to an accumulator as might be desired. Turner ran for Suckling, who came and tried to turn the switch, but in consequence of its being partly fused he could not do so, and the engine was finally stopped by Turner who threw off the belt, causing the piston to fall out and the damage, for the repair of which the claim was made, was thus sustained. The plaintiffs' contention was that the switch was faulty, and when put by Suckling, on going to his dinner, at the neutral position, fell to one which allowed the current, in the usual course under such circumstances, to flow back from the accumulator to the dynamo, which thereupon worked the engine, or in the words of his Honour, "the tail wagged the dog." They also contended that Suckling, upon leaving the engine room, should have lifted the brushes of the dynamo, which would have rendered the action impossible. For the defence it was contended that Turner must have handled the switch himself, but his Honour held this to be most unlikely, and found a verdict for the plaintiffs.

KIBBLE v. HARRISON PATENT KNITTING MACHINE COMPANY.

THIS case which came before Mr. Justice Bruce and a common jury at the Manchester Assizes last week, was a claim for breach of contract. Plaintiff was a comedian living in Manchester, and he complained that some electrical work undertaken by defendants for him was executed so badly that he was deprived of a pantomime engagement at the Shakespeare Theatre, Liverpool. The result of this was that he was out of an engagement during a winter season, and incurred heavy expenses in the reconstruction of the work done by defendants. The defence was that the company was not responsible for the way the fittings were made, and that defendants made them perfectly right for the required work. Plaintiff gave defendants an order for the illuminating and wiring of certain dresses, and also for the five batteries required to work them. An engagement was procured with the above theatre subject to the trials of the show being satisfactory. Defendants then informed plaintiff they would not be able to supply a portable battery, but that a stationary one would serve the purpose and the wires would be invisible. When the trials were made the so-called invisible wire, which counsel said was like a piece of clothes line, was used. The trial was a complete failure. The ladies had their wings on all right, and the plaintiff had his battery in the flies with the invisible wire to work it. The first thing they noticed when the thing commenced in the limelight was that the invisible wire stood out even more conspicuously than in the daylight. The next thing they noticed was that lamps on the demon's dress would not light, and plaintiff got his hand burnt. As regards the ladies' dresses some of the lights went out. Although they were angels their lamps were fixed with bitumen, which melted, and the lamps then fell off. As the result of the trial, the manager of the theatre at Liverpool told the plaintiff that "the thing was off," and the engagement was then cancelled. Mr. Harrison, manager of the defendants' electrical department, afterwards apologised to the plaintiff, and said his experiment had been tried and had failed.

Mr. JAMES HILL, a Manchester electrician, spoke of examining four pairs of wings and the demon dress in December last. The lamps in the wings were fastened with some stuff like bitumen, and upon these being lighted the heat generated would have a tendency to soften the bitumen and cause the lamps to fall off. He explained how the defects arose, and said the light was caused to flicker through an intermittent contact. He did not consider the fittings of the demon dress a workmanlike job. He considered it was possible to make a proper installation, and to construct a portable battery for the demon dress without a prior experiment.

Mr. SUTTON, on behalf of the defendants, submitted that the fault did not arise from the work they did. So far as the wings were concerned, the defect was on before it ever came into their hands. As to the demon dress, the defendants simply undertook to supply the things that it required when it was brought to them, but they did not undertake to overhaul it, and be responsible for it.

Mr. H. W. L. HARRISON swore that the plaintiff and he had been in partnership in Peter Street, Manchester, as electricians for stage purposes. Plaintiff worked on the electrical part of the demon dress, and subsequently, when they dissolved partnership, he brought it to him and asked him to put the lamps on it. Plaintiff frequently came to him and went into the workshop and examined the dress while the work upon it was in progress, and expressed his satisfaction with it when it was completed. All the lamps were lighted in Manchester before it left the defendants' hands, but at the trial at Liverpool they would not light. Any displacement of the wires would prevent the lighting.

After further hearing the jury returned a verdict for the plaintiff for £50, and judgment was entered accordingly with costs on the County Court scale.

BUSINESS NOTICES, &c.

Auction Sale.—Messrs. Percy Huddleston & Co. are to sell by auction the contents of the Copper Depositing Works, West Ferry Road, Millwall, E. This is in connection with the General Electric Power and Traction Company (in liquidation) v. Lewis. See our "Official Notices" this week for particulars.

Bankruptcy Proceedings.—An application was made on Wednesday to Mr. Registrar Brougham at the London Bankruptcy Court for an order of discharge on behalf of John Dewhurst, electrician, &c., 52, North End Road, West Kensington. The bankrupt failed last February with provable debts £590, and assets that will realise in all about £200. He attributed his failure to the excessive amount paid to a late partner, to a loss of £130 through embezzlement by a traveller, and to depreciation in the value of the stock-in-trade as estimated for a forced realisation. The Official Receiver reported the following offences, viz., insufficiency of assets to pay 10s. in the £ to the unsecured creditors, imperfect books, and misconduct in not having at once disclosed to the Official Receiver and Trustee the whole of his (bankrupt's) realisable assets. After hearing Mr. White in support of the application, the learned Registrar imposed a suspension of three years.

Electrical Wares Exported.

Week Ending May 3rd, 1897.

	£	s.
Albany	112	0
Amsterdam	85	0
Antwerp	68	0
Auckland	47	0
Bombay...	509	0
Buenos Ayres	150	0
Calcutta...	236	0
„ Teleg. mat....	19	0
Cape Town	1,272	0
„ „ Teleg. mat.	2,263	0
Colombo	24	0
Durban	590	0
East London	59	0
Flushing	31	0
Fremantle	637	0
Hamburg. Teleg. mat.	50	0
Melbourne	22	0
„ Teleg. mat.	23	0
Nagasaki	91	0
Ostend	34	0
Passages	1,935	0
Perth	488	0
Port Elizabeth... ...	245	0
„ „ Teleg. mat.	389	0
St. Petersburg. Teleg. mat	543	0
Singapore	67	0
„ Teleph. mat.	7	0
Sydney	823	0
Teneriffe. Teleg. mat.	558	0
Townsville	25	0
Wellington	370	0
Yokohama	222	0
Total ...	£11,872	0

Week Ending May 3rd, 1898.

	£	s.
Amsterdam	25	0
Auckland	43	0
Barcelona	298	0
Bordeaux	18	0
Boulogne	169	0
Calcutta...	42	0
Cape Town	1,673	0
Durban	466	0
„ Teleg. mat. ...	672	0
East London	31	0
Flushing	19	0
Fremantle	200	0
Lisbon	402	0
Mauritius	73	0
Melbourne	35	0
Monte Video	50	0
Penang	24	0
Port Elizabeth... ...	410	0
Stockholm. Teleg. mat.	435	0
Sydney	148	0
Yokohama	1,398	0
„ Teleg mat.	3,000	0
Total ...	£6,631	0

Foreign Goods Transhipped.

	£	s.
Brussels. Elec. motors	150	0
Total ...	£150	0

	£	s.
Barbadoes. Teleph. mat.	43	0
Barcelona	11	0
Total ...	£54	0

Birmingham Exhibition.—The Electrical and Trades Exhibition at Bingley Hall closed last Saturday night.

Books Received.—"Steam-Boiler Construction: a practical handbook for engineers, boiler-makers, and steam-users." By Walter S. Hutton. Third edition, carefully revised and enlarged, by the addition of 175 pages and 194 new illustrations. Price 18s. Crosby Lockwood and Son, Stationers' Hall Court, E.C.

"Submarine Telegraphs: their history, construction, and working." By Chas. Bright, F.R.S.E. Published by Messrs. Crosby Lockwood & Son, London. Price £3 3s.

Brown, Boveri & Co.—On April 1st Messrs. Conrad Baumann and Sidney W. Brown were made partners in this well known concern.

Catalogue.—The International Trading Company, of 35, Queen Victoria Street, E.C., who are sole agents in Great Britain and the Colonies for Herr G. Wehr, Sohn, Berlin, have issued a well illustrated catalogue of telephones, microphones, telegraph instruments, electric bells, batteries, and a variety of electrical accessories. The numerous articles are arranged in table form and numbered for easy reference, and the letterpress pages are followed by about 30 pages which are devoted exclusively to illustrations.

Commutator Bars.—Our readers will remember that about six or seven months ago a correspondence took place in our columns in which it was demonstrated that there was room for improvement in lists of stock sizes of commutator bars. We have now received a new list published by Messrs. Thomas Bolton & Sons, for whom it has been prepared by Mr. Theodore Stevens, E.M., A.I.E.E., which ought to prove of considerable utility to designers and makers of dynamos. The list contains over 70 pages of tables which are divided off into three sections: Table I. enabling the dimensions of the bar of any commutator to be easily calculated; Table II. giving a list of sizes arranged according to the number of sections in the commutator; and Table III. giving a list of Bolton's stock sizes arranged according to their dimensions. Messrs. Bolton will send a copy of this useful little book to any electrical engineer who applies at the offices at 90, Cannon Street, London.

Concert.—The Dover Electricity Supply Company held a staff smoking concert on Wednesday last week.

Country House Lighting.—The electric light has recently been installed in Mr. Wood's house at Gwernyfed Park, South Wales. About 180 lights have been fixed, the plant consisting of an oil engine and dynamo with a battery of D.P. accumulators, provision being made for water power or a second oil engine as an auxiliary. The work has been carried out by Messrs. Drake and Gorham.

Dissolution of Partnership.—Messrs. C. Geary and J. Hall, trading as electrical engineers at Swadlincote, under the style or firm of Hall, Geary & Co., and at 164, Corporation Street, Birmingham, as the Birmingham Electrical Accessories Company, have dissolved partnership by mutual consent. Debts will be attended to by Mr. John Hall, and the business carried on under the same name as heretofore.

Foreign Trade.—We have sometimes thought it would be interesting to know to what extent our foreign trade is affected by the official reports of our consuls abroad. The great value of periodical reports of the outlook, accompanied by business hints from official quarters, needs no emphasis in our columns, for we believe many manufacturing and merchant firms who trade with foreign parts, but who, for divers reasons, have not establishments in those countries, have found them of much assistance. During the past few years they have become an essential to the foreign trader, whether from choice or necessity, and with the increasing commercial rivalry between ourselves and other countries they promise to become even more important.

But we have no monopoly in a matter like this, and competitive countries have also their consular trade reports, and we have no doubt that in these any particularly good points noticeable in our business methods are emphasised for the benefit of our competitors, in the same way as we ourselves are kept informed of the efforts of German and other traders with a view to following their example so far as may be practicable.

Electrical manufacturers in this country undoubtedly have plenty to do at the present moment, but a good supply of home orders should not lessen the desire for export business. Everything that can be legitimately done to extend our foreign electrical trade should be taken advantage of.

As a rule we suppose the first thing to be done in the cultivation of a trade with any new district is to watch the opportunity and make a market where none existed before, and having done that, to see that the requirements of that market are catered for in the most thorough manner possible. Were this done, the likelihood of being outdone by foreign rivals would, we venture to believe, be smaller than at present, although the Englishman prides himself upon the fact that his markets are open to all comers, be they friends or foes. That we are not mindful enough of the markets where we should have supremacy is clear, from the remarks of several of our consuls, and we are occasionally thought to give far greater attention to the article ordered than to the man who has ordered it. From one standpoint this is a satisfactory charge, and its outcome is a better quality of goods supplied. The complaint is not that the quality ought not to receive so much attention, but that the customer and the probable customer should be more considered. For instance, it has been attributed to the Englishman that he declines to depart from certain lines and standards of manufacture which he has himself laid down. His manner says, "Take it or leave it; my goods are suitable for home consumption, and they should be good enough for you." But are they? Does it follow that because a thing is suitable for use in England, it can be just as easily applied in the service of the Heathen Chinee? He may be behind the times, but that is not the point, it is a matter of business; and when a man asks for a thing it is the manufacturer's work to supply that specific article if it is at all possible.

What is the result? The German or American trader comes along, and when questioned whether he can supply such and such a thing which his British competitor fails to do, sees a splendid opportunity for ousting his rival, and by hook or by crook he will take and execute the order. The customer does not fail to take a note of all this, and though in the long run he may prefer to deal with the Englishman for other reasons, he for the time being trades with our rivals, and a blow is struck at our supremacy. Mr. Cusack Smith, the British Consul at Samoa, in his report on the trade of the islands during last year, despises the system of circularising which is so largely adopted by our manufacturers, and belauds the personal representation which we have over and over again recommended in these columns. He considers a day's work done by a "civil, ingratiating, well-informed traveller" more than equal to five years' persistent circularising, and quotes a curious instance of German methods in those parts: A German commercial traveller recently visited Samoa with excellent samples at marvellously cheap prices, and obtained £2,000 worth of orders, mainly from British traders, but most or many of his goods were originally made in Manchester. These were ordered by German firms, and marked in Germany with German trade marks, and were sold by the German traveller with the remark: "The English manufacturers won't send out the goods, so we do it, and make the profit." Mr. Cusack Smith says that this only emphasises the folly of "not sending out British travellers," and he declares that British trade will suffer far more severely during the next five years from German competition than it has done already, unless British manufacturers attack the colonial and foreign markets in the energetic, well-organised, up-to-date, and conciliatory manner adopted by the Germans.

A financial contemporary the other day remarked, in connection with this matter, that it is not easy to understand why British manufacturers should be so slow to act upon the advice, in the main sound and practical, conveyed through the medium of our consular reports. German houses go in for a very high standard of education for young men who lay themselves out for commercial pursuits, and our consul at Stettin recently drew attention to the great service rendered in this direction by the Stettin Commercial Association, which was opened about 27 years ago. One of the objects of this association is to send young men out abroad to the British colonies, America, and elsewhere, to improve their knowledge of business, and to work in the interests of Stettin trade, a free grant of about £75 being made to each man for the purpose. At least 50 of these grants have been made, and the German consul of each country visited was informed of the arrival of the student. Here is a form of organised competition which might do untold harm to the business of this and other countries. It should be well digested by Englishmen. What can be the value of mere circularising in the face of such facts as these?

American houses by no means ignore British consular reports, and for that reason we can hardly afford to completely ignore theirs. The American Resident and Consul-General at Bangkok recently addressed some important remarks on the trade opportunities of Siam, a part of the world, by the way, which receives some attention at the hands of American electrical contractors. He draws attention to the splendid field offered for development, and advises special efforts to be made to increase the trade of the United States with this rich and prosperous kingdom of South-Eastern Asia. A critical period is approaching, and the results thereof will determine the control of Siamese foreign trade.

The report says that exporters of Europe have fully awakened to the importance and possibilities of Siam's markets, and adds:—

"After a residence of four years in Siam, I think that here is one of the best opportunities for the United States to build up a trade that is afforded anywhere in the world, considering, of course, the population and area. But all efforts to induce American exporters to enter these markets have been unsuccessful. Letters have come in unlimited numbers, to all of which careful attention has been given; catalogues have arrived and been distributed where they would do the most good; questions asked have been answered in detail; and many reports, general and specific, have been sent to Washington and duly published for the benefit of the exporters and manufacturers of the United States; but still there is a most discouraging lack of interest. This interest should be evidenced by sending to Bangkok experienced and capable representatives to carefully investigate the field, secure trial orders, and establish reliable agencies. In this connection, three facts are worthy of note: First, not more than six qualified representatives of American houses have visited Siam during the past three and a half years; second, almost without exception those that have come have been surprised at the extent and opportunities of the market, and have gone away with satisfactory orders, or, at least, with sufficient to pay expenses; third, in the same period no less than 100 capable representatives of European firms have visited Bangkok, and, in 90 per cent. of the cases, have done very well.

"Catalogues are valuable in their way—invaluable, in fact—but too much reliance is placed on them. They do not discuss the matter with the buyer; they do not answer all his inquiries; they do not obviate his objections to trying a new firm, a new class of goods, or to giving up his relations with some European house which has supplied him for years. If firms which are rich enough to publish the elaborate catalogues, which they issue annually, would devote even a small portion of that expense to sending energetic, educated, and tactful representatives to the far East, they would obtain far more substantial returns."

Some important facts are mentioned in the *Consular Journal*. It is to be hoped, says our contemporary, that our electrical engineers and our public works contractors are fully alive to the field for enterprise which China is now affording. It is, of course, too much to expect that China will now awaken completely from the comatose condition in which she has lain for centuries, but that she is exhibiting greater signs of vitality, owing to the action of the Powers, than she has ever done before is not to be denied. Her rulers are, it seems, learning to appreciate the truth of the scriptural injunction that it is no use kicking against the pricks, and European enterprise has pricked her coast-line sorely of late. The municipal authorities of towns like Shanghai, Pekin, Tientsin, &c., are therefore taking steps to establish electrical tramways, and tenders will presently be invited for undertaking these works. The Shanghai authorities, says a Consular correspondent writing to us, have already adopted the following resolution: "That the Council be, and is hereby, authorised to consider the expediency of establishing a system of electric tramways in the settlement." Our contemporary's correspondent urges electrical and other engineering firms to send out representatives or appoint agencies.

Langdon-Davies Motor.—The business of the Davies Motor Company, of 16, Red Lion Street, Clerkenwell, has been transferred to the Langdon-Davies Electric Motor Company, Limited. This company has taken premises at 101, Southwark Street, S.E., where there is every facility to enable them to cope with a fast increasing business. The entrance floor of the building affords room for spacious showroom and offices, and in the other parts of the building there is ample space for the manufacturing department. The workshops are equipped with machine tools and special labour-saving appliances of the most up-to-date character.

London School Board.—The Industrial Schools Committee has been authorised to obtain tenders for the supply of an auxiliary engine, dynamo, and switchboards, and connecting up circuits for direct lighting on the *Shaftesbury* training ship. The engineer's estimate is £950.

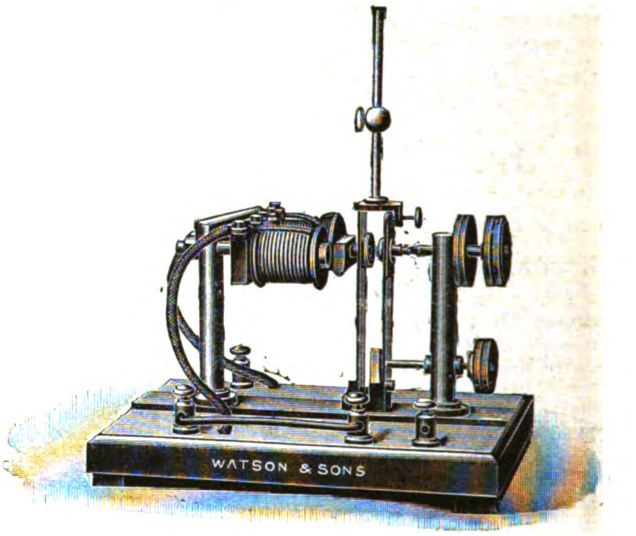
The Microphonograph.—From Mr. G. A. Nussbaum, of 29, Ludgate Hill, who represents La Société Industrielle des Téléphones in this country, we have received a pamphlet describing the new microphonograph which that company has recently brought out. The pamphlet contains an illustrated and general description of the Dussaud microphonograph (Berthon-Dussaud-Jaubert system) and its applications in the treatment of deaf mutes. Some of the illustrations show deaf mutes who are in the seventh heaven of delight upon discovering that by the aid of the microphonograph they are enabled to hear musical and other sounds.

Mill Lighting.—Messrs. W. H. Baughan & Co., of Charlbury, have secured the order for a complete installation comprising dynamo, shafting, accumulators, &c., of the new mills of Messrs. Early & Sons, blanket manufacturers, of Witney.

Personal.—Mr. John Shaw, electrical engineer, of Manchester and Ashton-on-Mersey, has just been elected chairman of the Ashton Urban District Council, and he will thus be entitled to sit on the Bench as a Justice of the Peace for the County of Chester. Mr. Shaw has been a member of the Council since its formation, and in that capacity was enabled to render excellent service when the mains for the electric light now supplied by the Altrincham Electric Supply, Limited, were laid down for the supply of the township. Mr. Shaw was also elected a member of the Sale and Ashton Technical Instruction and other Committees.

Smoke Nuisance.—At Greenwich Police Court on Thursday, the Crystal Palace District Electric Supply Company, Limited, and Mr. B. G. Blanchard, their secretary, were summoned in respect to a nuisance arising from black smoke issuing from a chimney at their works. The offence was admitted by Mr. Dumas who asked for the summons to stand over so that the company might provide other apparatus and get smokeless coal. Mr. E. Wright, clerk to the Lewisham Board of Works, said the Board would agree to this course, and the magistrate adjourned the case for a fortnight.

The "Vril" Contact Breaker.—The "Vril" Contact Breaker for induction coils is the invention of Mr. James King, A.I.E.E., and the sole right of manufacture has been acquired by Messrs. W. Watson & Sons, of High Holborn. The apparatus is claimed to afford many advantages to workers with Ruhmkorff coils. It can be supplied to almost every make of existing induction coil. It is claimed, among other things, that the construction is such, that it gives a prolonged period of contact, affording the necessary time for the thorough magnetic saturation of the core, combined with a very sudden break. The results obtained with the ordinary vibrating break are said to be yielded by the "Vril" with 50 per cent. less battery power, and with 25 per cent. less battery power than is requisite to run the ordinary vibrating break, 15 per cent. more spark length is



yielded by the coil if the "Vril" Contact Breaker be employed. The heating of the platinum contacts is greatly diminished, and does not become very appreciable with a long run of 30 minutes or more; liability to adhere is obviated, and the wear of platinum very much reduced. Workers with Rontgen's X rays will especially appreciate this feature. The speed of the make and break is controlled by means of an adjusting screw. The "Vril" affords facilities for varying the speed of the vibration exactly. It produces the same effect as a mercury interrupter, without any of its trouble and annoyance. The figure shows the breaker mounted on a separate case unattached to the coil.

ELECTRIC LIGHTING NOTES.

Aberdeen.—The Gas and Electric Lighting Committee reported to the Town Council on Tuesday, recommending that the electricity mains should be extended to the West End, and that the low tension direct system, with drop of 110 volts at full load, should be adopted, at an estimated expense of £5,750, as recommended by Prof. Kennedy. The Committee suggest that it be remitted to the engineers to prepare specifications and invite tenders for the work. The Committee did not see their way to recommend the Council to take any action in regard to dust destructors at present.

Barrow.—Mr. R. H. Burnett, the borough electrical engineer (late of St. Pancras), commenced his duties on Monday last.

Basingstoke.—The Electric Lighting Committee, after considering terms proposed by Messrs. Warburg, Dymond & Co., for putting down an electricity installation, has recommended the Town Council to apply for electric lighting powers themselves for carrying out the works. This course was approved by the Council.

Bedford.—The Bedford Town Council have decided to increase, by £1,400, the amount of the £4,000 loan they are about to apply for, the addition being made expressly in order that the electric light may be installed on the Market Hill.

Bermondsey.—At Monday's Vestry meeting the report was considered of the sub-committee, which appeared before the Board of Trade on April 27th, when the opposition of the London Electric Supply Corporation, and the County of London and Brush Provincial Electric Lighting Company, to the Vestry's application for an electric lighting provisional order, was heard by Sir Courtenay Boyle. The Committee reported that after the opposition had been heard, Sir C. Boyle asked whether the Vestry intended to carry out the order if granted, and on being assured by the chairman of the Electric Lighting Committee that such was the case, Sir C. Boyle said that the Vestry could have no objection to the deletion of the clause which empowered the Vestry, with the consent of the Board of Trade, to transfer its powers; and this was accordingly agreed upon. Sir C. Boyle advised the Vestry to again consider the financial aspect of the question, and stated that if within 14 days the Vestry decided to go on with the order, he would recommend that the same be granted. The sub-committee recommended that Sir C. Boyle should be informed that the Vestry, after again considering the financial question at his suggestion, respectfully asked that a provisional order should be granted to the Vestry. This recommendation was unanimously adopted.

Bromley.—The Bromley (Kent) Electric Light and Power Company, Limited, who have just acquired the powers formerly vested in the local authority, have, within the past week, made a practical start. A contract has been entered into for the erection of a central lighting station, and at the present time workmen are busily engaged in preparing the foundations. Many of the shareholders are tradespeople and private residents, who have given notice of their desire to be supplied with the light. The contract for the installation has been secured by Messrs. Edmundsons, of Westminster, and one of the first places to be lit is the new Bell Hotel, now approaching completion. The Bromley Company have also entered into a contract with the newly-formed Chislehurst Electric Lighting Syndicate to supply them with current. The secretary of the Bromley Company is Mr Martin J. Dickins, of the Market Square, Bromley, and, notwithstanding the difficulties experienced in acquiring possession of the order, the future of the company is generally regarded as most hopeful.

Canterbury.—Good progress is now being made with the work connected with the establishment of the electric light here. The whole of the contracts have been settled; the construction of the generating station is well in hand, and the laying of mains is to be commenced in a few days. At the meeting of the Town Council this week the Lighting Committee submitted a schedule of the proposed positions and number of incandescent lamps to be used in public lighting. There are to be 144 on posts and 29 on brackets, the latter of a design costing £3 1s. 10d. a piece. The Committee recommended that the main thoroughfare from St. George's Gate to Westgate be illuminated by means of arc lamps, 12 in all, at an additional cost of about £140. Six separation stations are also to be provided for lighting and extinguishing the arc lamps, at an outlay additional to the estimate of about £707 10s. The contract for wiring the new Reaney Institute for the electric light has been secured by Mr. E. J. Philpot. It is hoped to have the light in use by next winter.

Chorley (Lancs.)—The Corporation have obtained a provisional electric lighting order from the Board of Trade.

Colchester.—The electric light station is to be opened about the month of July.

Colombo.—The contract for the lighting of the public streets and roads of the Fort of Colombo has been given to Messrs. Boustead Bros.

Dewsbury.—The 69 applications for the position of electrician to the Dewsbury Corporation has been reduced from six to three by the Electricity Committee. The final selection will shortly be made. The salary is £250 a year.

Dublin.—The Dublin papers say that on Wednesday evening last week there was a failure in the electricity supply, a number of hotels being seriously inconvenienced. The *Daily Nation* says that "the failure was occasioned by the breakdown of three different engines." That paper also says that several of the hotels are about to take legal proceedings against the Corporation.

Dundee.—The Gas Committee has recommended that the estimate of a Dundee firm be accepted for erecting a new economiser house at the electricity works at £600.

Durham.—A local correspondent says that from Wednesday's Town Council proceedings it would appear that incandescent gas will be adopted for street lighting. The matter of electric lighting *v.* incandescent gas is in the hands of a committee.

Eastbourne.—On Monday the Eastbourne Town Council decided to consult Mr. Wright, the engineer to the Brighton Corporation, anent the public electric lighting works being combined with the destructor. Mr. Wright will be consulted either alone or in conjunction with another expert, who had been approached by the Committee.

Edinburgh.—The Electric Light Committee's provisional estimates for the year ending May 15th, 1899, shows:—Estimated expenditure for 1898-99, £49,250, and the revenue £51,250, leaving a surplus of £2,000 to be transferred to the credit of the rates, after providing £6,000 for reserve fund. Last year the estimate was £33,390, and the revenue £35,455, leaving £2,065 to be credited to the rates, and after providing for £4,000 to be contributed to the reserve fund.

Glasgow.—The Electricity Works Sub-committee recommends the Corporation to adopt proposals which have been brought forward by Mr. Chamen, the borough electrical engineer. The statement, which comes before the Electricity Committee shortly, says that the Waterloo Street station, with its capacity of 3,300 horse-power, was completely overloaded during the fog last winter, and as the increase in the number of lamps fixed had been, on an average of five years, about 30 per cent., this meant, with the erection of over 100 lamps on the Springburn electric tramway route, a necessity for at least 100 horse-power additional. Waterloo Street station being taxed to its utmost capacity, a new site had been purchased at Port Dundas, where work had already been begun, and arrangements had been made for the purchase of another site for a generation station on the south side of the river, near Eglinton Street station. At Port Dundas there would be no difficulty in installing some 30,000 horse-power, and at the southern station another 15,000. The question of distribution had also to be considered. Waterloo Street station was at present distributing current at a pressure of 100 and 200 volts, but the Board of Trade regulations now permitted current to be supplied at 250 and 500 volts, which enabled the current to be carried much farther, and saved very largely in the amount of copper required in the distributing mains and feeders, the saving being about 50 per cent. The new plant already ordered for Port Dundas was designed to supply current at the increased pressure, and the plant for the southern station could be similarly designed. There would be no difficulty in supplying feeding points about two miles distant from each of the new generating stations, and in further supplying an area of about half a mile radius from such distant feeding points. This area practically included the whole municipality, so that there would be no necessity for resorting to high tension current. The use of the increased voltage rendered it impossible to work the new stations in connection with the same mains which at present distributed the energy from Waterloo Street, and so it would be desirable in time to relieve that station of its entire load. The capital expenditure detailed in the report is £551,000, made up as follows: Capital expenditure at present, £150,000; capital expenditure proposed in report, £396,000; cost of removal of Waterloo Street plant, £5,000. The surest way to arrive at a low rate of charge for the supply of electric light, concludes Mr. Chamen, is to make the concern as large as possible, so that the sooner the capital expenditure contemplated in the report is reached the better. He therefore recommends (1) That in addition to the £95,000 to which the Corporation already stand committed, a further expenditure of £61,000 be authorised for the Port Dundas station and mains, and (2) that an expenditure of £108,000 be authorised for the South Side station and mains. The expenditure would be spread over a period of about two years.

Glossop.—A special meeting of the Town Council discussed the electric lighting question last week. A sub-committee of investigation was appointed, with power to engage a consulting engineer. The meeting was adjourned to June 5th, when the question of applying for the provisional order will be dealt with.

Heaton Norris.—The District Council has resolved to apply for a provisional order.

Hereford.—The Electric Light Committee has been empowered to take the necessary steps for providing the electric light for the town. Expert advice will be obtained, and inquiries made *re* site, and on the subject generally.

High Wycombe.—Last Saturday the foundation stone of the electric lighting station buildings was laid by Councillor Wood (chairman of the Electric Lighting Committee of Wycombe Corporation). The company which has been formed to carry out the work is entitled the High Wycombe Electric Light and Power Company, Limited, Mr. Alfred Slatter being the managing director. A site for the electric light station was found in a meadow adjoining Lily's Walk. The buildings have been designed by Messrs. Moxham and Son, of Wycombe, and include a boiler house, engine house, accumulator house, and various offices. The contract for their erection has been entrusted to Mr. Henry Flint, whose tender amounted to £2,383. The contract for the electrical plant has been placed in the hands of Edmundsons Electricity Corporation, Limited, under the supervision of Mr. J. C. Wigham, and of the resident engineer, Mr. Fippard. It is hoped that supply will be ready by July 1st.

Hornsey.—The provisional order has been granted by the Board of Trade with slight alterations.

Hull.—The Electric Light Committee, on 28th ult., decided to recommend the Council to extend the electric light installation of the city into East Hull, at an estimated cost of £25,000. When the extension is made, the circuit of the city will have been completed.

Ilford.—Mr. Hawtayne is to survey certain lands in the district with a view to selecting a site for electricity works.

Islington.—As we have seen several mis-statements regarding the success of the Islington electric lighting undertaking, the following notes will be interesting as being the facts of the case. The Vestry has spent £144,226 capital up to December 31st last, and is now spending a good deal more. The *net loss* last year was £318. The *gross profit* was £4,432, and these figures are good for a business in its second year. The total cost per unit is 3 57d., and to this has to be added interest, &c., amounting roughly to 6 per cent. on the capital invested. As a matter of fact, long before the supply commenced the price of current was fixed, and for public lighting it is 5d. per unit. This covers all charges for current, interest on capital of lamps, &c., repairs to lamps, &c., trimming, erection, management, &c. The 1½d. per unit over works' costs does not quite pay all these charges, so that the supply is quite reasonable at 5d. per unit, and Mr. Hulland, the chairman of the Hackney Electric Lighting Committee, is quite wrong in assuming that the books are balanced by a "cooking" process. Every arc lamp at Islington costs £30—£40 total including *all* costs, as explained above. The Works Committee pay 5d. per unit, and that is all; the Electric Lighting Committee find all plant, labour, lamps, &c, and do all the work, light the streets, &c., and get the sum mentioned as return for *all* and every expense incurred in so doing.

For the quarter ending March 31st, the receipts for the supply of electric light in Islington amounted to over £6,000. The estimated cost of production was £2,700, leaving a gross profit of £3,300. After deducting repayment for loans, there is a net profit of £1,750.

Keighley.—The Corporation is about to approach the electric light question in earnest. A visit was paid to Southport last week, and a provisional order is being applied for.

Lancaster.—The Town Council resolved on April 27th, upon the recommendation of the Electricity Sub-Committee, that the tender of Messrs. Willans & Robinson, Limited, for the supply and erection of a close-type high-speed engine for the electricity works (£1,347) be accepted. The Committee were authorised to accept tenders for a dynamo. Applications for the supply of electricity to Ripley Hospital, the Royal Grammar School, and Bowerham Board School, were granted, subject to guarantees being made that the income from each building would be equal to 15 per cent. on the outlay. With the exception of a few churches, all the principal buildings in Lancaster are now lighted by electricity.

Liverpool.—The Lighting Committee last week agreed upon extensions of mains in various streets at a cost of £800.

Ludworth.—The Parish Council has appointed a sub-committee to inquire fully into the subject of electric lighting.

Mexborough.—The ratepayers will oppose the scheme of the General Power Distributing Company, as in a year or two the district may put down its own plant.

Mitchelstown.—Major Cardew held a Board of Trade inquiry last week regarding the application of the Guardians for a provisional order to light the town with electricity. Mr. Richard O'Driscoll, engineer to the scheme for the Board of Guardians, gave evidence as to the manner in which it was proposed to light the town. The stream from which they proposed to derive the motive power had a horse-power of 17½ on an average. The stream varied very little, though it was occasionally flooded in winter. The average fall in the level would be 3 or 4 feet at the very outside. Major Cardew, quoting from an estimate made by Mr. Harris, of Bray, said he noticed the amount estimated for cost was £825. He afterwards visited the stream, and pointed out that considerable expenditure would be necessary in the making of embankments, and expressed an opinion that a cheaper scheme of public lighting than that now proposed could be adopted with advantage to all parties.

Morley (Yorks).—At Tuesday's meeting of the Corporation Mr. Robert Hammond submitted his report on the progress of the electricity works, which has now been in successful operation for some time. The motor alternator has been returned to Wolverhampton for alteration to the bearings. Mr. Hammond was hoping to be in a position to report that the final tests of the plant had been completed this week, but the contractors have asked to be allowed a few more days' delay. The apparatus for measuring the water is ready, and there is now nothing to prevent the tests taking place at an early date. In accordance with instructions, Mr. Hammond submitted a statement made up to March 31st, showing the commitments on capital account sanctioned by the Local Government Board, £22,500; commitment to date, £20,764; balance of the original scheme still available for mains, extensions, connecting up customers, &c, £1,735 10s. 2d. In November last year, in accordance with the request of the committee, he presented a report on the electric lighting of all the streets through which the mains are laid, and then pointed out that immediate decision on the matter was not necessary, as cable ducts were to a large extent available for accommodating the necessary mains without re-opening the streets. The committee ultimately resolved to order cable for connecting the present arc lamps direct to the sub-stations, instead of the general distributing mains, but to defer consideration of the remainder of the scheme until the works were completed and in operation. Mr. Hammond again brings forward a scheme for the general lighting of the streets where mains are laid. In his previous report he deprecated a mixed scheme of arc and incandescent lighting, and set forth the cost of either type of lighting by itself, for each section under consideration. An extension of the arc lighting might be desirable in South Queen Street and Chapel Hill, but the remaining sections could be best dealt with by means of incandescent lamps enclosed in glass lens refractors, as at Brighton, Ayr and elsewhere. Mr. Hammond recommended that a trial lamp or two on this system should be fixed in some favourable spot for actual experiment. Mr. Hammond then concludes his report by giving his scheme for lighting, which will cost, with special mains, £650, and without special mains, £575.

Portsmouth.—It is proposed to purchase certain property in St. Mary's Street, Portsmouth, adjoining the electric light station, the space being required for extra machinery.

Preston.—The National Electric Supply Company has reduced its charges for lighting current. The company has adopted 220-volt distribution. After July 1st the price will be reduced from 7d. to 4d. per unit after one hour's use, less 15 per cent. cash. Current for heating and motive power purposes will be 3½d. per unit net.

Provisional Orders.—The Electric Lighting (Provisional Orders No. 1) Bill relating to Airdrie, Brechin, Hamilton, and Rothesay was read a second time in the House of Commons last week.

Ryde.—The Board of Trade have decided in favour of the Corporation *re* the Electric Light and Power Company, and consequently the latter will not proceed with their application for powers to supply electricity to the island borough.

Sheffield.—Judging from the correspondence and comments in the local press, and also the discussion in the Council Chamber, it appears to be true that the public meeting at which the proposed purchase of the electricity undertaking was disapproved, was really "packed" by ironmongers and other tradespeople who might be justly termed interested parties. It seems, therefore, that the poll which is to be held is quite unnecessary, yet it must now be held at a cost of about £1,000. Mr. T. Scott Anderson (of the local electrical firm Scott Anderson & Beit) writes to the local press to say that his firm had nothing to do with the opposition. He says, however, that he, as president of the Contractors' Association, wrote to the Town Clerk asking for particulars as to the Corporation's proposals regarding the clause which gave it the right to manufacture and trade, but to the question whether the Corporation would not compete with ordinary contractors no answer was forthcoming. He questions whether six of the votes at the public meeting could be said to be electrical. He considers the Corporation itself is only to blame, as it has known of the opposition for some time past.

Shoreditch.—At the fortnightly Vestry meeting on Tuesday, Mr. H. Winkler again raised the question as to when the electric lighting accounts, which had been promised, would be placed before the Vestry. In his opinion it was desirable that the accounts should be forwarded generally to the members of the Vestry without going specially before the Lighting Committee. In answer, the accountant stated that the accounts were in the possession of the printers, and that he hoped to have corrected copies ready for presentation to the Lighting Committee on the following day, so as to be brought up at the next Vestry meeting. On behalf of the Electric Lighting Committee, Mr. H. E. Kershaw said they had no feeling in the matter. If the Vestry desired to have the accounts before going before the Committee it could have them; but as it was purely a Committee matter, he thought the figures should go before the Committee in the first instance. The discussion on the subject then terminated. The Lighting Committee announced that they had considered a report from the chief engineer to the effect that he had received three proposals from three insurance companies as to insuring the engines. It was resolved to insure the six engines with the National Boiler Insurance Company for £200 on each engine, at a total premium of £49 13s. The same Committee had had under consideration a report from the chief engineer (Mr. Russell) as to whether it was right to charge the capital cost of the arc lamps and posts to the electric lighting capital account, or whether same should be paid for out of the general rate, as in the case of gas lamps, as some of the work in connection with painting same had been charged to the general rates. The Committee recommended and the Vestry decided that the cost of the arc lamps, columns, &c., should be paid for out of the general rate.

Shoreham.—The Local Government Board is prepared to sanction the £6,000 loan for electric lighting if the District Council obtains the necessary powers, submits plans, and complies with the usual conditions as to information. The Council, on receipt of this intimation on Tuesday, decided to leave the matter in abeyance for the present.

Singapore.—A draft scheme has been submitted to the municipality by Messrs. Moine & Co. for electric tramways and the electric lighting of Singapore. The proposal, says *Indian Engineering*, will be taken into consideration in due course, and if vested interests do not intervene, the Settlement will make a necessary advance in its development.

Southampton.—Last week the Council adopted a report of Mr. Manville's, submitted by the Electric Lighting Committee, in which he recommended public lighting by 62 2,000-C.P. arc lamps for various streets. The standards will also be provided with brackets for two 32-C P. incandescents for lighting when the arcs are extinguished at midnight. Thirty-two of these lamps will be used in the streets in which both electric lighting and tramways will be combined, and some of the standards will be arranged for both purposes and some for lighting only. Tenders are to be invited for the supply of the steel and iron columns recommended. It is expected that the streets will be electrically lighted by September.

Southport.—The report of the Gas Committee shows that electricity is rapidly superseding gas in that town as an indoor illuminant. The profits on gas for the year have only amounted to £7,000, or £4,000 less than was estimated.

Stafford.—The annual report of the Corporation Electricity Department shows that the consumption of electricity for the 12 months ended March 31st amounted to 52,231 Board of Trade units, as compared with 39,606 units last year, being an increase of 12,625, or nearly 32 per cent. The manager has submitted a short report upon the advisability of doubling the present pressure of the electric supply, and he was authorised to confer with Dr. Hopkinson, and report fully upon the question at the next committee meeting.

St. Helen's.—The Electricity Committee recommends the erection of arc lamps in a number of streets.

St. Pancras.—A very satisfactory statement was placed before the Vestry at the meeting held on Wednesday last week by the Electricity and Public Lighting Committee, in regard to the working results of the electric light works during the year ended December 31st, 1897. The Committee reported that the total revenue for the year amounted to £33,347 19s. 11d., which is an increase over the year 1896 of £6,258 3s. 6d., equivalent to more than 22 per cent. The net profit amounted to £6,517 19s. 9d., which, after writing off the deficit of £800 12s. 7d. brought forward from 1896, left a net profit for the year 1897 of £5,717 7s. 2d. The Committee recommended the Vestry to forward copies of the accounts to the Board of Trade and the Local Government Board, and that from the profits a sum of £4,000 should be transferred to a reserve fund, and that the balance of £1,717 should be carried forward to the accounts for 1898. In moving the adoption of the report, Mr. H. J. Menzies (chairman of the Committee) complimented the Vestry on the very satisfactory results, as exemplified by the accounts, which showed that the early anticipations in regard to the electricity undertaking were, in the main, being fulfilled. If the enterprise had been of a private nature, the past year's results would have yielded a dividend of 6 per cent, and allowed of £3,000 being carried to the next account. The works had sold a larger quantity of current, which had been generated at a lower cost than in previous years. In three years the revenue from private lighting had been doubled, and the undertaking was still growing. The speaker thought it right that the labours of the staff should be recognised. If the stokers had not quite fully earned the bonus promised to them he hoped the Committee would take their case into consideration and make some recommendation. The Vestry should also recognise the work of Mr. Sidney Baynes (the chief electrical engineer), and that of Mr. A. E. Pycraft (chief clerk of the electricity and public lighting department). The Committee, the speaker concluded, could at last see clear water, and he hoped that the confidence placed in them would not be unappreciated.

Tipton.—The District Council has decided not to withdraw its objections to the scheme of the Midland Electric Corporation for Power Distribution. The Council could not agree to the rates proposed to be charged to them by the company.

Wells.—The provisional order of the Wells (Somerset) Town Council expires in July next, and the Council at their meeting on Monday decided to apply for an extension of time. The Gas Company have fitted incandescent lights throughout the town, but during a gale lately they suffered severely.

West Ham.—The Council has issued a notice to the effect that it will commence to supply electric current in various thoroughfares on September 29th.

West Hartlepool.—The Town Council on Tuesday instructed the borough surveyor to forthwith invite tenders for taking out the quantities for the electric lighting station, and ask for the shortest time in which they can be ready; and that upon acceptance of a tender by the committee, he at once advertise for tenders for the plant. The Local Government Board has sanctioned the application to borrow the money, and the Board of Trade has approved of the system. The Mayor remarked that negotiations were proceeding with the tramway company in regard to the light railway to Seaton Carew, and also in regard to the town supplying electricity to drive the trams. He thought the matter would be settled and an agreement signed before long.

Wormit.—A public meeting last week considered the question of introducing electric lighting into the village. A scheme was brought forward by a Mr. Cowley which would cost, for buildings, plant, &c., £3,000, and an annual expenditure of £335. It is interesting to note that a recent canvass of the district showed one ratepayer to be in favour of gas, 12 oil, and 77 electric light. The meeting adjourned for a week, and a committee is to be appointed.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Algeria.—The first line of electric tramway in Algiers was put in operation on 19th ult. The line, which is 10 kilometres long, extends from Bad-el-Oued to Mustapha.

Birkenhead.—The Special Committee appointed to inquire into the question of tramways in the borough issued a report for presentation to the Council on Wednesday. The Committee report that they have been unable to come to any arrangements with the Birkenhead Company as to the surrender of their lease, which expires at the end of 1900, and they had not thought it necessary to negotiate with the Wirral Company, whose lease expires in 1916. Applications had been received since the closing of the negotiations with Mr. Ross from several bodies desirous of running electric trams in the town, but all had been declined on account of the Council's decision in regard to Mr. Ross's proposal. The Committee have unanimously decided that a more extended system of lines should be laid down for electrical trams on the overhead system, and they consider that the Council should settle upon the routes as soon as possible, and they have drawn up a scheme to submit to the Council, so that work might be decided upon and begun as soon as necessary. In arriving at their recommendations as to routes the Committee have carefully taken into account the following general points:—(1) Suitability of the road, *i.e.*, as to probable traffic, interception of branch or side roads, gradients, widths, &c. (2) Possibility of profitable and useful future extension. (3) General requirements of a district. The routes proposed are the Borough Road line, the Dock line, the Higher Tranmere line, the Shrewsbury Road and Oxton line, the Park Road North line, and the Central Claughton line. The surveyor (Mr. Charles Brownridge) estimates that the expense of relaying existing lines, where utilised, and laying down new lines will be about £104,500, and the wires, poles, cars, and installation will be about £77,500.

Bradford.—Some quick work in cable laying was performed between 11 p.m. last Saturday and 6 p.m. on Sunday, in laying the feeders for the Great Horton section of the Corporation electric tramways. The cables were laid by the staff of the electricity department of the Corporation. Four large mains were put down with a sectional area of 1·6 square inch of copper, together with a telephone cable for the tram service, and a "pilot wire" for recording the pressure at different parts of the route. The greater portion of the work was finished for traffic on Sunday evening, a length of 330 yards being completed, equal to 1,980 yards of cable.

Bristol.—On Friday last week the Bristol Tramways (Electrical Power, &c.) Bill, and the Bristol Tramways (Extension) Bill were read a second time.

Bromley.—The Mason's Hill, Bromley, residents strongly oppose the scheme for a light electric railway to be made in four sections, running from Herne Hill to Farnborough, through Dulwich, Sydenham, Penge, Beckenham, Shortlands, and Bromley. The promoters of the railway are the London Southern Tramways Company, Limited.

Ceylon.—Work in connection with the overhead trolley tramways is being pushed forward. Last month the rails were being laid, the power station erected, and part of the plant was ready to put in position. The span-wire system is to be employed.

Chatham and Rochester, &c.—The Light Railway Commissioners finished their inquiry last Saturday in reference to applications that have been made to carry out an electric tramway system for the towns of Rochester, Chatham, Strood, and Gillingham. Unfortunately, the opposition has proved too strong, and it does not appear that for the present anything further will be done in this respect, and thus a great boon has been lost to the whole neighbourhood. For some time past considerable dissatisfaction has been expressed by many at the present omnibus system, which is very inadequate, and it was thought, very properly, that a tramway system throughout the whole district (which comprises a large area of many miles, as all the towns mentioned adjoin one another, and has a population of more than 100,000) would be very beneficial. There was a great deal of evidence given for the trams. Foremost among the opposing parties was Mr. Thomas Aveling (managing director to Messrs. Aveling & Porter, engineers and steam road-roller and traction engine manufacturers). Their works are situated on the Medway's banks, at Strood. The firm employs nearly 1,000 men, and traction engines were constantly going in and out of the works daily. He maintained that the trams were perfectly impracticable in the streets, and would stop their business. Their firm turned out 360 engines in a year. They did a lot of work for the Dockyard and the Royal Engineer Barracks at Chatham, and he considered their engine traffic could not be worked with the trams. Of course the proprietors of the local omnibuses put in a strong opposition. For the purposes of the scheme it had been put forward that the tram company, if formed, would be prepared to assist the authorities to purchase certain properties in order to widen and improve the streets at necessary places. Numbers of people very greatly regret that the proposition has failed, as the district is being continually extended, and the trams would have been a great convenience to all classes.

Cheltenham.—At the Town Council meeting on Monday it was resolved to inform Mr. Bickerdike, of Montreal, Canada, who has applied for a franchise to immediately construct and operate a line or system of lines for electric cars, forming a complete service for the town, that if he likes to make a proposition the Council will consider it.

Colombo.—Work in connection with the construction of tramlines in Colombo is being pushed forward rapidly under the direction of the resident and consulting engineers, Messrs. Beveridge and Etlinger, sen. The poles for the trolley lines are erected.

Dover.—The contractor for the electric tramways permanent way has asked the Dover Town Council to remit the fine of £254 imposed on account of his contract not being completed to time.

Flamborough and Bridlington.—The promoters of the proposed light railway to Flamborough from Bridlington intend applying to the Light Railway Commissioners for an amendment of the order granted in 1897, to enable the company to increase the capital authorised to be raised, and to extend the time for the completion of the construction of the railway and works.

Holland.—Negotiations are in progress with reference to the conversion of the horse tramways in the town of The Hague into an electric line.

Kidderminster-Stourport.—The electric tramline which will start from the railway station in Comberton Road, and passes into the Stourport Road, following the line of highway, and terminating at the Stourport Bridge, will probably be opened by Whitsuntide. The boilers and engines have been put down, and one of the dynamos has been fixed. The cars, nine in number, are all at the depôt. Each car is constructed to carry 40 passengers, and fitted for electric lighting. Some of the cars are specially adapted for summer traffic, having open sides. Matters are so forward that in the course of a few days it is intended to have a trial trip along the line. A Dudley paper gives some notes on the present position of tramway affairs locally. The Light Railway Commissioners have made an order empowering (if it be confirmed by the Board of Trade) the British Electric Traction Company to make two lines—one from the existing tramcar line at Holly Hall to Kingswinford and thence by Wordsley to the bottom of Brettell Lane; another from Queen's Cross by way of Old Hill to the Five Ways at Cradley Heath. On both these lines the order provides for electric traction on the overhead system. The order has to be confirmed by the Board of Trade. Dudley Town Council has intimated its intention of opposing the order, so far as it deals with the portion of the routes within Dudley borough. Of course, the British Electric Traction Company will be represented by counsel at the Board of Trade inquiry, and backed by the other local authorities concerned outside Dudley, namely, Brierley Hill, Stourbridge, Rowley, and Amblecote Urban Councils and Kingswinsford Rural District Council. The inquiry will probably be held in a few weeks' time.

Leeds.—An interesting epitome of the working expenses and receipts for one week in connection with the Leeds overhead electric tramway system has just been published. The total receipts amounted to £656 16s. 4d., the mileage covered being 14,777 miles, the receipts per mile thus working out at 10·66d. The working expenses, depreciation, interest and sinking fund charges usurped 8·60d., thus leaving a surplus of 2·06d. per mile, or a profit of £6,595 per annum. The capital outlay up to date amounts to £138,374. Mr. E. Basil Lupton, a local solicitor, points out in a letter to the *Leeds Press* that the system has so far cost double the original estimate, and that the system is working at a loss. The figures at first sight show a profit; but he claims that an insufficient amount is taken off for depreciation, which should be 15 per cent., and not 7½ per cent.

The Highways Committee has resolved to recommend that the Headingley, Chapeltown, Dewsbury Road and Hunslet sections be equipped with the overhead electric system.

Limerick.—The firm of Zeitz, of Hamburg, are stated to have written to the Corporation in quaint English offering to establish an electric tram system all over the city "without any cost, on getting a lease of the streets." This is cool! We guess many an English promoter would like to get tramway concessions on these terms.

Liverpool.—The Tramways Construction Committee decided on Monday by seven votes to three, to order for use on the experimental electric tramway between St. George's Church and the Dingle 14 German electric cars—seven of the Altona type and seven of the Ring-Bahn type—with trailers to each. The cars, with their trailers, will accommodate 50 persons each. The Committee resolved to leave Sir Arthur Forwood to order 14 other cars from America, provided the specification of the electrical work was altered so as to fulfil the requirements of Dr. Hopkinson, consulting electrical engineer to the Corporation. About four months must elapse before the cars are ready for use. The Committee are desirous of seeing both the German and American cars at work, with the object of adopting a car of their own pattern which they hope to have made in Liverpool.

The City Council on Wednesday refused to agree to the recommendation of the Generating Stations Committee (of which Sir Arthur Forwood is the chairman) to accept tenders for the supply of electrical generating engines of a certain type, whereupon Sir Arthur intimated that he had striven during the last two years to provide the city with a worthy tramway system, but his Committee had not received the support and sympathy of the Council. He, therefore, not only would resign from the Committee, but that would be the last occasion upon which he would be present in that chamber. This is not the first time Sir Arthur Forwood has resigned from the Tramway Committee!

Newark and Worksop.—An important scheme is on foot to construct an electric railway between Newark and Worksop, which will run through a part of the far-famed Dukeries, so popular as a holiday resort. The line in many places will be laid along the side of the highway, and in others across land to be acquired for the purpose. The total length of the railway will be 22 miles 7 furlongs, and the gauge 4 feet 8½ inches.

Newcastle.—At a meeting of the Special Tramways Committee on Monday a discussion took place as to the two experts to be called in to advise on the cable and electric systems respectively. The resolution passed by the Council stipulated that these should not be financially connected with any tramway company or system of trams. Mr. Laws, city engineer, presented a report suggesting the following gentlemen as experts:—Cables, Mr. Callomb, Edinburgh; electric, Dr. Hopkinson, Mr. James Swinburne, and Mr. Manville. After a lengthy debate the matter was adjourned for a fortnight to enable members of the Committee to make further inquiries.

Nottingham.—The proposals of the Corporation to equip the tramways on the electric trolley system were referred to in our April 8th and 15th issues. On Monday last the following resolution was passed unanimously, and the Bill will accordingly be presented to Parliament:—"That the report of the Tramways Committee now presented to the Council be received and adopted as and for the second reading. That the Town Clerk be and he is hereby authorised, under the direction of the Tramways Committee, to take the necessary steps to obtain all such Parliamentary powers and the consent of the Board of Trade, and any other authorities as may be necessary to enable the Council to carry out the works mentioned in the said report, and that the costs to be incurred in so doing be paid by the Finance Committee in such manner as they may deem most expedient."

Paisley.—Detailed notice of the application which is being made by the British Electric Traction Company, Limited, for the construction and working of electric light railways within the counties of Renfrew and Lanark, is published in the *Glasgow Herald* of 23rd ult.

Portsmouth.—Notice has been given of the intention of the Hampshire Light Railways (Electric) Company, Limited, to apply to the Light Railway Commissioners for an order authorising them to construct and work light railways between Portsmouth, Cosham, Purbrook, Waterlooville, and Horndean. One line from Cosham to Horndean is about 5 miles, 7 furlongs, 3 chains in length, and the other, from Waterlooville along the road leading to Bargreen, about 5 chains in length. The gauge proposed is 4 feet 8½ inches, and the motive power electricity. Powers are to be sought by the company to generate, use, convey, distribute, and sell electricity either for power, lighting, heating, or any other purpose. Mr. A. W. White, J.P., manager of the Portsmouth Street Tramways, has taken an active part in promoting the scheme which is regarded with marked favour by the residents along the line of route, and especially at Waterlooville, a popular resort of Portsmouth people during the summer.

Ripon.—The City Council on 28th ult., had the question of tramways before it. The committee, which has been going into the question of the provision of better railway and tramway facilities, has been considering several schemes for cheaper transport between the city and the railway station, and proposed to visit Blackpool and Lytham to inspect the gas and electric trams; but in this the committee was overruled, the idea being considered premature.

Shanghai.—The Shanghai Municipal Council is considering the expediency of the establishment of a system of electric tramways in the streets of the Settlement, and "in its discretion to formulate scheme for ratification by the ratepayers by which the system be carried into effect."

South Staffordshire.—For some years past the local authorities in South Staffordshire have been agitating for an improved method of traction on the lines belonging to the South Staffordshire Tramways Company which traverse all the principal towns lying between Birmingham and Wolverhampton. At length the Board of Trade intervened, and in consequence of representations by the various District and Borough Councils, the tramway company have been pressed to substitute an improved method of traction for the steam engines at present in use. An important conference, convened by the Board of Trade, was held on Tuesday at the Town Hall, West Bromwich, to consider the question. All the local authorities in the district through which the company's lines pass were represented. Col. Marindin, of the Board of Trade, presided. Mr. Schuster, chairman of the tramway company, explained that they were promoting a Bill in Parliament, the cost of which would be borne by the British Electric Traction Company, the object being the introduction of an improved system of traction along the whole of the South Staffordshire routes. Mr. H. Ward, on behalf of the Handsworth authorities, opposed the overhead electric system, and suggested that a cable system should be substituted for steam engines, because passengers from the various Staffordshire towns would be able to travel to Birmingham without changing cars. Mr. G. H. Dunn (Mayor of Dudley) explained that in four years the lease of the tramways within their borough would expire, and then it was the intention of the Dudley Town Council to municipalise the tramways. Councillor S. Pitt, Mayor of West Bromwich, said, whilst his Corporation did not object to a further extension of the time for the use of steam by the company, yet they wished the Board of Trade to impress upon the company the necessity of improving the method of traction as speedily as possible. He thought probably the suggestion made by the Mayor of Dudley would be accepted by the other authorities, and if thought desirable they would take over the tramways, and then they could introduce what system of traction they liked. They thought, if they consented to a lease of the existing lines to the British Electric Traction Company for 21 years, it would prove disadvantageous to the interests of the local authorities. Mr. Sellon, of the British Electric Traction Company, explained that it was proposed to lay down the overhead electric system. Some of the shareholders objected to this, and preferred the conduit system. Ultimately the conference was adjourned for a month, and in the meantime Mr. Sellon undertook to supply the various authorities with full particulars of the Bill which it is proposed to promote in Parliament. The Wednesbury Town Council favour the introduction of the overhead electric system, which has proved satisfactory in other parts of the Black Country.

St. Helen's.—On 27th ult., a Corporation Committee received the Board of Trade's sanction to the £25,000 loan for equipping the tramlines and putting down plant. The inquiry into the matter was held only eight days previously by Major Cardew. The loan is to be repaid in 20 years. The Board was rightly thanked for its prompt and courteous attention to the matter.

Stockport.—The Stockport Corporation, who expect to be able to publicly supply electric light and power in the autumn, have approached the Stockport and Hazel Grove Tramways Company with the object of purchasing the concern and running electric tramways. At present the company shows no disposition to sell on the terms proposed.

The Surrey and Middlesex Light Railways.—The proposal of the London United Tramways Company to apply to the Light Railway Commissioners in June for powers to construct a light railway, with electric traction as the motive power, through Richmond, Ham, and Kingston, to Hampton Court, is threatened with severe opposition. The route proposed will lie through the residential portion of Kew Gardens, Richmond, over Richmond Hill, through Petersham, past the historical Ham House and the Dysart estates, to Kingston-on-Thames, thence over Kingston Bridge to Hampton Court Palace. In Queen's Road, Richmond, where the best class of houses in the borough are situated, the residents in the proportion of about 100 to two, have declared strongly against the proposal, the Parliamentary Committee and the Amenities Committee of the Richmond Town Council have recommended unqualified opposition, and the house agents in the town and the locality unanimously agree that the line if it came would ruin the place as a residential suburb. Upon the other hand, the Mayor of Richmond, a gentleman of close knowledge of the wants of the borough, and a good judge of its future, cannot definitely make up his mind upon the details of the proposal, and such local leaders as Sir Roland Wilson and Admiral Alington have expressed opinions in favour. A petition in Richmond assenting to the scheme has received 1,500 signatures, Avon-on-Kingston has received 2,000, and at Ham, Petersham, and Hampton numerous signatories testify their approval. In Ham and Petersham the public feeling is all in favour, the need of better means of communication being recognised. The Hampton Wick District Council have met privately, and their decision is kept a close secret; but several members have stated their approval of the scheme. At Kingston, the Town Council have referred the question, with the discussion, to their General Purposes Committee, but there is in the borough a feeling of satisfaction at the proposal. Mr. E. J. Halsey, chairman of the Surrey County Council, in the course of an interview, stated that he considered a tramway a great convenience, and he should support it, provided it was not unduly dangerous or inconvenient. The Ratepayers' Association, on the other hand, have met, and expressed the view that the Corporation and the borough should maintain tramways if they were wanted. The second proposal of the company to carry their line to Uxbridge is meeting with approval along the suggested route.

Volk's Electric Railway.—At yesterday's (Thursday's) meeting of the Brighton Town Council, the borough engineer and surveyor's report to the Works' Committee on Volk's electric tramway was considered. It seems that it will be necessary to reconstruct a part of the line on piles to the south of the new widened Madeira Road, the cost of this to Mr. Volk being estimated at £1,500. The Committee considered this a favourable opportunity for reconsidering the existing arrangement between Mr. Volk and the Corporation, and recommended the grant to Mr. Volk, at a yearly rental of £120, of a lease of the arch he occupies for his machinery, dynamo, &c., and a license for his line for a period of 21 years, subject to conditions for the proper maintenance of the line and such repairs as may be needed; the line, rolling stock, and plant, to become the property of the Corporation at the end of the 21 years.

Wednesbury.—The Town Council on Monday had a discussion *re* tramways. The Mayor said there was no doubt the tramways in that district were a great boon, and he considered it to be the duty of the authorities to do all they possibly could to prevent the stopping of the tramcars, and to give their best encouragement for improvements to be carried out. The electric traction adopted between Wednesbury, Walsall, Bloxwich, and Darlaston was very satisfactory, and he hoped the Handsworth and West Bromwich authorities would support the scheme, and adopt the same system in their respective districts. The overhead electric traction had been proved to be satisfactory, and preferable to the cable system.—Alderman Wilson Lloyd concurred.—The Mayor said whilst they were all desirous of the use of steam on the tramways being abandoned, they were most anxious that tramway traffic should not be stopped.

TELEGRAPH AND TELEPHONE NOTES.

Durham Telephones.—The County Council is of opinion that there should be telephone competition, but does not bind itself to support the New Mutual Syndicate.

Indian Telegraphs.—Mr. C. H. Reynolds, C.I.E., Director-General of Telegraphs in India, recently left Calcutta on a tour of inspection in East Bengal and Assam, whence he proceeds, according to *Indian Engineering*, to Simla, after inspecting some of the newly-constructed lines in the Punjab. A more thorough inspection of these lines is to be made by Mr. A. B. Larkins, Director of Construction. A committee is to determine the value of old telegraph stores dismantled from the field lines on the frontier.

Pacific Cable.—The opening up of China, through recent International developments, has led to the mooting of another proposal for a Pacific cable. It is suggested that a cable may be carried from Vancouver Island to some port in the Sandwich Islands or to Fiji, bifurcating thence to New Zealand and Hong-Kong. There is no doubt, says the *Standard*, that strong efforts will, in the present circumstances, be made in influential commercial quarters to improve both the steamship and cable communications with China.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1898 ...	...
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Cayenne-Pinheiro ...	March 24th, 1898 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Cable beyond Gurupa ...	April 4th, 1898 ...	
Cyprus-Latakia	Feb. 10th, 1898 ...	...
Bolama-Bissao	April 12th, 1898 ...	...
Cape Town-Mossamedes ...	„ 14th, 1898 ...	...
Maranham-Para	„ 17th, 1898 ...	...
Benguela-Mossamedes ...	„ 20th, 1898 ...	...
Kotonon-San Thomé ...	„ 27th, 1898 ...	...
Hong Kong-Manilla... ...	May 3rd, 1898 ...	...
San Thomé-Loanda... ...	„ 4th, 1898 ...	...
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Cartagena-Barranquilla ...	July 4th, 1896 ...	...
Saigon-Bangkok	April 29th, 1898 ...	April 30th, 1898

Telegraphic Communication between Liverpool and the Continent.—Some correspondence has been passing between the Liverpool Chamber of Commerce and the General Post Office regarding telegraphic communication between Liverpool and the Continent. The following letter has been addressed by Mr. J. C. Lamb to the Chamber:—

"With reference to your letters of the 26th ult. and the 25th inst., and previous correspondence on the subject of telegraphic communication between Liverpool and the Continent, I beg leave to inform you that the proposal to use a new cable wire for the traffic between Liverpool and Hamburg was duly carried out, and this department has since been in communication with the German Administration in regard to the adoption of duplex-Hughes working between England and Germany. It has not been found practicable under existing circumstances to introduce duplex-Hughes working between Liverpool and Hamburg, but the experiments in this method of working on other circuits between England and Germany have proved so far successful as to afford ground for entertaining the hope that a similar result may ultimately be attained under the more difficult conditions applicable to the Liverpool-Hamburg circuit. I may add that the German Administration have intimated that they share the desire of this department to expedite the transmission of telegrams between Liverpool and Hamburg, and have expressed their readiness to substitute a copper for an iron wire on the inland section of the circuit in Germany if it is found that the working of the circuit would be improved thereby, and experiments will be made as to the effect of such an alteration as soon as certain new wires which are now under construction in Germany have been completed. With regard to the question of the transmission of telegrams from Liverpool to Bremen *viâ* Hamburg, instead of, as at present, *viâ* London, I have to state that the Liverpool-Hamburg circuit is at present fully occupied, and would be unable to carry additional traffic without delay. In any case the proposed alteration would not lead to any reduction in the number of transmissions, telegrams sent *viâ* London being only subject to two transmissions, viz., from Liverpool to London and from London to Bremen, while, if sent from Liverpool to Hamburg, they would have to be re-transmitted from the latter city to Bremen. Similar considerations apply to the suggested use of the route *viâ* Havre in preference to that *viâ* London for telegrams from Liverpool to Paris. It is feared that the suggestion that the former route should be tried experimentally for a certain time is not one to which it would be practicable to give effect. The question of the transmission of telegrams between Liverpool and France is, however, under consideration, and this department is in communication with the French Administration in the matter. I have to add that if certain experiments which will shortly be carried out yield satisfactory results, it is proposed to extend to provincial towns in England and France the telephonic service, which has hitherto been restricted to the two capitals, and in that case Liverpool would obtain the advantage of telephonic communication *viâ* London with Paris, and, where possible, with other French towns."

Telegraphists' Grievances.—A conference of M.P.s. and representatives of the Postal Telegraph Clerks' Association took place last week at the House of Commons. The matter will be brought up upon the discussion of the Postal Service estimates, and there will be supporters on both sides of the House.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belgium.—May 25th. The date for the receipt of tenders for the electric lighting plant at the railway station at Ghent (Gand-Sud) for the Belgian State Railway Authorities has been fixed for May 25th.

Belgium.—May 31st. The Municipal Authorities of Ixelles, a suburb of Brussels, are inviting tenders until May 31st for the exclusive concession for the supply of electrical energy for lighting and power purposes during a period of 26 years, that is, to September 1st, 1924. Tenders to be sent to the Secretariat de la Commune d'Ixelles, Brussels, from whence particulars may be obtained.

Blackburn.—May 17th. The Committee of St. George's Presbyterian Church invites tenders for the electric lighting of the Church. See our "Official Notices" this week for details.

Dublin.—May 23rd. The Corporation wants tenders for the supply of high tension feeders and low tension distributors laid and jointed complete on a solid system, not including road work, but including the connecting up of existing consumers to the new mains. Also for transformers (20 to 50 kw., about 700 kw. in all) with instruments and apparatus in sub-stations erected and fitted complete. Particulars at the office of the city engineer; or from Prof. Kennedy, 17, Victoria Street, S.W. See our "Official Notices" this week for particulars.

Edinburgh.—May 6th. The Corporation wants tenders for the wiring of the St. Leonard's police station. Particulars from the resident electrical engineer, 5, Dewar Place, and see our "Official Notices" last week.

France.—May 21st. Tenders are being invited by the French Post and Telegraph Authorities in Paris for the supply, in 10 lots, of 111 kilometres of paper-insulated electric cables. Particulars may be obtained from, and tenders to be sent to, Le Sous-Secretariat, d'Etat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris.

Great Eastern Railway.—May 12th. The directors invite tenders for the supply of stores and materials. For particulars see our "Official Notices" last week. Forms of application from the secretary's office, Liverpool Street Terminus, E.C.

London.—May 17th. The Bethnal Green Board of Guardians invites tenders for the supply of plant, and installing the electric light at the new infirmary, Palestine Place. Plans, &c., to be obtained from the architects, Giles, Gough & Trollope, 28, Craven Street, Charing Cross, W.C. See our "Official Notices" April 22nd for particulars.

Victoria.—June 24th. The Council of the city of Hawthorne (Colony of Victoria, Australia) is inviting tenders for the supply and erection of buildings, boilers, engines, dynamos, transformers, mains, meters, arc lamps, poles; also running the plant for three years. See our "Official Notices" March 11th.

West Ham.—May 10th. The Council wants tenders for certain electroliers, standards, &c., required for its public buildings. Mr. J. J. Steinitz, borough electrical engineer. See our "Official Notices" last week for particulars.

CLOSED.

Blackpool.—The Corporation has placed the order for 120 rectified current double carbon lamps, with special switches, &c., with the Gilbert Arc Lamp Company, Limited, of Chingford. This order has been given out after careful tests.

Coventry.—The following tenders were submitted for wiring the new police buildings for the electric light, in accordance with specification prepared by Mr. Ram:—Ellis & Ward, £230; Drake & Gorham, £316 10s.; Veritys, Limited, £197 10s; Dobson and Curtis Bros., Limited, £187 17s.; Coventry Gas Fitting, &c., Co, Limited, £170; W. Tasker & Sons, Limited, £161 13s. Messrs. Tasker's tender was accepted by the City Council on the Watch Committee's recommendation.

Derby.—Messrs. Read, Holliday & Co. have secured the contract for wiring the Fore Street Yard buildings at £197.

Hampstead.—The tenders accepted by the Hampstead Vestry for electric lighting extensions plant are given by a daily contemporary as follows:—Siemens Bros. & Co., Limited, two 350-kilowatt steam alternators, Willans-Siemens sets, £7,100; S. Z. de Ferranti, Limited, two "Ferranti" switchboard panels, £111; John Brown & Co., two induced draught boilers, £4,850; John Fraser and Son, feed water heater, steam and exhaust pipes, &c., £911; also two duplex compound steam feed pumps, £895; Siemens Bros. & Co., Limited, a 50 kilowatt exciter in place of existing 23-kilowatt alternator, £910; less allowance for existing alternator, to be removed by and belong to the contractors, £300 = £610.

Hull.—Messrs. A. Bannister & Co. have secured a contract from the Electric Lighting Committee for the supply of Hickleton coal at 12s. 2d. per ton. Messrs. King & Co. have received the order to wire the Sculcoates Lane station.

Liverpool.—The Generating Stations Committee accepted the tender of Messrs. Willans & Robinson, Limited, for the supply of two compound engines and dynamos, at the price of £6,530 each, and one triple expansion engine and dynamo, at the price of £5,939.

London.—The London County Council received the following tenders for the supply of nine parapet lamp columns and lanterns, and four standard columns and lanterns for the electric lighting of Waterloo Bridge:—McDowall, Steven & Co., £189 12s.; W. MacFarlane & Co., £192 15s.; Young & Co, £250. The tender of McDowall, Steven & Co. is recommended for acceptance.

Newington.—The contract for the erection of the electric light works in Penrose Street at £12,928 has been given out by the Vestry.

Wallasey.—Eleven tenders were submitted for the erection and completion of extension of engine and boiler house at the Council's electric supply station in Sea View Road, Liscard, and that of Messrs. Hughes & Stirling (£3,077) was accepted.

FORTHCOMING EVENTS.

1898.

Friday, May 6th, at 8 p.m.—The Institution of Junior Engineers at the Westminster Palace Hotel. Paper to be read and discussed:—"Evaporative Condensers and Independent Air-pumps for Same," by Mr. Harry Fraser (member).

Monday, May 9th, at 8 p.m.—Society of Arts. "Electric Traction." Cantor Lectures by Prof. Carus Wilson. Lecture II.:—Acceleration—Conditions under which a train is started—Method of drawing acceleration curves—Uniform and accepted acceleration—Example—The City and South London Railway—Control—Comparison of different methods—How to ensure a smooth start—The series-parallel controller—Example—The Buffalo and Niagara Falls Electric Railway—Effect of the slipping of the driving wheels.

The Northern Society of Electrical Engineers.—Palatine Hotel, Hunt's Bank, Manchester. Paper on "Electric Elevators," by Mr. W. C. C. Hawtayne.

Tuesday, May 10th, 7 p.m.—The Institution of Junior Engineers. Visit to Messrs. Brin's oxygen works, Horseferry Road, Westminster, to inspect in operation Dr. W. Hampson's self-intensive refrigerator of gases.

At 8 p.m.—General meeting of the Röntgen Society, at 11, Chandos Street, Cavendish Square, W. Prof. Silvanus P. Thompson, F.R.S., in the chair. Papers will be read on "Notes on the Description of a New Induction Coil in ELECTRICAL REVIEW, February 4th, 1898" (with demonstration), by Mr. A. Apps, M.I.E.E.; and "Some Notes on Contact Breakers," by Dr. J. Macintyre. Discussion to follow.

Thursday, May 12th.—Institution of Electrical Engineers. Meeting at the Society of Arts (subject to the discussion on Mr. Andrews's paper being concluded last night). Papers on "A Magnetic Balance for Workshop Test of Permeability," by Prof. J. A. Ewing, F.R.S., member; and "The Registration of Small Currents used for Electric Lighting and other Purposes," by A. H. Gibbings, member.

Friday, May 13th, at 5 p.m.—Physical Society. Paper on "Galvanometers," Part II. By Prof. W. E. Ayrton and Mr. T. Mather.

NOTES.

Water-Tube Boilers.—A series of interesting trials with the New Haythorn water-tube boiler was concluded on the Clyde last week. With a three months' certificate from the Board of Trade the Caledonian Steam Packet Company fitted the boilers on board their paddle steamer, *Meg Merrilies*. The engines were compounded by fixing a cylinder of 24 inches in place of one of 42 inches. The pressure of the two tubulous boilers is 200 lbs., reduced by reducing valves to 130 lbs. at the engines. Although, says the *Times*, there is always a possibility of defects developing in boilers of the type, the success of the trials so far is marked, a speed of 14 knots being obtained with half the consumption of coal necessary formerly to get a knot less.

Jubilee of the American Association for the Advancement of Science.—Writing in the *Scientific American*, Horace C. Hovey says:—

Fifty years ago the American Association for the Advancement of Science was organised for the purpose of promoting intercourse between scientific men throughout the Continent, encouraging systematic scientific research, and increasing the facilities for more thorough investigation, and enlarging the usefulness of scientific labours. These ends have been sought by periodical and migratory meetings, by publications, by wide correspondence, and perhaps, most happily of all means, by encouraging genial and familiar intercourse between scientists. The completion of the first half century of this noble work will be celebrated in an appropriate manner in the city of Boston, August 22nd—27th, 1898, and the preliminary announcements for the jubilee are already made. The meeting will be held in response to the invitation of the Governor of Massachusetts, the Mayor of Boston, and the numerous scientific and educational institutions that cluster about that centre of intellectual life and activity. This cordial invitation was accepted at the Detroit meeting of the Association. The Boston Local Committee, now organised, includes a most distinguished list of names, among which we note those of his Excellency Governor Wolcott, as the honorary president; 25 presidents of universities, colleges, and other institutions, together with others of distinction as honorary vice-presidents; 129 members at large; Dr. Thomas Dwight, Prof. Alpheus Hyatt, and Prof. E. C. Pickering as honorary secretaries, and Col. H. L. Higginson as honorary treasurer. The latter gentleman is also the chairman of a strong committee on finance. The chairman of the Reception Committee is Dr. J. R. Chadwick, that of the Committee on Invitations is Dr. Henry P. Bowditch, that of the Committee on Excursions is Gen. F. H. Appleton, and that of the Executive Committee is Prof. W. T. Sedgewick. The local secretary, to whom all correspondence should be addressed, is Prof. H. W. Tyler, of the Massachusetts Institute of Technology, Boston, Mass. The Boston scientific Jubilee promises to be one of the most important and interesting assemblies of the kind ever convened. Many foreign scientists of eminence will take part in the exercises, and make addresses. Foreign educational and scientific bodies will send delegates, thus giving the occasion an international character. A number of "affiliated societies," really the offspring of the A.A.A.S., will meet during the Association Week, including those for the study of geology, chemistry, botany, forestry, entomology, mathematics, engineering, &c. All general and sectional meetings will be held in the halls and rooms of the Institute of Technology and of the Boston Society of Natural History. One day will be spent as the guests of Harvard University, one day in the historic city of Salem, and excursions are planned for the White Mountains, Cape Cod, and other regions of interest. Members who have allowed their membership to lapse are requested to renew their connection with the Association. A thousand new members are called for, and every scientific man in America is appealed to in order to make this Fiftieth Anniversary of a great Association a marked event in the intellectual history of our continent. Anniversary cards will be sent, previous to the meeting, to all entitled to them, and a list of members in good standing will be printed for the opening day. Each of the nine sections will prepare a programme in advance, and notice of papers offered should be sent at an early date to the proper secretary. A special invitation is given to all surviving founders of the Association, that is, of those who shared in the meeting of 1848. The names and addresses of such should be sent at once to Prof. F. W. Putnam, Harvard University, Cambridge, Mass., so that they may enjoy the recognition to which they are entitled.

Cables in War Time.—There appear to be some people who have taken seriously a passing remark recently made by Prof. S. P. Thompson, hence the following letter in the *Pall Mall Gazette*:—

Sir,—In these stirring times of war, it has become more patent than ever how important it is for this country to be in uninterrupted telegraphic communication with its numerous colonies and dependencies. The mere possibility of the cables between Cuba and the outer world being cut naturally suggests what is in store for this country should it unfortunately be at war with a European power. I am surprised that a proposal made by Prof. Silvanus Thompson, in his recent lecture on "Telegraphy Across Space" at the Society of Arts, has not created the attention it deserves, coming, as it does, from so high an authority. The proposal was that if £10,000 were put at his disposal for the purpose, he would be able to erect the necessary apparatus for telegraphing without wires intervening between this country and any part of the globe. To be able to telegraph from London to Cape Town or to Calcutta, or to anywhere you like, without the possibility of the wires being cut, for the simple reason that under Prof. Thompson's plan there would be none to cut, is certainly "a consummation devoutly to be wished." I suggest that Prof. Thompson's plan be further examined, and if he can substantiate his claim—as from his great reputation there should be little doubt—the necessary funds should be put at his disposal by Government, in order to enable him to complete his experiments and to bring to perfection his plan of telegraphing across space.—Anglo-German.

Hedging.—We understand that Mr. Killingworth Hedges, C.E., has been elected a director of the Semzée Greyson Intensified Gas Light Syndicate, Limited.

Royal Institution.—The annual meeting of the members of the Royal Institution of Great Britain was held on Monday afternoon. Sixty-six new members were elected, and 63 lectures and 19 evening discourses were delivered in 1897. The following gentlemen were unanimously elected as officers for the ensuing year:—

President - The Duke of Northumberland, K.G.; Treasurer—Sir James Crichton-Browne; Secretary—Sir Frederick Bramwell, Bart.; Managers—Sir William Crookes, Sir Edward Frankland, The Right Hon. George Joachim Goschen, Donald William Charles Hood, Esq., David Edward Hughes, Esq., Alfred B. Kempe, Esq., Hugh Leonard, Esq., Sir William Huggins, Thomas John Maclagan, Esq., Ludwig Mond, Esq., Alexander Siemens, Esq., The Hon. Sir James Stirling, Sir Henry Thompson, Sir Richard Everard Webster, Sir William Henry White. Visitors—Sir Alexander Richardson Bennie, Sir James Blyth, Bart., Charles Vernon Boys, Esq., Edward Dent, Esq., James Edmunds, Esq., Maures Horner, Esq., Edward Kraftmeier, Esq., Sir Francis Laking, T. Lambert Mears, Esq., Lachlan Mackintosh Rate, Esq., John Callander Ross, Esq., William James Russell, Esq., Sir James Vaughan, James Wimshurst, Esq., Alfred Fernandes Yarrow, Esq.

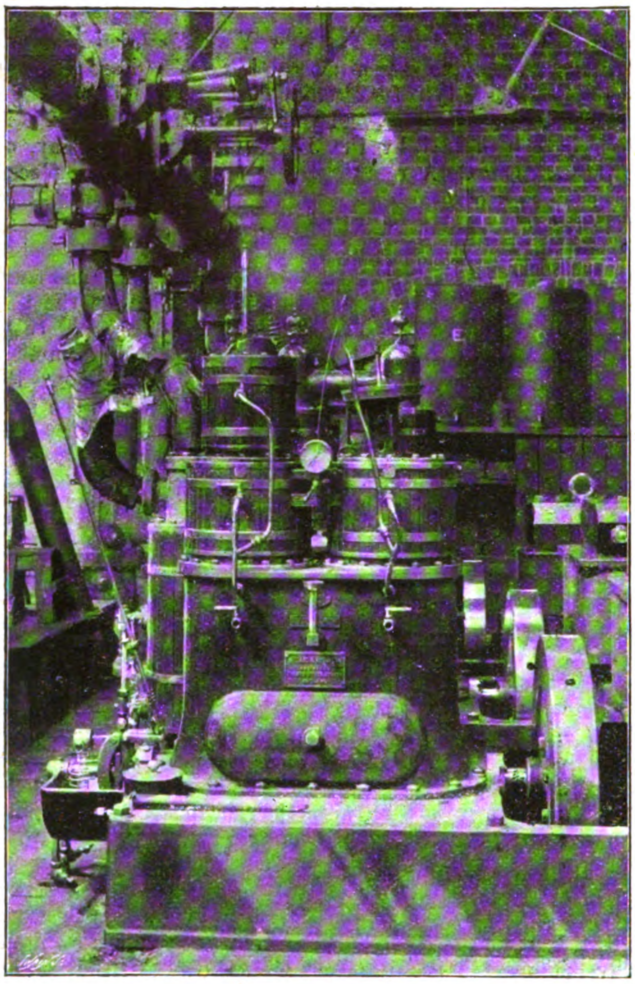
The Jandus Lamp.—The New York *Electrical Engineer* says that a very successful alternating enclosed arc lamp of the non-focusing type for circuits of from 7,000 to 16,000 alternations per minute, and voltages from 100 to 120, is being manufactured by the Jandus Electric Company, of Cleveland, Ohio. A resistance (or economy) coil is placed in the canopy of the lamp, easy of access and conveniently adjusted for the voltage of the arc. The efficiency is high, showing a loss of but 20 watts as the lamp is ordinarily adjusted, *i.e.*, 6 amperes on a 100 to 110-volt line. The lamp ordinarily consumes from 400 to 450 watts across the terminals, thus showing an average efficiency of 95 per cent. The carbons furnished with lamp consist of an equal number of $\frac{1}{2}$ inch core and $\frac{1}{16}$ inch core, each 8 inches long. By using the stub of the upper carbon for a lower in the succeeding run, but one fresh carbon per trim is necessary. One $\frac{1}{2}$ inch core and one solid carbon give good results. The life of one pair of carbons is about 80 hours.

The Welsbach New Gas Burner.—The Welsbach new gas burner has been introduced to the public with the usual blare of trumpets and the inevitable luncheon. At the refection which followed the demonstration at Niagara Hall on Monday, Sir J. Blundell Maple, M.P., gave the company a magnificent advertisement by announcing that his firm had abandoned electric lighting, and had substituted the Welsbach incandescent gas light, because it was cheaper, and produced greater warmth. We should have thought that even the shopkeeping aspect of the question would have had some regard for the truism that cheapness in first cost is not always compatible with economy. That the Welsbach gas light produces, at the expense of the atmosphere, greater warmth than an electric lamp no one will deny, and the Welsbach Company is welcome to the benefit of this argument. We are ourselves not above giving a gratuitous advertisement to the Welsbach Company, and it takes this form: When one is compelled, for one's sins or otherwise, to burn gas, then the Welsbach burner is probably the best in existence. Still, whatever improvements are made in this form of lamp, the great fact still remains that they burn the same old gas.

The Trolley in America.—From the *Electrical World* we learn that by a recent final decision given by the United States Circuit Court of Appeals in an action of the Thomson-Houston Electric Company *v.* the Union Railway Company, henceforth anyone can make or use the overhead trolley in America without paying royalties. The case referred to involved two claims of the Van Depoele Patent No. 450,443, over which there has been almost continuous litigation for several years. Although, according to our contemporary, the decision is merely on a motion for preliminary injunction to prevent the Union Railway Company from using the overhead trolley while the main case is awaiting decision, this opinion, being based on a point of law, applies to the main case, and renders the use of the trolley free from any fundamental patent claims, although there are, of course, plenty of details of construction still covered.

The War and the Malaga Electricity Works.—The chairman of the Malaga Electricity Company, Mr. R. C. Wyatt, of Moorgate Street, E.C., has been in communication with the Foreign Secretary, stating that this and another English company in Spain are in urgent need of coal, and if a supply cannot be obtained at once they must stop work, in which case the action of the idle Spanish workmen might be disastrous. The Foreign Secretary in his reply regrets that he cannot advise the companies in regard to their request for permission to charter two steamers from England to carry coal for the purpose of these works.

Mishap at Southampton Electricity Works.—On Thursday evening last week an accident occurred in the engine room at the Corporation Electricity Works at Southampton. The top of a G.G.S. Willans engine blew off, the cause being either water or something such as a broken ring or



pin getting into one of the steam ports. The damage is practically confined to the engine itself. The supply was maintained by the engines which were running in the new engine room. Very fortunately no one was injured. The photographic illustration will give some idea of the damage.

Appointments Vacant.—The Redditch District Council wants an engineer for the electricity works. See our "Official Notices" this week for particulars.

The Poplar Board of Works wants a resident electrical engineer to devise and carry out an electric lighting scheme. See our "Official Notices" to-day for particulars.

The Institution of Civil Engineers.—The Council have made the following awards for papers read and discussed before the Institution during the past session:—A Telford medal and premium to Mr. A. H. Preece, and a Telford premium to Mr. L. B. Atkinson. The presentation of these awards will take place at the inaugural meeting of next session.

The Telelectroscope.—Although we are not much impressed with the invention of the gentleman whose name wants ironing out, Herr Jan Szczepanik, we believe it is, there seems to be sufficient evidence that his suggested arrangement of oscillating mirrors has been anticipated by Messrs. Bastian & Parsons, who carried out experiments seven years ago. We have seen the correspondence and drawings referred to by these gentlemen in their letter, and, without going into the matter very closely, there seems to be *à priori* publication of Herr Szczepanik's idea of employing vibrating mirrors.

Holophane Globes.—The Committee on Science and the Arts of the Franklin Institute is reported to have recommended the award of the John Scott Legacy Medal and premium to Messrs. Blondel and Psaroudaki for their invention of holophane globes.

Falcon Works Engineering Society.—The annual dinner of the Falcon Works Engineering Society was held at Loughborough on Friday last. Mr. J. S. Raworth presided, and there were some 56 other guests present, including a large proportion of old members of the Society.

NEW COMPANIES REGISTERED.

Electric Laundry Company, Limited (57,077).—Registered April 22nd, with capital £10,000 in £1 shares, to carry on at Hampstead and elsewhere in the counties of London, Middlesex, Hertford, Surrey, Kent and Essex, the business of a laundry, as the same has been carried on by A. W. Armstrong, and to adopt a certain agreement. The subscribers (with one share each) are:—F. M. Marden, 3, Welbourne Road, Tottenham, clerk; F. Dawson, 41, Bookham Street, Hoxton, clerk; T. Dunsdon, 53, Shrubland Road, Walthamstow, clerk; W. T. Edmunds, 118, Beckenham Road, Beckenham, clerk; W. J. Hanbury, Iseldene, Beddington Corner, Mitcham, clerk; H. Elliott, 32, Chichester Road, Leytonstone, clerk; B. Templeman, 10, Haxlitt Road, Kensington, clerk. Table "A" mainly applies. Registered office, 16, Rosemont Road, Hampstead.

Electric Railway and Tramway Carriage Works, Limited (57,082).—Registered April 25th, with capital £150,000 in £5 shares, to acquire "The North of England Railway Carriage and Iron Works," West Strand Road, Preston, and to adopt a certain agreement and to carry on the business of tramway car builders, tramway, railway, omnibus and van proprietors, carriers, electricians, electrical and mechanical engineers, suppliers of electricity, machinists, &c. The subscribers (with one share each) are:—J. Kerr, 94, George Street, Edinburgh, contractor; G. Flett, 110, Cannon Street, E.C., contractor; B. Sykes, 33, Winckley Square, Preston, civil engineer; T. S. Turnbull, The Woodlands, St. Anne's-on-Sea, solicitor; A. H. Mayne, 13, Spring Gardens, Manchester, solicitor; F. Cox, Ruthven House, Marple, Cheshire, accountant; F. Crimes, 5, Merimer Street, Greenheys, Manchester, clerk. The number of directors is not to be less than four nor more than seven. The first are G. Flett, G. F. Fry, J. Kerr, R. H. Prestwick, and G. Richardson. Qualification, £500; remuneration, £600 per annum and a share in the profits divisible. Registered office, 13, Spring Gardens, Manchester.

British Continental Electricity Company, Limited (57,088).—Registered April 26th, with capital £20,000 in £10 shares (1,000 5½ per cent. cumulative preference), to carry on the business of electricians, mechanical, hydraulic, and general engineers, suppliers of electricity, electrical apparatus manufacturers, &c. The subscribers (with one share each) are:—W. A. Brodie, Villa Olivetti, Bordighera, electrical engineer; W. R. Cooper, 87, Upper Tulse Hill, S.W., electrical engineer; R. Alioth, 10, Albanalage, Basle, electrical engineer; C. J. Brodie, Fern Hill, Wootton, Isle of Wight, surgeon; F. C. Brodie, Sandown, Isle of Wight, physician; Mrs. S. C. Brodie, Sandown, Isle of Wight; S. Ward, 35, Gracechurch Street, E.C., solicitor. The number of directors is not to be less than two nor more than five; the subscribers are to appoint the first; qualification £1,000; remuneration not exceeding 20 guineas each per annum. Registered by Ward & Co., 85, Gracechurch Street, E.C.

Davey Paxman & Co., Limited (57,093).—Registered April 26th, with capital £250,000 in £10 shares, to adopt an agreement with J. N. and W. Paxman, for the acquisition of the business carried on as "Davey Paxman & Co.," at Colchester and elsewhere, and to carry on the business of mechanical electrical mining, water supply and general engineers, agricultural implement and tool makers, boiler makers, rolling stock and waggon builders, &c. The subscribers (with one share each) are:—J. N. Paxman, Colchester, engineer; W. Paxman, Colchester, engineer; A. P. Butcher, Colchester, manager; H. G. Plane, Colchester, manager; W. H. King, Colchester, secretary; J. J. Phillips, Colchester, foreman; T. W. Hall, Colchester, draughtsman. The number of directors is not to be less than two nor more than five; the first are J. N. Paxman (chairman), W. Paxman, and W. Marriage; qualification, £250; remuneration as the company may decide. Registered by Robinson and Stannard, 19, Eastcheap, E.C.

Macartney, McElroy & Co., Limited (57,101).—Registered April 26th, with capital £12,000 in £10 shares, to carry on the business of electrical engineers and contractors, consulting electrical engineers, and undertakers for the construction, supply and sale of electric plant, and to adopt an agreement with J. F. Macartney, J. A. McElroy, and B. W. Champion. The subscribers are:—J. F. Macartney, 41, Edgware Road, W., contractor, 90 shares; J. A. McElroy, 26, Cortland Street, New York, U.S.A., mechanical engineer, 90 shares; B. W. Champion, Queen's College, Cambridge, gentleman, 100 shares; H. J. Dawson, 15, Emmanuel Road, Cambridge, gentleman, one share; L. Cobbett, M.B., 2, Round Church Street, Cambridge, one share; W. R. Scott, 100, Great Western Road, Glasgow, engineer, one share; J. Speak, Kirton Grange, near Boston, England, gentleman, one share. The number of directors is not to be less than three nor more than seven; the first are the first three subscribers; qualification, £500. Registered by C. F. Martelli, 10, Staple Inn, E.C.

Electricity, Limited (57,121).—Registered April 27th, with capital £51,000 in £1 shares (1,000 founders'), to adopt an agreement with C. O'D. Barrow and C. H. Smith, and to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity, and electrical apparatus manufacturers. The subscribers are:—P. W. Davis, 61½, Fore Street, E.C., merchant, 250 shares; G. W. Grabham, M.D., Mathyns, Witham, Essex, 250 shares; C. G. Smith, 59, Hatton Garden, E.C., manager, one share; A. I. Grabham, 59, Farrington Road, S.E., engineer, one share; T. J. Stockall, 6, Clerkenwell Road, E.C., merchant, 250 shares; J. J. Stockall, 50, Ferme Park Road, N., merchant, 250 shares; H. Verden, 14, Great Winchester Street, E.C., solicitor, one share. The number of directors is not to be less than three nor more than seven. The first are the first five subscribers. Qualification, £250; remuneration, £200 each per annum (£300 for the chairman) and a percentage of the profits. Registered office, 6A, Austin Friars, E.C.

Frank Suter & Co., Limited (57,193).—Registered May 2nd, with capital £20,000 in £1 shares (4,000 5 per cent. cumulative preference), to adopt an agreement with F. W. Suter, H. E. H. Wyman, and T. White, and to carry on the business of electricians, electrical engineers, workers and dealers in electricity, motive power and light, founders, tool makers, boiler makers, millwrights, &c. The subscribers (with one share each) are:—F. W. Suter, 66, Berners Street, W., electrical engineer; H. E. H. Wyman, 66, Berners Street, W., electrical engineer; T. White, 66, Berners Street, W., electrical engineer; F. H. Jerson, 44, Downshire Hill, Hampstead, secretary; A. M. Bramall, 23, Leadenhall Street, E.C., solicitor; P. Holmes, Brookfield Cottage, Chigwell, Member Stock Exchange; G. S. Saunders, 23, Leadenhall Street, E.C., solicitor. The number of directors is not to be less than three nor more than five; the first are the first three subscribers; qualification £500. Registered by Bramall and Co., 23, Leadenhall Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Notting Hill Electric Lighting Company, Limited (25,921).—This company's return was filed on April 5th, when the whole capital of £100,000 in £10 shares (6,452 ordinary, 550 founders', and 2,998 ordinary preference) was taken up. The full amount has been called, and £100,000 has been paid.

Kensington and Knightsbridge Electric Lighting Company, Limited (26,193).—This company's return was filed on March 24th. The capital is £350,000 in £5 shares (50,000 ordinary, 10,000 first preference and 10,000 second preference); 15,000 ordinary, all the first preference, and 5,500 second preference have been taken up, and 5,000 ordinary are considered as paid; £5 per share has been called on the others, and £127,500 has been paid.

Rugby School Electric Lighting Company, Limited (39,309).—This company's annual return was filed on April 18th, when 90 shares were taken up out of a capital of £5,500 in £50 shares, and paid for in full.

Hove Electric Lighting Company, Limited (36,942).—This company's return was filed on March 29th, when the whole capital of £40,000 in £5 shares was taken up; £5 per share has been called and £39,970 has been paid, leaving £30 in arrears.

CITY NOTES.

Kingston-on-Thames Accounts. WE have not previously had an opportunity of referring to the very marked progress that was made by the Municipal Electricity Works at Kingston during the year 1897.

Mr. J. E. Edgcome, the borough electrical engineer, in his report to the Corporation points out that after the payment of all the works' costs for generation of electricity, maintenance and repair of machinery and mains, taxes, insurance, and all management expenses, there remains a balance of £867 19s. 9d. as compared to £301 3s. 1d. for 1896. This sum is sufficient to pay the interest for the year on the capital expended on the undertaking, leaving a balance of £43 12s. 1d. towards the repayment of principal. In other words, if the undertaking were the property of a company, sufficient profit on the works had been made during 1897 to pay interest at the rate of 3½ per cent., and to leave a sum of £43 12s. 1d. in hand to be carried to the reserve fund.

We note that very considerable extensions are in hand, and if the present rate of progress is maintained, there is little reason why the close of the present year should not see the works approaching the profit-earning stage. The cost of production has been largely diminished, as will be observed from the subjoined figures.

The following table gives the cost per unit:—

	1897.	1896.
Total capital expended	£36,700*	—
Number of units sold	194,268	155,681
Number of lamps connected	9,200	6,825
Revenue from sale of current	£3,765	£2,892
Net revenue	£868	£301
Average price obtained per unit	4·85d.	4·64d.

Cost of production.	£		Per unit.	1896.
Coal	1,314		1·62d.	1·79d.
Oil, waste, water, and engine room stores	155		·19d.	·22d.
Salaries and wages at generating station	625		·77d.	·93d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	364	Works' cost 3·03d.	·45d.	·60d.
Rent, rates and taxes	100		·12d.	·12d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	454		·56d.	·58d.
Depreciation of buildings and plant account	-		—	—
Renewal fund account	—		—	—
Total	£3,012		3·71d.	4·24d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	3,765	0	0	4·85d.
Meter rents, &c.	104	0	0	—
Supply of steam	—			—
Transfer fees	—			—
Sundry sales	60	0	0	—
Total	£3,929	0	0	4·85d.

* Includes extensions now in hand.

Total cost per unit (exclusive of depreciation and renewal accounts), 3·71d.; works' cost, 3·03d.

Elmore's German and Austro-Hungarian Metal Company.

THE report of the directors of Elmore's German and Austro-Hungarian Metal Company, Limited, for the year 1897, to be submitted to the general meeting to be held in London on May 11th, states that the reduction of capital authorised by the meeting of July 21st last has been duly carried out, and that after writing off the amount brought forward, and the charges for the year, the amount standing to the cost of patents has been reduced to £84,252. The preference shares issued have been increased by the issue of £10,000 in July last. It will be remembered that this issue was made at the request of the meeting called for the reduction of capital. The loan to the "Metall" Company has been increased to £39,045, and mortgages to the extent of £40,000 upon the property at Schladern have been lodged with the trustees for the debenture holders. The option given to a syndicate in Hungary for the purchase of a license expired, and the directors did not see their way to renew it. They are now negotiating with one of the most important firms in Hungary, upon terms similar to those asked for last year, and, they believe, with a fair prospect of success. The debenture stock of the company, which now stands at £44,983, falls due for redemption on July 1st next. It is proposed to take power to issue £75,000 of debenture stock at 6 per cent., and to issue £60,000 during the present year, out of which the 8 per cent. stock will be repaid, and the balance expended in the purchase of copper, &c., at Schladern. With regard to the "Metall" Company's accounts, the directors, while regarding a profit of £3,203 as satisfactory, cannot but admit that the amount does not come up to their expectations. The value of the sales was 50 per cent. more than those of 1896, while the trading profit was £333 less. The decrease in the profit was due to the Government ordering a very much larger quantity than the directors were informed they would of tubes at the base, or lowest price. The directors demurred to this, and as a new regulation came into force, which gave the company power to cancel the contract, it was arranged that it should be cancelled. This was done, and, at the request of the Admiralty, the company tendered again, but at greatly enhanced prices. The directors are glad to report that the tender has been accepted, and that the company has been allotted nearly the whole of the new contract, only small tubes up to 1⅝ inches in diameter going elsewhere. Notwithstanding the increase in the sales during the past year, the company were unable to accept even a moiety of the orders offered, and therefore gave orders for new plant, sufficient to double the output of the year 1897. A portion of this new plant is already at work. The sales for the quarter ended March 31st show an increase of 77 per cent. over those for the same period last year. The directors have also purchased additional land available for further extensions, upon a portion of which they have erected workmen's dwellings. The directors are pleased to report that the process now works smoothly, and that the new plant being erected contains improvements which reduce materially the cost of repairs and maintenance. With regard to the profit shown, the directors would beg to remind the shareholders that the sum of £5,749 has been deducted from revenue by way of depreciation during the past three years. In view of the cash requirements of the "Metall" Company for the new plant and copper at Schladern, the directors regret they cannot recommend the payment of a dividend out of the profit, and have carried forward the amount to the credit of the accounts for this year.

Calcutta Electric Supply Corporation, Limited.

The first annual general meeting was held on Friday last, at Cannon Street Hotel, Colonel A. J. Filgate presiding.

In moving the adoption of the report, the Chairman regretted that greater progress had not been made with the works of the company, but they had had many matters to deal with which had occasioned delay. The question of what mains should be laid underground and what wires fixed overhead had involved protracted negotiations with the Government of Bengal, the Telegraph Department, and the municipality of Calcutta, but in February last the Government engineer approved a scheme which enabled the directors to give the necessary orders to the contractors to carry out the works. According to a telegram received a day or two ago, the Government authorities and the Calcutta municipality had agreed that, on the expiration of the period of 21 years for which the company's concession had been granted, it should be renewed for a further like period unless the undertaking was purchased by the municipality. On the whole, he thought the affairs of the company were now in a satisfactory state, and that the whole of the mains at present contemplated would be ready by the time the generating station was in a position to supply current. From what he knew of Calcutta, he believed they were likely to have a very successful undertaking.

Mr. E. Boulnois, M.P., seconded the motion, which was adopted.

City of Birmingham Tramways Company, Limited.

Mr. James Ross presided at the annual meeting of the company, held at Birmingham last Friday, and pointed out that the financial results had been satisfactory, in spite of the fact that their endeavours to improve the system had been frustrated by the Committee of Public Works and the Council. The chairman then detailed the circumstances, and quoted from letters to show that the Council had accepted the terms of the company to construct an overhead wire system with not more than 10 miles of conduit. Subsequently the Council withdrew their consent to permit an overhead system to be erected. The chairman, in conclusion, mentioned that the board had appointed as managing director Mr. G. C. Cuningham, who had had considerable tramway experience in Canada. Under the extended powers arranged between the Council and the company some time ago a new system was to be installed, and the public were looking for splendid concessions, but all this had been put on one side by a sudden and unexpected change of front on the part of the Public Works Committee.

The report was then adopted, and a dividend at the rate of 5 per cent. declared on the ordinary shares.

The Eastern Extension, Australasia, and China Telegraph Company, Limited.

The gross receipts for the half-year ended December 31st, 1897, including Government subsidies, amounted to £275,142 7s. 2d., against £325,405 12s. 6d. for the corresponding period of 1896. This decrease is due to the reductions of tariff brought into force during the past year and the falling off of Australasian traffic. The working and other expenses, including £30,956 8s. 6d. for cost of repairs to cables and expenses of ships, absorb £102,844 13s. 10d., against £106,270 9s. 7d. for the corresponding period of 1896, leaving a balance of £172,297 13s. 4d. From this is deducted £4,559 2s for income-tax, £32,606 13s. 9d. for interest on debentures, debenture stock, and contribution to sinking fund, &c., leaving as the net profit for the half-year £135,131 17s. 7d., which, with £34,812 16s. 3d. brought forward from the previous half-year, shows an available balance of £169,944 13s. 10d. One quarterly interim dividend of 1¼ per cent. has been paid for the half-year, and it is now proposed to distribute another of like amount on the 12th prox., making, with the interim dividends paid for the first half-year, a total dividend of 5 per cent. It is also proposed to pay a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the year 1897. The balance of £57,444 13s. 10d. has been transferred to the general reserve fund. The report states:—"The policy of strengthening the service by making judicious renewals from time to time in the weakest sections of the cables has been continued during the half-year under review, and the cost of the renewals carried out during that period has been charged against the general reserve fund. The contract made with the Spanish Government for extending the company's system from Manila to the islands of Panay, Negros and Cebu was successfully completed, and the new cables opened for traffic in November last. Since the close of the half-year a further contract has been entered into with the Spanish Government for improving telegraphic communication with the Philippines by extending the Hong Kong cable, which was originally landed at Cape Bolinao (Luzon), direct to Manila. The contract was completed last month, and the station at Bolinao removed to Manila. In accordance with the provisions of the trust deed dated May 10th, 1879, 451 of the company's 5 per cent. Australian Government subsidy debentures, amounting to £45,100, were drawn by lot on the 4th inst., for payment at par on July 1st."

The West Coast of America Telegraph Company, Limited.

The report of the directors for the year ended December 31st, 1897, to be presented at the first ordinary general meeting on May 10th, 1898, states that the gross income for the year 1897, as shown in the annexed revenue account, was £25,773. The continued depressed state of the nitrate industry, and of trade generally on the West Coast of South America, has had an adverse effect upon the traffic receipts; but the income of the company was sufficient to provide for the working expenses (£19,476 0s. 2d.) and the interest on the 4 per cent. debentures, leaving a balance of £296 19s. 10d. to be carried forward. The company's cables, landlines, and the repairing steamer have been maintained in a state of efficiency. The directors regret to report the decease of their esteemed colleague, Lord Sackville A. Cecil, on January 29th last, to replace whom, Sir Albert J. Leppoc Cappel, K.C.I.E., has been elected by the board.

The Spiral Globe, Limited.

As foreshadowed in our last issue, the prospectus of this company is now before the public, the capital offered being 75,000 shares of £1 each, out of a total capital of £150,000.

The vendor, Mr. S. B. Apostoloff, of 5, Fenchurch Street, London, has fixed the price at which he is willing to sell the whole of the patents and patent rights to the company, at £10,000 cash, £25,000 in fully paid shares, and £30,000 in cash or shares at the option of the directors. The company has in addition to pay a further sum of £25,000 in cash to the vendor on the sale or commercial working of the various foreign patents if as and when sold, a certain sum being allocated to each patent.

The spiral globe is a simple and pretty addition to an ordinary incandescent lamp, and apparently acts as a collector and diffuser of the light rays. It has, however, the disadvantages of acting as a dust collector, and of being fragile. Mr. F. J. Down estimates the sales at the rate of 2,000,000 per annum, and the profits on these sales at £26,000 per annum, increasing with a natural increase of sales to £35,000 per annum in subsequent years. We cannot follow this enthusiast in his appreciation of the invention, as shown by his report, but we think the spiral globe a pretty addition to the lamps ordinarily sold, and were the vendor content with pence, instead of the pounds named, there might be some future for the company.

London Platino-Brazilian Telegraph Company, Limited.—A meeting of this company was held at the offices of the company at London Wall yesterday, but we were informed that the proceedings were private.

TRAFFIC RECEIPTS.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending April 29th, 1898, were £2,694 4s. 7d.; corresponding period 1897, £2,292 0s. 3d.; decrease, £402 4s. 4d.

The City and South London Railway Company.—The receipts for the week ending May 1st, 1898, were £988; week ending May 2nd, 1897, £934; increase, £54; total receipts for half-year, 1898, £18,757; corresponding period, 1897, £18,546; increase, £211.

The Dover Corporation Electric Tramways.—The receipts for the week ending April 30th, 1898, £130 8s. 10d.; total receipts to April 30th, 1898, £1,951 11s.

The Dublin Southern District (Electric) Tramways Company.—The receipts for week ending Friday, April 29th, 1898, were £476 15s. 8d; corresponding week last year, £537 18s. 7d.: decrease, £61 2s. 11d.; passengers carried, 77,851: corresponding week last year, 81,812; aggregate to date, £7,3[illegible] 17s. 1d; aggregate to date last year, £7,655 3s. 10d.; decrease to date, £286 6s. 9d.; mileage open, 8 miles.

The Liverpool Overhead Railway Company.—The receipts for the week ending May 1st, 1898, amounted to £1,451; corresponding week last year, £1,276; increase, £175.

The Western and Brazilian Telegraph Company, Limited.—The receipts for the week ending May 2nd, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,362.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation. April 27th.	Closing Quotation, May 4th.	Business done during week ended May 4th, 1898. Highest.	Lowest.
137,400l	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	...	...	100 104	100 - 104	...	...
25,800	Amazon Telegraph, Limited, shares...	10	...	...	...	7 — 8	7 — 8	...	...
125,000	Do. do. 5% Debs. Red.	100	...	...	...	93 — 96	93 — 96	...	...
923,960l	Anglo-American Teleg., Ltd.	Stock	£2 9s.	£2 13s.	3 %	59 62	60 63	60	...
3,038,020l	Do. do. 6 % Pref.	Stock	£4 18s.	£5 6s.	6 %	109 110	110½ 111½	111½	109½
3,038,020l	Do. do. Defd.	Stock	...	..	...	12½ 13	14 - 14½	14 9/16	12¾
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	7 %	7 %	15¾ 16¼	15⅝ 16¼	15 15/16	15⅝
75,000l	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	...	...	112 116	112 - 116	...	...
44,000	Chili Teleg., Ltd., Nos. 1 to 44,000	5	4 %	4 %	...	3 — 3½	3 — 3½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	8 %	...	155 —165	160 —170	...	...
918,297l	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	104 —106	103 —105	104½	104
224,850	Consolidated Teleg. Const. and Main., Ltd.	10/-	1½%	2 %	...	1/16 — 3/16	1/16 — 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	7 %	6 — 7	6 — 7	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	14 — 15	14 — 15	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 11	10 — 11	...	...
30,000l	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	4½%	103 —106%	103 —106%	...	...
60,710	Direct United States Cable, Ltd.	20	2½%	2½%	...	10 — 10½	10½ 11	10 9/16	10
120,000	Direct West India Cable 4½% Reg. Deb	100	...	...	...	98 —101	98 —101	..	...
400,000	Eastern Teleg., Ld., Nos. 1 to 400,000 ...	10	6½%	6½%	...	16⅞ 17¼	17 - 17½	17⅜	16⅞
70,000	Do. 6 % Cum. Pref.	10	6	6%	...	18 19	18 19	18⅞	18½
89,900l	Do 5 % Debs., repay. August, 1899	100	5 %	5%	...	100 103	100 103	...	...
1,302,615l	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4%	...	125 129	127 —130 xd	123½	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7%	7 %	17⅝ 18¼	18 — 18½	18½	17⅞
25,200l	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5%	5 % 5 %	99 103	100 —104	...	...
100,500l	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5%	...	100 103	101 —104	...	...
320,000l	Do. 4 % Deb. Stock	Stock	4 %	4%	4 %	127 - 130	127 - 130	...	...
35,100l	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5%	... ...	100 - 103	100 —104	...	...
46,500l	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5%	...	100 - 103	101 —104	...	...
300,000l	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1906	100	4 %	4%	...	102 - 105	102 —105	...	...
200,000l	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4%	...	107 - 110 %	105 —108 xd	108½	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	...	11¼ - 11⅝	11¼ - 11⅝xd	11⅝	11 7/16
180,042	Do. do. 6 % Pref.	10	6 %	6%	...	16¾ - 17¼	16⅝ - 17¼xd	17	16⅝
150,000	Great Northern Teleg. Company of Copenhagen	10	10 %	10%	10 %	29 — 30	28½ - 29½	29⅜	...
160,000l	Do. do. do. 5 % Debs.	100	5 %	5%	5 %	100 —103	100 - 103	101	...
97,000	Halifax and Bermuda Cable Co., Ltd., 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	95 —100	97 —102	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10%	...	52 — 55	50 — 53	52	...
100,000l	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6%	...	106 —109	106 – 109	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	4 %	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5½%	5½%	6 %	5 - 5½	5½ - 5⅝	5 11/16	5⅝
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	15 - 17	15 - 17	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 - 17	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5 — 5½	5½ 5⅝	5 9/16	5 7/16
1,329,471l	Do 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½ %	100 - 105	100 - 105	102¾	102½
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	⅝ — ⅞	⅝ ⅞ xd	...	...
100,000l	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	...	105 108	105 108	...	.
11,839	Reuter's Ltd.	8	5 %	5 %	...	8 9	8 9	...	...
3,381	Submarine Cables Trust	Cer.	...	...	...	136 141	136 141	...	..
58,000	United River Plate Teleph., Ltd.	5	4 %	5 %	...	4 - 4½	4 - 4½	...	...
146,733l	Do. do. 5 % Debs.	Stock	5 %	...	...	105 - 108	105 - 108	106	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	nil	...	3½ - 4½	3½ 4½	...	...
213,400l	Do. do. do. 5 % Debs.	100	5 %	5 %	...	99 102	99 102	...	...
64,269	Western and Brazilian Teleg., Ltd.	15	3 %	2 %	...	11½ 12	11½ 12	11 13/16	11½
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	...	7½ 8	7½ 8	7½	...
33,129	Do. do. do. Def. Ord.	7½	1 %	nil	...	4¼ — 4⅝	4¼ — 4⅝	4 7/16	...
389,521	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	106 —109	105 —108	...	...
88,321	West India and Panama Teleg., Ltd.	10	½%	1 %	¾ %	½ — ⅝	½ — ⅝	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	7 — 7½	7¼ — 7⅝	7½	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	5 — 7	5 — 7	...	...
80,000l	Do. do. 5 % Debs. No. 1 to 1,000 ...	100	5 %	5 %	5 %	105 —108	105 —108	106½	106½
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7%	...	105 —110	105 – 110	...	...
160,100l	Do. do. 6 % Ster. Bonds.	100	6 %	6%	...	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share.	1895.	1896.	1897.	Closing Quotation. April 27th.	Closing Quotation, May 4th.	Highest.	Lowest.
30,000	Charing Cross and Strand Electy. Supply	5	5 %	6 %	7 %	13 — 14	13 — 14	13¾	13½
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	...	...
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	6 %	9½— 10½	9½— 10½	10½	9 15/16
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	4½%	4½%	4½%	115 —117	115 —117	...	...
50,000	City of London Elec.Lightg. Co., Ltd., Ord. 40,001—90,000	10	5 %	7 %	10 %	25½ - 26½	26 — 27	26⅞	26⅛
10,000	Do. do. Prov. Certs. Nos. 90,001 to 100,000 £5.	10	...	...	...	17½— 18½	18 — 19	18⅜	18
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17½— 18½	17½ - 18½	18	17¾
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	129 —134	129 —134	...	...
30,000	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—30,000	10	nil	nil	nil	14 — 15	14 — 15	14⅜	14¼
10,000	Do. do. do. Nos. 30,001 to 40,000 £4 pd.	10	...	...	...	8½— 9	8½— 9	...	...
20,000	Do. do. do. 6% Pref., 40,001—60,000 ...	10	6 %	6 %	6 %	15 — 16	15 — 16	...	...
17,400	Edmundsons Elec. Corp., Ld., ord. shares 1—17,400 £4 pd.	5	...	...	...	4 — 4½	4 — 4½	...	...
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5		..	4 %	10 — 11	10 — 11	...	...
10,000	Do. do. 7 % Cum. Pref. ...	5	7 %	7 %	7 %	11 — 12	11 — 12	...	...
62,400	*Metropolitan Electric Supply, Ltd., 101 to 62,500 ...	10	4 %	5 %	6 %	17½— 18½	18½— 19½	18 15/16	18⅛
220,000l	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½%	117 —121	117 — 121	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	2 %	4 %	6 %	19 — 20	19 — 20	20	19 9/16
31,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord.	5	7½%	10½%	14½%	17½— 18½	17½— 18½	18¼	17¾
20,000	Do. do. 7 % Pref., 20,001 to 40,000	5	7 %	7 %	7 %	10 — 11	10 — 11	...	..
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	4 %	107 —110	107 —110	...	...
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2½— 2¾	2½— 2¾	2 11/16	2 9/16
79,900	Westminster Electric Supply Corp., Ord., 101 to 80,000 ...	5	7 %	9 %	12 %	16⅞— 17⅛	17 — 18	17⅜	17⅛

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation April 27th.	Closing Quotation, May 4th.	Business done during week ended May 4th, 1898. Highest.	Lowest
30,000	British Electric Traction	10	...	...	...	15½ — 16½	15½ — 16½	...	...
10,000	Do. do. 6 % Cum. Pref. 30,001—40,000 (issued at £2 10s. prem. all paid)	10	...	...	...	7½ — 8½	7½ — 8½	...	...
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000... ...	3	2½%	*nil*	*nil*	1⅛ — 1⅜	1⅝ — 1⅞	1⅝	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	*nil*	4 %	2⅜ — 2⅝	2¼ — 2½	2$\frac{5}{16}$	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	110 —114	110 —114	...	...
50,000	Do. do. 4½% 2nd Deb. Stock Red. ..	Stock	...	...	...	102 —105	102 —105	103	...
19,894	Central London Railway, Ord. Shares	10	...	...	...	10 — 10½	10 — 10½	10⅝	10$\frac{7}{16}$
129,179	Do. do. do. £6 paid	10	...	...	...	6½ — 6¾	6 — 6½	...	...
59,254	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1½ — 2	1¼ — 1¾	...	...
67,680	Do. do. Def. do. £5 pd. ...	...	...	...	...	4½ — 4¾	4¼ — 4¾	...	...
630,000*l*	City and South London Railway	Stock	1$\frac{3}{16}$%	1$\frac{3}{16}$%	1⅞%	67 — 69	67 — 70	70	69
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	...	...	2 — 2½	2 — 2½	...	...
99,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 99,261	5	5 %	5½%	...	2¼ — 2¾	2¼ — 2¾	2½	2⅝
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5½%	...	4 — 5	4 — 5	...	...
194,023	Do. do. do. 4% Deb. stock Red. ...	100	...	...	...	103 —105	103 —105	...	...
118,000	Electric Construction, Ltd., 1 to 118,000	2	5 %	6 %	...	2⅝ — 2⅞	2⅝ — 2⅞	2¾	2$\frac{11}{16}$
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343	2	7 %	7 %	...	3⅛ — 3⅜	3⅛ — 3⅜	3⅛	...
111,100	Do. do. 4% Perpetual 1st Mort. Deb. Stock	Stock	...	...	...	106 —108	106 —108	...	...
91,196	Elmore's Patent Cop. Deposg., Ltd., 1 to 78,000	2	...	...	...	½ — ¾	½ — ¾	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	...	...	...	⅜ — ⅝	⅜ — ⅝	...	...
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	10½%	7 %	7 %	9 — 11	9 — 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	8 %	10 %	12 %	21½ — 22½	21½ — 22½	22¼	22⅛
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½ — 19½	18½ — 19½	19½	...
56,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½%	110 —115	110 —115	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	21 — 22	21 — 22	21¾	21¼
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	102 —106	102 —106	102	...
37,500	†Liverpool Overhead Railway, Ord.	10	2⅞%	2⅞%	3¼%	10$\frac{11}{16}$ — 10$\frac{13}{16}$	10⅝ — 10⅞	...	...
18,000	†Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15¾ — 16¼	15¾ — 16¼	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	15 %	15 %	35 — 38	35 — 38	37	35¼
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	...	...	133 —136	133 —136	133	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*** Birmingham Electric Supply Company, Ordinary £5 (fully paid) 10⅝.**

House-to-House Company, 4½% Debentures of £100, 108—110.

Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 16—17; 1st Preference Cumulative 6 %, £5 (fully paid), 8—8½. Debentures, 107—110. Dividend, 1897, on Ordinary Shares 10 %.

* From Birmingham Share List.

London Electric Supply Corporation, £5 Ordinary, 3½—4.

*** T. Parker, Ltd., £10 (fully paid), 15½.**

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8—8½. Dividend for 1896—6 %.

Bank rate of discount 4 per cent. (April 7th, 1898).

THE STEAM TURBINE ENGINE AND ITS APPLICATIONS.*

By JNO. D. BAILIE.

During the 13 or 14 years which have elapsed since the introduction of the compound steam turbine, many modifications and changes have been made both in the engine itself and in its auxiliary parts. A *résumé* of the various forms through which this engine has passed would occupy more time than is at disposal; it may, however, be said that the two most prominent types—judging from the standpoint of practical and commercial success—have been the "Twin Parallel Flow" and the "Radial Flow" turbines, and as many of both of these are still at work in central electricity supply stations and elsewhere, it may be well to begin the paper by a brief description of their leading features.

In the twin parallel flow turbine the motor spindle is fitted with two sets of rings of curved blades, one complete set in each half of the machine, and on the inner periphery of the cylinder are corresponding rings of blades of opposite curvature between which those on the spindle rotate. The blades on the inside of the cylinder are guides, their function being to direct the steam on to those on the spindle. Steam is admitted at the centre of the turbine case, all round the shaft, and flows simultaneously right and left through each series of rings of blades to the ends of the cylinder, thence to the common exhaust—the rotation being caused by the impact of the steam on the spindle blades. The flow of steam being equal in each direction, end pressure and excessive wear on the bearing collars are avoided.

The bearings are of somewhat unusual construction. Surrounding the bearing sleeve, or bush, are two sets of steel washers, which are in turn encircled by a steel liner—the latter being a free fit in the bearing seat. Each washer is about $\frac{1}{16}$th inch thick. They are of two diameters, and are arranged alternately small and large, the smaller being a close fit on the bush and about $\frac{1}{32}$nd inch clear of the liner, and the larger a close fit in the liner and about $\frac{1}{32}$nd inch clear of the bush. They are held tightly together by a strong spiral spring, and any lateral movement due to imperfect balance makes them slide mutually against one another, thus permitting the shaft to find its own centre of gyration, relieving the pressure on the bearings, and damping vibration.

The lubrication of the bearings is automatic and continuous by means of a fan and a screw fixed on the turbine shaft. The suction of the fan acting on the free surface of the oil in the stand-pipe draws it up to the screw, which in turn forces it through the adjacent bearing, and also through a feed-pipe to the other bearings, from whence it flows back through a return pipe to a reservior, to be again raised by the fan, and the process repeated.

The speed is controlled by a rather nice arrangement. A leather diaphragm is mechanically connected to the throttle valve by means of a rod and crank, and so operates it, that as the diaphragm distends the throttle valve opens to steam, and *vice versâ*. An airway leads from the diaphragm to the inlet of the fan, so that when the turbine is working, the suction of the fan tends to close the diaphragm against the tension of a spring. The action is as follows:—When the speed becomes too high, the suction of the fan increases, partially closes the diaphragm, and so reduces the admission of steam; conversely, when the speed falls below the normal, the suction of the fan decreases, the diaphragm extends, and opens the throttle valve to admit more steam. This combination in itself exerts very fair control, but is scarcely sensitive enough for electrical work; it is therefore supplemented by an electrical regulator. On the magnet yoke is a vertical spindle, on which are delicately pivoted a small iron bar or needle, and a tuning fork shaped arrangement with flat heels. An air-pipe leads thence to the leathern diaphragm. When the machine is excited, the magnet yoke attracts the needle, and a spiral spring makes it tend to resist the attraction. The spring is so adjusted, that the greater the magnetic pull, the more is the mouth of the air-pipe closed by the hind heel of the tuning fork. When, therefore, the speed of the machine, and consequently the magnetic pull, get below the normal, the heel falls back and opens up the mouth of the air-pipe, the inrush of air tends to neutralise the suction of the fan, and allows the diaphragm to extend, thus opening the throttle valve to admit more steam. On the other hand, when the speed and magnetic attraction get above the normal, the heel closes the air-pipe inlet, allows the fan to contract the diaphragm, and so reduces the admission of steam.

The radial flow turbine differs from the foregoing in that, instead

* Abstract of a paper read before the Yorkshire College Engineering Society, February 14th, 1898.

of the steam flowing in a direction parallel to the axis, it flows radially outwards. In this type there are several discs fixed on the shaft, and revolving with it, from the front faces of which the blades or vanes project in the form of a series of concentric rings. In one complete turbine motor there would be, perhaps, six of these discs of equal diameters, also a disc of considerably greater diameter fitted on both its faces with rings of blades of larger dimensions than those on the other discs; this large one may be termed the low pressure disc. Between the moving discs are stationary discs, attached to the case, on which the rings of guide vanes are so arranged as to alternate with the rings of moving blades. Steam enters at one end of the cylinder, inside the smallest ring of blades on the first disc, passes through the successive rings to the circumference, thence between the back of the rotating disc, and of the next stationary disc, to the inmost of the next series of rings. This is repeated until the centre of the low pressure disc is reached, when the steam flows through the blades on both sides of the disc simultaneously, and thence to the exhaust.

The steam turbine as now made is somewhat similar to the one first described, in that it is of the parallel or axial flow type.

The turbine shaft is encircled concentrically by a series of "drums" of several diameters, round the outer circumference of which the sets of rings of moving or rotator blades are fitted. The interior of the turbine case is correspondingly stepped, and is fitted with rings of guide blades of similar but opposite obliquity to those on the spindle. The rings of guide blades alternate with the rings of rotator blades, so that when the machine is at rest the spaces between the blades form a series of zig-zag passages or channels. The diameters of the drums, the dimensions of the blades, and the steam passages, are graduated to suit the increase in the volume of the steam as it expands towards the low pressure end. Each ring of guide blades, together with its corresponding ring of rotator blades, may be regarded as a turbine complete in itself, the steam turbine engine therefore consists of a considerable number of small turbines, at each of which expansion of the steam takes place. Steam is admitted through a double-beat valve, and entering the cylinder all round the spindle, passes through the first ring of guide blades on to the first ring of rotator blades, then through the second ring of guide blades to the second ring of rotator blades—and so on, losing pressure at each step, until it has passed the last ring of rotator blades, when it exhausts into the condenser or atmosphere, as the case may be.

No effective work is done by the barrels; they are merely revolving baffle pistons, or "dummies," to balance the end thrust due to the pressure of the steam on the turbine blades. They are stepped similarly to the bladed barrels, with which those of corresponding diameters are connected by channels in the casting in order to equalise the pressure. The adjustable thrust bearing takes up any slight endlong pressure which may not be neutralised by the dummies. This thrust bearing differs from the usual pattern only in that the grooved bush is split longitudinally into halves, with separate adjustment for taking up wear. The thrust bearing is adjusted by a screw at the end keep of the engine. The end play can be tried when the engine is running slow by slackening the nuts holding down the keep, and inserting a lever between the keep and the cylinder; it should not be more than, say, $\frac{1}{100}$th inch. If the bottom half of the thrust is worn, a thin liner may be put in at the back.

The bearings are of the tubular type, and consist of a phosphor bronze, or gun-metal bush in which the shaft rotates; round this bush are slipped three concentric steel tubes, each fitting loosely over the one inside it, the outermost being a free fit in the bearing seat. The bush has grooves cut on its inner periphery, and the tubes are perforated to allow the free passage of the oil. When the machine is working the clearance between each tube and its neighbour is charged with a film of oil, with a result that, while the shaft retains a small amount of freedom, the viscosity of the oil acts as a damper to prevent oscillation. The circulation of the oil is continuous and automatic by means of a pump driven by an eccentric and worm gear from the turbine shaft, the supply of oil is therefore proportionate to the speed. In some machines the oil is continuously fed into the bearings under a head of some 6 or 8 inches, from cisterns immediately above them; it then drains into a receiving chamber, from which it is again pumped to the various cisterns. In other machines the keeps are sealed, and the oil is forced through the bearings under a pressure of from 5 to 10 lbs. per square inch. The cisterns are all connected by pipes, so that the one pump maintains the circulation.

When the turbines are to be used in tropical climates, or in exceptionally hot places, oil coolers are frequently fitted. These may be built into the bed-plates, and consist merely of a cast-iron shell containing a spiral copper tube, through which the oil is passed on its way to the reservoir, the cooling being effected by a water circulation.

The engine is coupled to the fan, dynamo, pump, or other machine to be driven, by means of a square bored sliding sleeve, fitting loosely over the squared ends of the respective shafts. The exterior of this sleeve carries the worm which drives the worm-wheel, which in turn, by means of an eccentric and connecting rod, transmits the motion to the oil-pump plunger.

This worm gear also plays an important part in the governing arrangements; but as the method adopted for controlling the turbine depends upon the nature of its work, it will be dealt with later on.

When very large powers are required, it is sometimes found advantageous to use more than one cylinder, and to pass the steam through them in the usual sequence.

Turbines are designed for working either condensing or high pressure, and they lend themselves readily to either condition. At some places they are required to work part of the time on the condenser, and part on the atmosphere; when this is so, they are bladed for condensing, but fitted with a bye-pass and valve, with which the excess blades may be cut out when working on the atmosphere. The relative saving effected by condensing is more than with reciprocating engines, for the steam may be expanded down to 1 lb. absolute, or even lower, without any material increase of frictional resistance, and a very high ratio of expansion is therefore practicable; indeed, it is usual to blade a condensing turbine for the terminal pressure of 1½ lb. absolute per square inch. It is evident, therefore, that where condensing is feasible it should be resorted to, and the condenser adopted should be one giving a high vacuum. Frequently the engine is fitted with its own condenser; the shell containing the tubes forming part of the bed-plate, and the air and circulating pumps being driven from the worm on the turbine shaft by a rocking beam.

The turbine is best adapted for speeds of not less than 2,000 revolutions per minute, and they are usually designed to run at from 3,000 to 6,000 revolutions; when the speed of the machine to be driven is considerably below 2,000, gearing or belts may be interposed. At first sight, gearing would seem to be unsuitable for these speeds, both as regards durability, efficiency, and quietness of running, but very fair results have been obtained with double helical spur gear made of steel. This type of gear is also used when it is desired to adjust relatively higher speeds, and ratios of as high as 8 to 1 have been successfully negotiated. In a 16-kilowatt turbo-dynamo built some time ago, the turbine ran at 25,000 revolutions, and the dynamo at 4,000 revolutions, a ratio of 6¼ to 1. A 150-kilowatt turbo-alternator at the Newcastle and District Company's station has a ratio of 2 to 1, the turbine running at 9,400 revolutions and the alternator at 4,700 revolutions. Hitherto, reducing gear has not been employed when the machines have been built for power work, but at the present time a launch is being engined with a turbine gearing on to two propeller shafts. The use of reducing gear enables the turbines to be run at a very high speed, and so greatly decreases the weight per horse-power, but at present the writer much prefers direct driving, especially when the load is liable to sudden variation.

The Steam Turbo-Dynamo.

When the turbine engine was first introduced, electrical engineers recognised its marked suitability for driving dynamos, and for several years this was the only use to which it was put. The first turbo-dynamo built was a small one, giving only 4½ kilowatts, and running at 18,000 revolutions per minute; nowadays, for central electricity supply stations, plants having capacities of from 350 to 1,000 kilowatts are not uncommon. One of the large London companies alone has no fewer than 13 of these turbine plants, each giving 350 kilowatts, four each giving 500 kilowatts, and others equally large are being built for them at the present time. They are also used in the supply stations of Newcastle, Cambridge, Woking, Portsmouth, Scarborough, Madeira, Woolwich, Blackpool, &c., so that their fitness for this class of work would seem to be proved.

Turbo-dynamos are also being largely and increasingly used for power work at collieries, for driving iron works and other places where heavy and sudden changes of load are met with, as well as for electric traction, and they do their work well. Indeed, this is a direction in which, in the opinion of the writer—and in the opinions of the users also—they score heavily over reciprocating engines. He would emphasise this by adding that, so far as he is aware, in no single instance where users have installed turbines for power work have they, when extending, reverted to reciprocating plant. The principle of the engine eminently fits it for dealing with extremely variable loads without detriment, and the governor, which being a special feature will be described at length later on, exercises such perfect control that practically no attention is required.

The steam turbine dynamo ordinarily comprises a multiple expansion steam turbine coupled direct on the same bed-plate to a high speed dynamo, by means of a square bored sleeve. The dynamo bearings are similar to those of the engine, and are connected with them by pipes, so that the one oil pump provides the circulation for all.

The electrical governor which controls the speed of the machine is very quick and reliable in its action.

A centrifugal "safety" governor is usually fitted to large machines, to come into action only in the event of accident. It derives its motion from the worm on the turbine shaft through the worm wheel and the bevel gear, and actuates a valve in the relay by means of a rod and clutch. It is set so as just not to blow off when the machine is at full speed.

The hand lever above the relay is merely for the purpose of lifting the main valve at starting, or for admitting steam to warm through. A similar lever embraces the collar of the centrifugal governor spindle. Either of these levers might be used in an emergency for shutting off steam from the engine; the long lever will answer the same purpose, for if moved either to its top or bottom position, the main valve closes.

Turbo-alternators run perfectly in parallel, either with each other or with any of the leading slow speed machines.

These turbo-electric generators would seem to compare very favourably with other types as regards economy in steam consumption, especially when working condensing. A 100-kilowatt turbo-dynamo supplied to one of the Lancashire corporations gave a consumption of 20·1 lbs. of steam per electrical horse-power at full load, and 22·3 lbs. at half load. The steam pressure at the machine was ·02 lbs., and the and the vacuum was 26¾ inches. A 50-kilowatt plant, supplied to the same corporation, used 20·9 lbs. per electrical horse-power at full load, the steam pressure being 90 lbs. and the vacuum 28½ inches.

A 200-kilowatt plant supplied to a large ironworks near Chester gave, with a boiler pressure of 100 lbs. per square inch and a vacuum of 25 inches, a consumption of 19·51 lbs. per electrical horse-power at full load, and 20·9 lbs. at half load, a rise from full load to half load of only 7½ per cent.

A 150-kilowatt turbo-alternator supplied to a central electricity supply company gave the following results:—The steam pressure at the machine was 70 lbs. per square inch, and the vacuum was 26½ to

26¾ inches; the steam consumption at full load was 17·28 lbs. per electrical horse-power, at half load 20 lbs., and at one-fourth load 22·01 lbs.

In all the above, the consumptions are to be taken as per electrical horse-power-hour.

The machines quoted are not necessarily the most efficient that have been built; the writer has chosen them because he has been connected with them to some extent, three out of the four having passed through his hands; he thinks, therefore, that they may be taken as fair examples of the efficiency of condensing type steam turbine plants of medium size.

The writer concludes by saying that the advantages claimed for the turbine are:—Simplicity, compactness, lightness, portability, absence of vibration, low cost of foundations, ease and cheapness of repairs, long life of bearings, automatic lubrication, steady governing, absence of cylinder lubrication, economy in oil, indifference to priming, low all round steam consumption, absence of cylinder condensation, general satisfactory working, and saving in attendance.

COMMERCIAL FORMS OF ELECTRICAL RESISTANCES FOR LIGHTING AND POWER PURPOSES.*

By Ll. B. ATKINSON.

(*Concluded from page 592.*)

Resistances for Regulating Dynamo and Motor Shunts.

Almost any of the forms are suitable for this purpose. As to capacity, the maximum amount of power to be dissipated is reached when the resistance is equal to the resistance of the shunt, and when the current comes down to half its original value.

Resistances working by compression, and therefore giving a perfectly steady graduation between maximum and minimum, have the advantage of allowing the E.M.F. to be regulated very exactly, an advantage where dynamos are being run in parallel.

Arc Lamp Resistances.

These form an important class, as very large numbers of them are used.

The usual form consists of a porcelain cylinder, having a spiral upon it, in which is wound a German silver wire. The resistance is regulated by a movable clamp, placing more or less of the wires in circuit.

Three forms of arc lamp resistances were designed by the writer some years ago, in each of which the base is an iron cylinder covered with asbestos, on which the resistance is wound. All these forms of resistance have the disadvantage that as the wire is heated and cooled it is subject to very considerable strains, and the wires are frequently fractured.

In that form of arc lamp resistance in which "Relugite" is utilised as the resisting material, and the resistance is adjusted, as required, by tightening or slackening the end on the top.

An important advantage possessed by this latter form of resistance is that as the coefficient of temperature variation is negative, the resistance is higher when first the current is switched on than it is when the arc has been burning a short time, and the resistance becomes warm, thus assisting in keeping the current to its normal value, whilst the arc becomes of a proper length.

Resistances for Lowering Lamps.

These are mostly used for stage effects, and if made with switches, should have a large number of contacts to make the graduation imperceptible, or liquid resistances or resistances worked by pressure variation should be used.

Owing to the peculiar nature of the fire risks in the theatre, special care should be taken that the rise of temperature should be small.

In the case of resistances designed by the writer for the Drury Lane Theatre, the specification was that the resistances should not rise more than 80° F. above that of the atmosphere.

Resistances for Meter and Instrument Testing

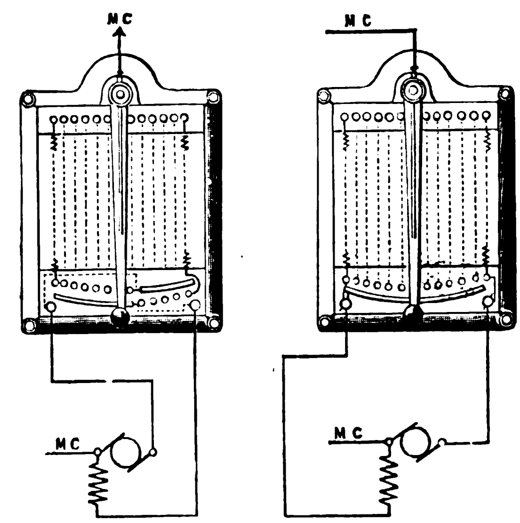
For this purpose resistances with sliding wire, or liquid resistances, have been generally used, enabling the current to be kept at an *exact* value. The "Relugite" pressure resistances is now being adopted for this purpose. It has the additional advantage with alternate currents, that the resistance being inductionless no errors are introduced.

Motor Starting Resistances.

It has frequently been a subject of complaint that the resistances for starting both continuous current and multiphase motors, particularly for small powers, cost almost as much as the motor itself. This has been largely due to want of standard designs specially suited for the purpose.

In general the resistance is not required for more than, say, one minute, but should be capable of carrying the full load of the motor for that time. Some forms recently introduced will only carry the load for 20 seconds; this is not safe.

For the purpose of regulating the speed of motors the resistances must be made larger, and must be capable of carrying a load depending on the range of regulation, but if this is a wide one practically the full load of the motor must be provided for. The simplest way of regulating the speed of a shunt motor is shown in the right-hand diagram, where a resistance is placed in circuit with the armature of



M C Main circuit.

Starting resistance with shunt regulation. Starting resistance without shunt regulation.

the motor, the full line pressure always being on the shunt coil. The left-hand diagram, a modified arrangement, in which part of the speed regulation is effected by varying the strength of the current in the magnet coils. In this case the method of working is to have, in the first instance, the full line pressure on the magnet coils and resistance in the armature circuit. The resistance is gradually taken out of the armature circuit, and resistance is then inserted in the magnet circuit, thus weakening the field and allowing the speed to rise.

If this form of regulation is to be adopted, the magnet windings should be specially arranged for the apparatus to have a low resistance, so that the motor is considerably over excited at starting.

In order to avoid the possibility of a motor being switched into circuit rapidly, it is preferable to fit such resistances with a screw motion, but if this is done arrangements must be made by a separate switch or otherwise, so that the circuit can be broken instantaneously in the case of accident or emergency.

An important point in connection with regulating resistances, particularly where the variation in resistance from point to point is considerable, is the question of the switch contacts, as considerable sparking occurs on the contacts, which, from this cause, become dirty or roughened, and causes considerable trouble.

In a form of switch pillar for starting and regulating speed of motors designed by Messrs. Royce, independent quick-break contacts are fitted at each resistance point, and the final break is effected by a carbon contact. In a form designed by Pochin, the switch arm itself carries a small wiper which takes the spark, and it may be renewed as required.

In the case of pressure resistances these precautions are unnecessary, and even in the case of resistances with multiple contacts and filled with "Relugite" material, owing to the fact that such resistances are inductionless, the spark on the contacts is practically eliminated.

Conclusion.

In conclusion, the writer desires to point out the advances which have taken place in the last few years in the design and manufacture of resistances, owing largely to the increased demand, and therefore to the specialisation which this has allowed, and hopes that the notes contained in the foregoing paper will prove of interest to the members of the Northern Society of Electrical Engineers, who have doubtless had considerable experience not only of the merits, but of the disadvantages, to which this class of apparatus is liable.

From a manufacturer's point of view, it is greatly to be desired that engineers designing plants will endeavour to avail themselves of manufacturers' existing patterns and standards rather than to specify for particular arrangements, as it is only in this way that the cost of accessories of the electric light and power plants can be brought to a point which will have the effect of greatly stimulating the use of electrical appliances in many cases where at present the admitted advantages do not outweigh the expenditure necessary.

* Abstract of paper read before Northern Society of Electrical Engineers.

A TABLE OF TELEGRAPH ROUTES TO SPAIN AND TO THE WEST INDIES

SHOWING THE VARIOUS SUBMARINE CABLE COMMUNICATIONS, SOME OF WHICH MAY BE AFFECTED BY THE PRESENT WAR.

———	Sections.	Countries.	Proprietors.
Spain	Porthcurno, England, to Vigo	Spain	Eastern Telegraph Company.
	" " Carcavellos	Portugal	" " "
	Falmouth, " Bilbao	Spain	Direct Spanish Telegraph Company.
	Marseille, France, to Barcelona...	"	" " " "
	Emden, Germany, to Vigo	"	Deutsche See Telegraphen Gesellschaft.
West Indies (Cuba, &c.)	Atlantic cables	... ...	Various.
	Halifax-Bermuda	English	Halifax and Bermudas Cable Company.
	Bermuda-Turk's Island	"	" " " "
	Turk's Island-Jamaica	"	" " " "
	Jamaica-Santiago de Cuba	Spanish	West India and Panamá Telegraph Co.
" " "	Atlantic cables	... ...	Various.
	Landlines to Punta Rassa (Florida) ...	U.S. America	Western Union Telegraph Company.
	Punta Rassa-Island of Key West	" "	" " " "
	*Island of Key West-Cojimar (Habana) ...	Spanish	" " " "
" " "	French Atlantic cables	U.S. America	Cie. Française des Câbles Télégraphiques
	New York-Hayti	Republic of Hayti ...	" " "
	Hayti-Guantanamo (Cuba)	Spanish	" " "
South Coast of Cuba and Jamaica.	†Batabanó-Cienfuegos	"	Cuba Submarine Telegraph Company.
	Cienfuegos-Santiago de Cuba	"	" " "
	Santiago de Cuba-Jamaica	English	West India and Panamá Company.
West Indies (Cuba, &c.), *viâ* Brasil.	Cadiz-Canary Islands	Spanish	Spanish Government.
	Canary Islands-Sénégal	French	Spanish National Submarine Telg. Co.
	Sénégal-Fernando Noronha-Pernambuco	Brasil	South American Cable Co.
	Pernambuco-Ceará-Maranham-Pará	"	Western and Brasilian Telegraph Co.
	Or by landlines Pernambuco to Pará ...	"	Brazilian Government.
	Pará-Cayenne	French Guiana	
	Cayenne-Paramaribo	Dutch Guiana	
	Paramaribo-Martinique	French	
	Martinique-St. Thomas	Danish	Compagnie Française des Câbles Télégraphiques.
	St. Thomas-Puerto Plata	Republic of Santo Domingo	
	Puerto Plata-Cape Haytien-Môle-St. Nicolas...	Republic of Hayti ...	
	Môle-St. Nicolas-Guantanamo (near Santiago de Cuba)	Cuba (Spanish)	
" "	Porthcurno (England) to Lisbon	Portugal	Eastern Telegraph Company.
	Lisbon-Madeira-St. Vincent	"	Brazilian Submarine Telegraph Co.
	St. Vincent-Pernambuco, and from Pernambuco onwards as per preceding route	Brasil	" " " "
West Indies (Cuba, &c.), *viâ* the River Plate.	To the River Plate *viâ* the South American Cable Company, or the Brasilian Submarine Telegraph Company, and the Western and Brazilian Telegraph Company.		
	River Plate-Valparaiso	Chile	Landlines.
	Valparaiso-Lima-Panamá	Perú	Central and South American Telg. Co. / West Coast of America Telg. Co.
	Panamá-Colon (Aspinwall)	Republic of Colombia ..	Landlines.
	Colon-Jamaica	English	West India and Panamá Telegraph Co.
	Jamaica-Santiago de Cuba	Spanish	" " " " "
West Indies (Cuba, &c.) *viâ* the States, Mexico, and Central America.	Atlantic cables	... ...	Various.
	U.S. landlines to Galveston	U.S.	Western Union Telegraph Company.
	Galveston-Tampico-Vera Cruz-Coatzacoalcos ...	Mexico	Mexican Telegraph Company.
	Coatzacoalcos (Gulf of Mexico) to Salina Cruz (Pacific) landlines	"	Central and South American Telg. Co.
	Salina Cruz-San Juan del Sur	Republic of Nicaragua ...	" " " "
	San Juan del Sur-Panamá	Republic of Colombia ...	" " " "
	Panamá-Jamaica-Cuba	... ...	West India and Panama Telegraph Co.

* The cables between Key West and Habana are reported to have been cut by U.S. vessels.
† Both Batabanó and Cienfuegos are connected by landlines with Habana.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

EARTH RETURNS FOR ELECTRIC TRAMWAYS. By H. F. PARSHALL, member. Paper read April 28th, 1898.

Considering the small difference of potential at which electrolytic action may take place, a matter of primary importance in electric tramway systems in which the rails are used as return conductors, is in reference to the rate of fall of potential, and the difference of potential between the rails and the general mass of earth, the magnitude of which may vary according to such local conditions as the locality of gas and water pipes, the conductivity of the earth between the rails and such pipes, and the conductivity of the pipes themselves.

The exposed surface for leakage of the track is very great; thus in the ordinary four-track tramway system there is some 50,000 feet per route mile. With so great a surface, and with, as is generally the case, considerable conductivity of the concrete and earth, a large fraction of the current may be diverted from the rails, even in short lines, and with a maximum drop as small as that specified by the Board of Trade.

Thus, in tests recently carried out in a line some 8 miles long, it was found, by cutting the track at the middle of the line and inserting an amperemeter, that some 60 per cent. of the current was returning through the earth itself. Tests made as to the conductivity of the earth return showed as a whole that it was about one and a half that of the rails, bonds, and fish-plates, which would indicate that on an average about 33 per cent. of the current was leaving the rails. In other words, the voltage drop in the earth return was but two-thirds of what it would have been had the current been wholly in the rails.

In laying the rails, therefore, it seems desirable to adopt such methods of construction as will, to a considerable extent, insulate the rails from the adjacent mass of earth. The conductivity of the earth is considerable, and with differences of potential up to the limit established by the Board of Trade is so great that, in the cases I have examined, stray currents are not diverted from the mass of earth by gas and water pipes. I have made tests by cutting the rails and measuring the currents at different points, and, so far as could be determined, the neighbouring gas and water pipes were not traversed by the current. In one special case two lines of the tramway formed two sides of an acute angle triangle, and a very large water main formed the third side, and even though some 50 per cent. of the current did not come back through the rails, the tests showed beyond doubt that there was no current whatsoever coming across the third side of the triangle through the water pipe. Of course, with the small difference of potential common in practice in this country, the C.E.M.F. of polarisation which accompanies currents flowing between conductors when electrolysis takes place is an important element in determining the law of current-flow.

The tests carried out by the writer have in every case shown that the joint conductivity of the rail and the earth is considerably greater than that of the rails themselves. For this reason there exists the necessity of determining the conductivity of the rails, fish-plates, and bonds, before the track is laid in the earth, so that after a roadway is completed the measured drop may be taken as an indication of what percentage of current is straying from the rails; further, so that tests made from time to time may indicate the general condition of the bonding.

In general it is desirable that the earth return be isolated to the greatest degree practicable from any other metallic conductors liable to be affected by electrolysis. In some cases, however, where the drop in the earth return has been comparatively great, attempts have been made to prevent electrolysis by bonding the rails to the adjacent gas and water pipes. The results have been more or less satisfactory. It is obvious that, if the rails and adjacent gas and water pipes can be kept at the same potential, electrolytic action can be effectively prevented. Considering, however, the very considerable conductivity of the earth, it would seem doubtful whether such bonding would prove effective with any considerable drop in the rails, since in this case stray currents would flow from one part of the system to another, and at such a difference of potential as would cause electrolysis.

In the case of lead-sheathed cables running parallel to earth returns of tramways, the results have been entirely satisfactory and are conclusive, since, in the absence of bonding, the lead sheathing was rapidly eaten away. This instance, however, is not to be relied upon as an indication that it would be safe to carry out the same process in dealing with gas and water pipes. The lead sheathing is homogeneous, of comparatively high resistance, and with small surface exposed to the earth, whereas the reverse holds true with gas and water pipes as ordinarily laid down. I have no doubt that there are cases in which effective bonding of the rails adjacent to conductors might give entirely satisfactory results, but I should hesitate to make any general recommendation to this effect, since in very many cases a result directly opposite might be obtained.

There is such a difference in soils—first, as to corrosive properties; second, as to electrical conductivity—that a general rule which would prevent electrolysis in every case would be unnecessarily severe, and in many cases prohibitive. It is obvious that, where currents stray generally into the earth so as to enter metallic conductors, the difference of potential should not be allowed to exceed that at which electrolysis begins, + the drop in the earth itself.

In a given system of distribution the controllable features in the earth return are practically limited to the method of jointing the cross section of the rails, and the chemical composition of the rails.

The chemical composition of the rails cannot be altered greatly, since rails low in carbon, but of high electrical conductivity, are found to wear away so rapidly that high carbon rails are a practical necessity.

The cross section of the rail in practice is largely determined from mechanical considerations, and in the best practice rails of from 80 to 100 lbs. per running yard are used.

The method of making the rail joints is practically, then, the only factor controlling the resistance of the rail return that is susceptible to wide variation in practice.

The electric welding of the rail joints has been tried in the United States, but thus far the results have not been such as to encourage the manufacturers to advance the use of the system, or the tramway companies to adopt it.

The joints in electrical tramway work are equally objectionable from either a mechanical or electrical point of view, so that a system of perfectly welded rails would meet with general favour. In practice the effect of temperature in causing expansion and contraction has been noticeable in long lengths of welded rails, but the effects thereof have not been of such a serious nature as might be expected from the range of temperature.

From the reports I have at hand it appears that there were unexpected results of the welding process that made themselves evident in the course of time.

First, the electrical conductivity of the welded section was less than that of a solid rail.

Second, the portions of each rail near the weld were so softened as to wear away unevenly.

Another unexpected result was that, owing to the sudden increase and decrease in temperature, the rail took a very high temper at the weld, so that its power to withstand shock was decreased.

To the writer's mind it is not improbable that these mechanical difficulties could be overcome. Welding apparatus of sufficient capacity, however, is costly, and it is frequently difficult to arrange for the amount of power required; so far, therefore, the process has not been employed in this country.

Another method of somewhat the same nature as the process of welding is that known as the "cast weld," or the "Falk joint." This joint is made by pouring molten metal into a metal mould clamped round the rail joint. The surfaces of the cast metal that come in contact with the mould and with the rail joint are chilled, and are thus prevented from forming a perfect weld. I believe it has been asserted that a weld is effected. It seems, however, extremely doubtful, since without the use of a flux a weld is almost impossible between cold wrought steel and molten iron. The rail expands after the metal is poured around it, and remains expanded until after the cast-iron has set, and finally resumes its former size. This affords a slight clearance for expansion and contraction, and accounts for the mechanical success of the joint, which, if carefully applied, makes when new a perfect mechanical track; although, in the writer's mind, the difference of resilience between the part surrounding the casting and the remaining part of the track may eventually cause uneven wearing away of the rail.

The clearance above spoken of undoubtedly admits a certain amount of moisture, so that by the formation of oxide the resistance of the joint increases in the course of time. From the results of tests which I have at hand, it also appears that the electrical resistance of this joint, even when new, varies considerably; so that, considering the low voltage restrictions in this country, it should be used in connection with an efficient form of bond. Owing to the rigidity of the joint, however, copper bonds will undoubtedly be found more durable in conjunction with it than with a fish-plate form of joint.

Bonds.

The bonds generally used up to this time are of the pressure-contact type, and in making any general statements this is naturally assumed as the basis.

In the discussion of a paper read some time ago before this Institution, the writer pointed out that, according to experience with pressure contacts in central station work, 100 amperes per square inch had been found the limit in best central station practice; and that, considering the trying conditions to which bonds are subjected in the earth, one-half of this value would more likely be satisfactory.

In actual practice I have found it advisable to work to a still lower limit, and in most of the systems which I have designed the current-density at surface of contacts does not exceed 25 amperes per square inch. Experience shows this limit a safe one, and that the contact resistance is negligible as compared with the resistance of the rails.

Considering the complicated phenomena accompanying a junction of copper and iron, in respect to the difference of potential caused by the contact of dissimilar metals, and the effect due to a current passing between dissimilar metals, it seems in the normal case that all E.M.Fs. would balance each other, since in the case of the current keeping uniformly through the rails the E.M.Fs. at the positive ends of a bond are balanced, and in the case of one end of a bond losing its contact the additional resistance would be greatly in excess of the unbalanced contact E.M.F.

The design of copper bond should be largely in reference to the permanency of the contact surface. If there is any working between the surfaces, sooner or later there will be a film of oxide, so that the value of the contact is destroyed. The working of the surfaces may be caused by heating from excessive current density, or by lack of flexibility in the bond. Numerous types have been forthcoming. Many of the bonds brought forward during the last two or three years have been designed with a recognition of the importance of greatly increasing the area of the contact surface, as compared with the cross-section of the body of the bond itself.

It is beyond the scope of this paper to discuss all the different types of bonds that have been brought forward from time to time. Samples of many of the different types are exhibited. The copper bonds that the writer has tested, since they have been more generally used in this country, are either of the "Chicago," "Crown," or "Columbia" type, samples of which are before you.

Flexible bonds are found desirable for use where the mechanical conditions are such that short bonds can be used, in which case the added resistance of the bonds to the track can be made as low as 5 per cent., or less. Bonds of this type have been frequently used in the United States, and with good results when the ends are made of drop forged copper. When, however, the ends have been made of cast copper, and cast on to the conductors, the results are not generally satisfactory. The resistance of cast copper is so much greater than that of drawn copper that it is not best suited for use in bonds. Further, the union between cast copper and drawn copper wires is imperfect, so that the electrical resistance is much higher than between two pieces of pure copper fused together.

The remaining type of bond that I propose to discuss is that known as the "plastic" bond, which was invented by Mr. Edison several years ago. From the results obtained from a line bonded over five years ago, it appears that this plastic alloy, which consists of mercury and other ingredients, as to the nature of which I am uninformed, is much more permanent than might be expected from its mechanical nature. The bond is placed between the fish-plate and the rail, in a cork receptacle, which is compressed to about half its thickness when the fish-plate is drawn up tightly.

The amount of copper required materially to increase the conductivity of well-bonded rails is so great that in ordinary practice auxiliary track feeders are not commercially practicable, unless they be connected in circuit with a source of E.M.F. to compensate for the drop in the feeder, so that this may exceed that in the track return.

I believe Major Cardew was the first to suggest employing E.M.Fs. in feeders to compensate for the drop therein. In the arrangement, however, of the earth return as originally devised by him, it was necessary to use generators of different E.M.Fs. in the generating station. I have used in my work a generator that is separately excited through a coil in series with the trolley feeder, so that the voltage generated by the armature is directly proportional to the current-output, provided the field magnet is not saturated. The armature is in series with an insulated feeder connected with the rail at whatever point it is necessary to take off current. The results in practice are most satisfactory. It has been found that the machine works perfectly automatically, and limits the voltage drop in the earth return to any desired amount by an adjustment of a rheostat in parallel with the field-magnet coil. Fig. 1 gives a diagrammatic representation of the system.

In a system that I have recently designed to carry some 250 cars, I propose to employ several earth generators feeding in from several points in the system. Pairs of test wires are run back to the station from various points, one of the test wires being connected to the track return, and the other to adjacent earth plates. The earth generators in the station will be adjusted from time to time, according to the difference of potential between the earth plates and the earth return. As far as possible the adjustments will be made so that the two are kept generally over the system at the same voltage.

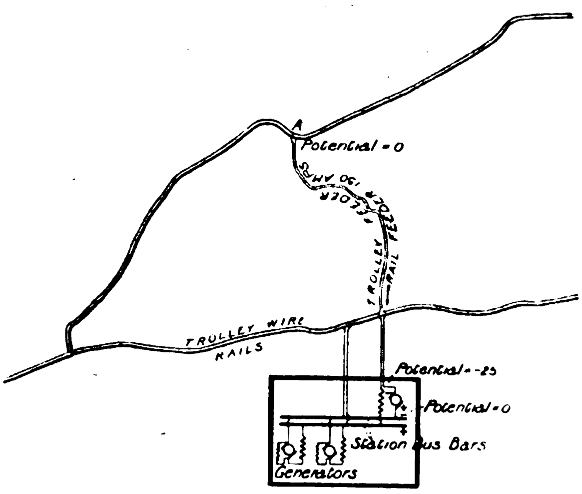


Fig. 1.—Return Booster System.

Whatever difference of potential there is between the two, will be such that the earth return is, in general, positive to the neighbouring water or other pipes, since in this case whatever electrolysis takes place will be in the track return itself.

Steel Rails.

The percentages of carbon, manganese, &c., in steel rails have varied considerably at different times; and there are, even now, wide variations in the practice of different companies, and in different countries.

It may be said that English rails some years back would commonly contain the following:—

Carbon	0·25 to 0·35
Manganese	0·8 „ 1·0
Silicon	0·05
Phosphorus	0·06
Sulphur	0·06

Of late years the percentage of carbon has increased. One large railway company specifies:—

Carbon	0·4 to 0·5
Manganese...	0·95 „ 0·85
Silicon	0·10 „ 0·06
Phosphorus	0·10 „ 0·08
Sulphur	0·08

In American practice the carbon runs still higher, as will be seen from the following:—

Carbon	0·45 to 0·55
Manganese	0·8 „ 1·0
Silicon	0·10 „ 0·15
Phosphorus	0·06
Sulphur	0·06

In France yet higher percentages of carbon have been tried, running up to nearly 1 per cent.

The results are shown in the following table—trials of some sample sections of steel rail of varying compositions which were furnished for testing purposes:—

Carbon.	Manganese.	Silicon.	Phosphorus.	Sulphur.	Resistance compared with copper 20° C.	Resistance of 1 mile 1 sq. in. sectional area at 20° C.
0·378	0·550	0·181	0·040	0·041	10·8	0·468
0·446	0·568	0·188	0·046	0·044	11·1	0·482
0·536	0·592	0·201	0·051	0·059	11·3	0·490
0·568	0·608	0·204	0·053	0·061	11·4	0·495
0·588	0·632	0·214	0·056	0·065	11·5	0·499
0·610	0·650	0·220	0·062	0·071	12·9	0·560

Eight 76-lb. track rails, tested in place after 2½ years' use, gave the following results:—

	Resistance compared with copper 20° C.	Resistance of 1 mile 1 sq. in. sectional area at 20° C.
Test No. 1	11·3	0·490
„ „ 2	10·3	0·447
„ „ 3	10·1	0·438
„ „ 4	10·7	0·464
„ „ 5	9·65	0·419
„ „ 6	10·07	0·437
„ „ 7	10·25	0·445
„ „ 8	10·50	0·455
Average ...	10·4	0·45

Two old 65-lb. rails, much worn, tested in place:—

	Resistance compared with copper 20° C.	Resistance of 1 mile 1 sq. in. sectional area at 20° C.
Test No. 1	11·7	0·508
„ „ 2	12·3	0·534
Average ...	12·0	0·52

High values would be expected owing to the wearing of the rail, which is not allowed for in the calculations.

Two new 90-lb. rails, tested in place:—

	Resistance compared with copper 20° C.	Resistance of 1 mile 1 sq. in. sectional area at 20° C.
Test No. 1	10·6	0·460
„ „ 2	10·4	0·451
Average ...	10·5	0·455

A 66½-lb. rail not laid:—

	10·0	0·434

Bonds.

The current flows across the joints partly through the fish-plates, and partly through the bonds. The resistance of the fish-plates is a variable quantity, but all tests on rails in use have shown that they contribute considerably to the conductivity of the joint.

For the bonds themselves the following tests have been made:—

(1) Conductivity tests on bond copper.
(2) Resistance due to contacts.
(3) Resistance due to current "gathering" from other sections of rail to enter the bond terminal.

(To be continued.)

ELECTRICAL ENERGY (GENERATING STATIONS AND SUPPLY).

(Continued from page 578.)

Lord Cross (chairman) presided over the sitting of the Joint Committee on Thursday, when evidence was given by Mr. James Swinburne, consulting engineer, and Vice-president of the Institution of Electrical Engineers, upon the fourth head of the reference to the Committee, viz., "Whether powers should be given in any case for the supply of electrical energy over an area including districts of numerous local authorities involving plant of exceptional dimensions and high voltage; and, if such powers may properly be given, whether any and what conditions should be imposed—(*a*) with respect to system and plant, and to the construction and location of generating stations in view of the powers of purchase conferred upon local authorities by Sections 2 and 3 of the Electric Lighting Act of 1888; (*b*) with respect to the relations of the promoters to other undertakers, and to local authorities within parts of the area."

Witness, examined by Mr. Pember, Q.C., said that it was now being realised by capitalists that electrical energy could be safely and cheaply conveyed a long distance by wires, and there was nothing to prevent the general development of the distribution of power from the pit's mouth, the only thing remaining to check such industrial development being legal difficulties. They could carry extra high electric pressure by comparatively small wires to various places where there was a demand. Overhead wires were used abroad, but in this country only underground wires would be employed. Such systems could supply power at a long distance and over an enormous area. In order to supply such an area there would be local transformer stations or sub-stations, which would be comparatively small affairs, and there would be no smoke, steam, or vibration. Electrical progress was disgracefully behindhand in England, one reason being that it was not realised as it should be, that distribution was as good in the case of coal as in that of water power; the novelty, from the engineering point of view, was practically nothing. He had considered how far an extended distribution was necessary for the purpose of cheapness. He would not say it was a necessity, but it would be an advantage. Besides lighting, there was the question of energy for motors and tramways and light railways. It frequently happened, if there was a central supply, many small villages and towns could be lighted, because the capital cost would only be for distribution. That would be especially advantageous in the Black Country. There was an extreme case to be considered in the fact that looms could be worked by motors. There was no doubt also in the future, that mills and engines, and so on, would be driven by motors. He had lately inspected one of the largest electric factories in Berlin, and found between 6,000 and 8,000 people employed making about 30 dynamos and motors a day. The majority of these motors were for the purpose of driving machinery. For cotton spinning, where uniform speed was an essential, a motor would be preferable to an engine. For all such things as these the central supply would be the cheapest way of bringing the current. With regard to the protection of the consumer, he thought competition might be allowed if the district was served badly either in the way of price or distribution. Local authorities had the chance of competing on exceptional terms with other people. He saw no need for a monopoly being given to any company. All sorts of people scattered about could get power, such as farmers, to drive threshing machinery, and even in an extreme case, it might pay to light up the harvest field all night. A thing managed on a large scale could be worked cheaper than on a small scale. In the case of a town supply, if the local authority worked a station properly there was no reason for the scheme of supplying power in bulk to come in; but if the station was not worked properly it would be to the advantage of the ratepayers to have a supply in bulk. The only thing which it would be to the advantage of the local authority to purchase would be the low pressure distribution; but even then the conditions were not the same as in the case of an ordinary electric light company. He thought if the local authority had the power to purchase in 42 years they would get a much better bargain than in an ordinary case.

Mr. PEMBER: You think such a distribution would be a great public and commercial benefit?—Yes, and it must be considered from a public and commercial point of view, and not from a parochial point of view.

And you see no reason why there should not be compulsory purchase of land for a generating station as much as in the case of a railway station?—I think there is more reason in this case.

Proceeding, WITNESS said there should be power to break up the roads. It only involved the taking up the roads once to lay down the mains.

Mr. COWARD: The position of the local authorities is this. Should such a scheme as you suggest be authorised without the consent of the local authorities within the area of supply. Is that your view?—I do not see why you should get the consent of, perhaps, 150 local authorities.

Further examined, WITNESS said that he saw no reason why there should be the consent of the local authority in the area where the generating station was erected, because places could be chosen where there could be no nuisance. Some years ago he worked out a scheme of transmitting power from the Midlands to London, and it would pay perfectly. He did not think they could make general principles of purchase fit in with regard to London as could be laid down with respect to the country, because the conditions were so different. He saw no reason why it should not be laid down that the local authorities should fix the route which mains should take, subject to an appeal to the Board of Trade, and also that the local authorities might carry out the work at the expense of the undertakers.

By Lord SPENCER: The chief disturbance to telephones and telegraphs came from electric traction, and no difference could ensue from the supply coming from a distance. He would give the local authority every kind of notice and right to appear before compulsory purchase was adopted.

Questioned by Mr. KIMBER: The cost of coal might be considered the governing power in the supply of electricity. He thought special conditions would have to be imposed with respect to the danger of high voltages, but such conditions could be easily met. It would be fair that notice should be given to the neighbouring owners of the intention to build a generating station. In many of the modern generating stations there was no vibration at all.

Replying to Lord KNUTSFORD, WITNESS said that some protection should be given to the consumer in regard to price, possibly by a reference to the Board of Trade.

By Lord BALCARRES: High pressure and extra high pressure mains were carried overhead abroad. It was a danger, but he thought too much was made of it. It was certainly not the case to say that the carrying of such mains overhead was the cause of considerable loss of life. He would not recommend the carrying of overhead mains in towns.

By Lord MONKSWELL: It would pay to supply London from the Midlands, because of the saving in the cost and handling of coal. He thought the ordinary law of nuisance should apply to electric lighting companies in towns.

Questioned by the CHAIRMAN, WITNESS said if they got the power to erect these large generating stations, they were safe from purchase.

Mr. HENRY GRAHAM HARRIS, partner of Sir Fredk. Bramwell, said his firm had erected several electric stations. They had been consulted with regard to the supply of electricity at high voltage from long distances, and the supply to a large area from a central station would be economical, and would lessen the price to the consumer. There were several grounds of economy. The management expenses would be less, and the cost of the installation of the works per unit would be less. Larger units of machinery were cheaper, proportionately. The cost of collection would also be less. The current could be used for various purposes besides that of lighting. He agreed generally with the evidence of the preceding witness.

Questioned by Mr. COWARD, WITNESS said he agreed with the evidence of the previous witness that the local authority should have the right to direct the route of mains in their streets.

By Mr. KIMBER: He thought the sliding scale of the gas companies was a good thing, but the question was that there should be no purchase if the scale was adopted with electric lighting companies.

By the CHAIRMAN: Before the Electric Lighting Act of 1888 extended the time to 42 years, it was not worth while for capitalists to put their money into such undertakings, because the period was not sufficient and the risk too great. It was extremely doubtful now, in some cases, whether 42 years was sufficient, but in a large number of cases it was sufficient.

Mr. JOHN FRANCIS ALBRIGHT, chairman of the Midland Electric Corporation Scheme, said his view upon giving a power to a company to supply wholesale was, that it was important to a company like he represented to have the power to supply to corporations for lighting purposes. At the present time the company was in a dilemma, because, whereas they contracted with the corporations to supply them only, yet, under the law, they were called upon to supply all demands. He did not say that such corporations as Manchester and Liverpool could not supply as cheaply as a large company, but a small local authority could not do so.

By Mr. KIMBER: He would not object to the sliding scale. He could not say at what price the London companies could supply light, because the conditions were so different.

By Sir ALFRED LYELL: In London there would never be the same demand as in the Black Country.

Mr. PEMBER said that would conclude the case for the companies.

An argument took place with Mr. STEVEN (representing the present companies) as to calling witnesses, and it was decided that he should not.

Mr. CRIPPS (Parliamentary Agent) asked that the Metropolitan Electric Lighting Company should be heard. That company was the largest in London, and as Mr. Pember was representing a combination of competing companies their interests were not identical.

The CHAIRMAN said the Committee would hear counsel for the company on any new point.

The Corporation witnesses were then called.

Mr. HIGGINBOTTOM, Alderman of the city of Manchester and chairman of the Corporation's Electricity Committee, was first called. He said that the Corporation had power to supply energy to the whole of the city, and they were also the undertakers of surrounding communities. The demand had become very great. Manchester had always maintained that the Corporation should have sole and absolute control of the streets. Gas, electric lighting, and hydraulic power were all supplied municipally. The duplication of electric mains would be extremely undesirable. The electric supply in Manchester had been a very profitable undertaking from the first. Local authorities ought to have power to acquire land compulsorily, and companies should be in the same position. Electrical undertakings should be exempt from proceedings for nuisance, where proper care was exercised. As far as possible, all stations should be confined within the area of supply, and in laying mains between an outside generating station and the area of distribution, the local authority should have the right of determining the route of the mains, and of itself doing the work of laying down if it so wished. The consent of the local authority should be necessary to any undertaking for the supply of electrical energy, and the right of purchase given under the general Act should remain. The case of London, he thought, was quite different from that of the other great provincial towns.

Lord Cross presided on Monday over a further sitting of the Joint Committee.

Sir SAMUEL JOHNSON, Town Clerk of the city of Nottingham, which had a population of 230,000, said the Corporation already possessed the gas works, and they supplied gas to an area of 100 square miles outside the city boundary. They also owned the water and the tramways. They started an electrical undertaking four years ago, so as to maintain their authority over the streets. It was not thought that the electric station would pay at first, but it had been a great success. They made a profit both from the gas and water. Last year they made £33,000 odd profit from the gas, most of which was due to the city. They attached great importance to the control of their streets. They agreed that Corporations should have compulsory power to purchase land for generating stations. In other words, they asked to be put on the same footing as other undertakings where power was given to acquire land compulsorily for the public benefit. He was authorised to speak for Lincoln, Rotherham, Chesterfield, Doncaster, and some 12 other cities, and the strong feeling of all those places was that they should keep the control of the streets, and that they should not be given up to dividend-seeking companies. There was no objection to the Board of Trade dispensing with the consent of the local authority, if it were shown that there were no good grounds for refusal to allow the streets to be opened.

By Mr. PEMBER: They supplied their largest consumers with electricity at 2⅜d. per unit. Ordinary consumers were charged 6d. for the first hour. They had about four miles of subways, through which all pipes were carried. The reason he referred to dividend-paying companies was that their chief object was to pay a dividend, and not the public convenience. According to the practice of the Board of Trade, his Corporation had the monopoly of the supply of electric light. In the case of a central supply company wishing to carry a main through their streets, and not to supply the city, they did not object to their consent being subject to the Board of Trade. They committed no nuisance whatever in respect of their generating station. He thought that notices of an intention to acquire land for an electric generating station should be served on occupiers within a radius of 50 yards.

Examined by Mr. BALFOUR BROWN, WITNESS said applications had been made for their consent to electric companies coming into the city, but having invested the ratepayers' money in an electric light undertaking, they did not see why a company should come in. If the Corporation were not doing their duty they should not be exempt from competition.

By Lord SPENCER: When he said the Corporation should have a veto regarding the breaking up of the streets, he meant that that should be subject to the Board of Trade or Parliament. The Corporation had not at present contemplated supplying electric light outside their area. They could generate all the power they required in their own area, but in the case of an authority being unable to generate within its own area, there should be power to carry a main through other areas, subject to conditions.

Questioned by Mr. KIMBER: Their powers with regard to electric light were conferred by a provisional order. It seemed a fair proposition that they should have compulsory powers for the acquisition of land for generating stations. At present they did not supply power; not because they could not do so as cheaply as steam, but simply because there was no demand for it before. Now they intended applying electrical power to the tramways, and the matter was now before the Corporation. They would be able to supply electrical power cheaper than the light, because there would be a day load.

Lord BALCARRES: If a great demand arises for energy in your city, are you convinced that the municipality will be able to meet that demand?—Certainly; to the uppermost.

Your municipality desires a monopoly?—Yes, the same as for gas.

By Mr. ASHTON: The municipality did not appear to have protection in the outside area they supplied with water in respect of interference by electricity. He had heard that 10,000 to 20,000 volts was contemplated being passed through mains, and in that case, in a county like theirs, liable to be broken up by mining operations, the water pipes might be damaged, and the supply to the town stopped.

By Lord MONKSWELL: The objection that manufacturers would not take power from the Corporation because of business secrets leaking out he did not think would hold good, because at present they supplied gas power to manufacturers.

By Mr. KIMBER: His Corporation was opposing the Bill of the General Power Distributing Company.

Further examined by Mr. PEMBER, WITNESS said that after paying off all preliminary charges, and providing for all costs, and all charges such as rates and taxes, interest on money and sinking fund, they made a profit in the first year of £500, and in the next year a profit of £2,200. Then they reduced the price of the light to the extent of £2,000, but still made a profit of £3,600. They were seeking to double their station now, and if they did that, and the demand for light still continued, they would be able to reduce the cost. They had 35,000 8-candle-power lamps, and supplied 4,800,000 units.

Mr. GEO. FRANKLIN, Lord Mayor of Sheffield, said that the Corporation had agreed to purchase the undertaking of the Sheffield Electric Light and Power Company, and they were promoting a Bill in Parliament to affirm the agreement for the purchase. They were opposing the Bill of the General Power Distributing Company. The generating station in Sheffield was situated almost in the centre of the town, and had been running about 12 years with absolutely no complaint as to nuisance. They got a plentiful and cheap supply of coal, and so far as Sheffield was concerned, there would be no advantage in having a huge generating station at the pit's mouth. He agreed as to compulsory powers being given for the acquisition of sites, and they deprecated any interference with the streets. He agreed generally with the evidence of the previous witness.

By Mr. RICKARDS: He thought that municipal corporations could undoubtedly carry out industrial undertakings as economically as private companies. Sheffield was indebted to private enterprise for the starting of an electric undertaking.

Questioned by Mr. KIMBER, WITNESS said that the present Sheffield Company did not supply power, but the Corporation intended to do so, and were making arrangements to work the tramways by electricity. He did not think electricity would be more economical to manufacturers in Sheffield of armour plate and things of that sort. The maximum charge of the Sheffield Company was 4d. per unit, and last year they supplied three-quarters of a million units. With the increase of output and the equalisation of the load, the Corporation hoped to decrease the price considerably. They hoped to bring down the cost in two years to 1d. per unit.

By Lord KNUTSFORD: So far as the mere breaking up of the streets was concerned, they would not object if the work was left in the hands of the Corporation.

Examined by Lord BALCARRES: Two years ago the Corporation would have objected to competition, because when the company went to Parliament an agreement was arrived at with the Corporation.

By Mr. ASHTON: A newspaper notice should be sufficient for neighbouring occupiers of intention to take land for a generating station.

Dr. JOHN HOPKINSON, F.R.S., and past-president of the Institution of Electrical Engineers, said he agreed that both companies and local authorities should have compulsory powers to acquire land for generating stations. With respect to breaking up the streets, the local authority should have the power of withholding their consent, subject to the action of the Board of Trade. The reason that the charge for power could be less than light was that those using power used it for a longer period.

By Mr. KIMBER: He came before the Committee at the instance of the Corporations. He was frequently consulted by electric light companies, and was connected with the Metropolitan Electric Light Company.

Questioned by Sir LEONARD LYELL, WITNESS said there was undoubted risk to gas and water pipes by the working of electrical tramways, but the Board of Trade had laid down conditions which would prevent that, and a careful engineer would take even greater precaution.

By Mr. ASHTON: There were dangers in a town from overhead electric wires, but much greater freedom might be permitted in the country with regard to overhead wires.

Lord BALCARRES: Do you think these great general distributing stations have in them the elements of success?—When their power is very cheap I think they have. In the case of coal I do not think it makes much difference, as coal can be easily carried.

The CHAIRMAN: Supposing you were an autocrat, and had to supply a large industrial area with the cheapest power, would you advocate one central station in one particular place, or a number of them?—A great many. Of course, you must take the particulars of towns into consideration. In the case of London there would be a difficulty of getting a site.

If you had to make a fresh start with London, what would you do?—If I had to make a start with all the experience we have had, I should put the stations outside.

Would you put up one station for the whole of London?—No; probably two or three.

On the ground of economy, how many stations would you have?—I do not think there would be much economy in having only one station, except as regards rent.

But suppose you get the land cheap for the supply of London, how many stations would you have?—Five or six.

Sir ALEXANDER BINNIE, chief engineer to the London County Council, said that at the present time there were in London 26 bodies authorised to supply electrical energy, 14 of which were companies, and 12 local authorities. Of the local authorities with electric lighting orders, five were supplying the areas shown. In consequence of the crowded condition of the streets, the matter was becoming serious, and would have to be dealt with in a more thorough manner than it had been.

Mr. J. W. BENN, chairman of the Highways Committee of the London County Council, described the powers which that body had over the companies in regard to opening the streets. The companies had to ask the consent of the County Council.

By Mr. BALFOUR BROWNE: He quite understood that the Board of Trade was the final authority as to opening the streets. The County Council had no power to purchase any portion of the electrical plant in London.

Questioned by Earl SPENCER: It was quite peculiar to London that the London County Council, while having certain powers over the Electric Light Company, had no power of purchase. He thought they certainly should have power of purchase. In the event of such power being given, they would ask for the power to erect stations outside their own area, and they had a precedent for that in the case of the sewage system.

By Mr. KIMBER: With respect to the proposals to supply energy in bulk, it seemed to him that the power of purchase was valueless to the local authorities.

By Lord CROSS: The County Council would reduce the price of the light before relieving the rates if they owned the electric lighting companies. Municipal ownership was, however, their chief object.

The CHAIRMAN: I thought so.

Earl RUSSELL, late chairman of the Highways Committee of the London County Council, said that if a central supply system was to come in, the power of purchase would have to be in the hands of the central authority.

By Lord BALCARRES: There was no suggestion that the local authorities should be deprived of the right they had now to buy up electric light stations after a certain number of years.

Mr. W. H. PREECE, chief electrician of the Post Office, said that generating stations were required for other purposes than those which had been brought before the Committee. They had been told of the supply of energy for lighting and power purposes which were growing at a considerable rate; but besides that there was the working of tramways, the supply of current for charging batteries for cabs and vans in London, and also generally for traction purposes. Then again, there was a very important field about to be opened, which was the working of existing railways by electricity. The Metropolitan District Railway had obtained a Bill, which had passed through one House, to enable them to work their railway by electricity. In the future, also, electrical energy would be used largely for chemical manufacture and the production of heat. These were things which showed that the construction of these central stations required legislation conditions. Their attention was first called to the nuisance likely to arise by the interference with telephones. Now the Telephone Company had learned wisdom, and the practice was invariably to make the telephone circuit a metallic circuit. With telegraphs it was quite a different matter, for with the enormous system it was impossible to duplicate the wires. Disturbances had been caused at Greenwich Observatory by the City and South London Railway, and at Liverpool by the Overhead Railway. All those disturbances could, however, be remedied. There was one difficulty which up to the present had not been entirely removed, and that was in the working of tramways by the trolley wire system. From them loose currents ran about which affected water pipes and gas pipes. There was no doubt, however, that with stringent clauses appointing proper control these disturbances would ultimately be removed also.

Do the power houses cause nuisance?—They might, but they are remedial. There is, of course, the cartage of the coals and the removal of the ashes, which cannot be avoided.

But vibration with these new engines can be avoided altogether?—Yes.

So that, practically, there is no nuisance?—The only nuisance is possible vibration from neglect.

The operation of opening streets might become a nuisance?—Yes, I would keep that under the local authority.

If you had to start afresh with London, how many stations would you have?—I think London could be served for all purposes if we had four large central stations. Two or three on the banks of the Thames, or two or three on the main railways. That would remedy almost all the difficulties I have enumerated.

Continuing, WITNESS said that the Manchester Corporation had its own station, and they were going to build another large station on the outskirts of their area. Glasgow was a very similar case. Glasgow was one of those places where electrical enterprise had advanced at a very rapid rate indeed. He had visited the great generating station at Niagara before it was opened, and was acquainted with its progress. There they utilised the water-power with the intention of distributing it to places at a great distance; but as a matter of fact, a large town had grown up close to the station. In Buffalo city, 20 or 30 miles distant, they found they could generate the energy as cheaply with coal. He did not think the Niagara station could supply further than 30 miles at as cheap a rate. He thought there should be power to compulsorily purchase land for generating stations.

The CHAIRMAN: Do you look forward to a great increase in the use of electricity in the next few years?—Yes, and I think the progress made in this country has been too much discredited. The progress made in England is very great indeed. Progress with regard to electric tramways has been slow, and that is due to the clauses in the Tramways Act. With regard to electric lighting, I am not sure that we are not in advance of America.

Proceeding, WITNESS referred to the network of pipes of all sorts under many of the streets of London, and he thought the time would come when the Post Office would have to put itself officially in communication with the London County Council and the local authorities to see if they could come to some terms by which subways could be constructed for the mains.

Sir COURTENAY BOYLE, recalled, put in a letter received from Mr. Alexander Siemens with regard to the question of insulation in Germany.

Questioned by Mr. KIMBER as to the possibility of having a sliding scale for electric lighting companies as in the case of gas companies, WITNESS said the difficulty was to fix the initial price; but the Board of Trade hoped soon to introduce the sliding scale.

(*To be continued.*)

HIGH RESISTANCE INSULATION.*

By REGINALD A. FESSENDEN.

(*Concluded from page* 598.)

As mentioned, this author considered a simple case of Maxwell's general theory, and proved the above results by making actual measurements on condensers and resistances connected up so as to correspond to a simple case of a dielectric of high resistance with conducting particles in it. This paper should be read by all electricians, especially those concerned with cable work. I would like to speak of this subject more in detail, but for lack of time will only add that most of the conclusions in that paper have been confirmed by me, and that some which had been arrived at independently were seen to be in perfect agreement.

It is this absorption and the consequent losses which make glass useless as an insulator against high A.C. voltages. In some experiments made by Messrs. Stanley & Chesney which were shown me, the glass plates of the condenser, when on an A.C. voltage (though thick enough to have stood 10 times the D.C. voltage), after a few moments got hot, sparks could be seen passing inside the glass, and the plates finally broke down. Glass is not homogeneous, as it is made up of a number of substances, some much better conductors than others, and of different capacities, and all stirred together but not dissolved. This is shown by the care which has to be used in getting glass homogenous enough for optical purposes, it even having, as has been told me by Mr. Brashear, to be kept perfectly horizontal when annealing, as the heavier parts tend so much to sink down to the bottom, even when the glass is only plastic, that the only way to do is to keep the levels of different density parallel to the surface of the disc so that their effect on the light will be as equal as possible for all rays. Otherwise one side of the lens would be of heavy glass and the other light, while at present it is so arranged that one face is dense and the other light. Mica is much less objectionable, especially if its cracks are filled up and it is well dried. Paraffin when properly treated makes very good condensers. The old method of piling together pieces of paraffin paper and tinfoil and then pressing them, left much air and moisture inside. This produced large electrical absorption and gave large capacity. Messrs. Hutin & Le Blanc were the first to discover that good condensers could be made by heating such condensers till the moisture and air were expelled. Their results† showed that the specific inductive capacity of this more homogenous dielectric could be reduced from 8 to 2·5. I have myself found it come down as low as two. They then found that the same results could be obtained by heating the paper before making up the condenser. Since then, this method of forming condensers by heating them to expel moisture, air and acid has been used quite generally, with some modifications and improvements resulting in a shortening of the process.

It may be said as a general rule that the capacity of all substances showing absorption may be reduced by this treatment, if the heating be kept up long enough. A great many oils, for instance, are given high capacities, but I have found that in many cases this can be greatly reduced by this method, and that the slight remaining excess of K. over that called for by Maxwell's theory can be almost entirely removed by removing the free fatty acids, mucins, &c. Oils tested by me were olive, castor, linseed, and cottonseed. All these have very high insulation resistance and low specific capacity when so treated and purified, but they soon lose this again when exposed to air. It is evident, therefore, that the anomalous results obtained by Hopkinson and others were due, in some cases at least, to impure material, and such results must be considered as forming a strong proof of the correctness of Maxwell's theory.*

But when the substances are not themselves solid, but viscous, they must have a mechanical backing. For this pure cellulose is generally used. Pure cellulose contains some loosely combined moisture. Consequently it can exist in two states. Dried below 100° C. it decreases its specific inductive capacity very much, and has very high resistance and is flexible. Kept above 100° C. for any length of time it loses some of its combined water, has a much higher ohmic resistance, and its specific inductive capacity sinks to 1·9 or 2. It, however, becomes very brittle, and even though the temperature be only a few degrees above 100° C., it finally cannot be bent without breaking. (This brittleness must be carefully distinguished from the so-called rottenness which cotton fabrics get when dipped in linseed oil and dried. The fact that cotton tears easily in such a condition is due to the same cause as makes a wire mosquito netting tear when painted, *i.e.*, the fibres are stuck fast by the varnish and cannot help one another. This can be proven by removing the dried oil, when the fibre will be found to have nearly its original strength.) In this condition it is best suited for making condensers. The paraffin itself is greatly improved, as was pointed out by Hutin and Le Blanc, by heating to about 140° C. Three hours heating I have found satisfactory. The dried paper, immediately on removal from the oven, is plunged into the hot paraffin, so as to protect it from absorbing moisture. The condenser is then made up and boiled so as to remove the air, for several hours. This boiling method was described in a recent patent as a novelty, but it was used by Mr. Chesney at Pittsfield in 1891.

A condenser so made, if perfectly pure cellulose is used (perfectly pure paper is used in practice), and with pure paraffin, will stand 250 volts per thousandth of an inch when the dielectric is less than ·01 inch, and at a higher rate for greater thicknesses, when the effect of small defects in one sheet of paper is not so serious.

Practically the same remarks apply to the making of induction coils. Here, however, we meet with the great difficulty that the paraffin in cooling is sure to shrink, and will leave hollows inside. The way to get over this is to construct the coil so that when cooling the shrinkage will take place outside, just as if one were making a casting of some metal having great contraction. The coefficient of adhesion also should be less between the walls of the mould and paraffin than between the wire and paraffin; also the outside should never be let harden first, as then, of course, a hollow space is left inside. Another precaution is to expel all gases by heating the paraffin for some time above the temperature at which the coils are to be boiled. The coils should be boiled above 100° C. for some hours to drive off the loosely combined water. This destroys the mechanical strength of the cellulose, but as the whole coil forms a solid mass this is of no great consequence.

Silk should never be used where high insulation is required, as pure cellulose, dry and boiled in paraffin, is so much superior to it that there is no comparison. With pure cellulose, coils with only 1,700 feet of wire per inch of spark stand perfectly, *i.e.*, the spark may be five times longer than the coil. In ordinary use, coils having a spark length $3\frac{1}{2}$ times that of the coil have been run for long periods with no breakdowns.

As regards oil insulation for ordinary induction coils, the writer has not had sufficient practical experience. I believe, however, that very good results are obtained. With regard to the Thomson high frequency coil,† there is no question of the efficacy of oil there, especially with regard to ease of repair. As is well known, however, the oil and coil should always be heated above 110° C. for some time if the best results are to be obtained. A very curious increase of insu-

* Extract from a paper read before the American Institute of Electrical Engineers. From an incomplete advance proof.

† *La Lumiere Elec.*; July 25th, 1891.

* A rule connecting this effect with the sign of the Kerr's electrostatic optical effect has been given by the writer.—*Elec. World*, January 2nd, 1897.

† Popularly known as the Tesla coil, on account of his having brought it into prominence through his use of it in his lectures though it was invented and first described by Elihu Thomson.

lating power for high frequencies in oil has been noted by Elihu Thomson, who has suggested that it might be due to inertia of the molecules of oil. To test this, one of the writer's students, Mr. Bennet, constructed a two-phase high frequency electrostatic field. Though insulators placed in this rotated even when placed within a $\frac{1}{16}$th inch glass flask, the effect was found to be due to air currents, and when these were eliminated no movement was obtained, so that the cause of this effect is still unknown, and it is doubtful if true dielectric hysteresis has ever been observed.

So far as Mr. Chattock's experiments and the experience of the writer go, there is not a great deal of difference between the dielectric strength of different substances. It is probably related to the tensile strength. As mentioned previously, the writer* pointed out that there was strong evidence to show that the tensile strength of a substance was due to the mutual attraction of charges on the atoms, and that the observed values agreed well with the calculated and followed the same law. Some time later, Chattock,† in a very interesting and able paper, showed that, as the results of his experiments, the dielectric broke down when the slope of potential was great enough to pull apart atoms having charges of the same dimensions as the ionic charges. This was shown for gases, fluids, and solids, and forms a very interesting—and, I believe, independent—corroboration of the writer's electrostatic theory of cohesion. Consequently, the nearer the atoms are together, and the greater their rigidity, the greater also their dielectric strength.

Chattock's experiments give for solids and fluids :—

Substance.	Volts per cm. for breaking down.
Glass	919.000
Water	1,050.000
Oil	930.000

which agrees well with the theory.

From the above it will be seen that, if the materials are pure, and ohmic resistance is of not much importance, a compound having its molecules held together tightly will have a good dielectric strength for D.C. voltages.

This paper is already so long that I cannot touch in detail on the question of cables. There are also other papers in existence written by men better equipped for the task. I had intended saying something about what Siemens has called the "absurd craze for high insulation resistance," but the fact is now generally recognised, except by inexperienced engineers, that the best cables are those of medium ohmic resistance. I will only mention two methods which have occurred to me as feasible for certain purposes. One is based on the fact that the dielectric strength of air, as shown by the experiments of J. J. Thomson and Peace, increases very rapidly with the pressure, at 90 lbs. per square inch being equal to that of a good quality of rubber. A similar plan, though not requiring any very large pressure, is due to Mr. Westinghouse, who thought of employing it four or five years ago in Philadelphia. The second occurred to the writer on reading Elihu Thomson's article on the use of liquid air as an insulator. It is this: Since ice at only 12 below freezing has a specific resistance of over 1,000 meghoms, *i.e.*, as good as some brands of insulation, why not make the conductors hollow, lay them in a trench filled with water, pass cold brine through the pipes, use the brine for cooling houses, making ice, &c., and let the frozen water act as the insulator. A rough calculation shows that this is commercially feasible, even neglecting all sources of profit from the furnishing of the brine (*i.e.*, if it were used only for cooling the pipes). After making all allowance for friction of fluid, cost of power, &c., the balance comes at the right end, if the line is always fully loaded.

The question is sometimes raised, whether we can ever hope to have a non-inflammable substance which shall be elastic like India-rubber. The probable cause of the elasticity of rubber is known,‡ and it would seem as if there was no reason why such a substance should not be prepared. All we have to do is to coagulate one substance in the midst of another. In fact, we have at present in tetrametaphosphate of sodium such a substance, elastic as rubber, transparent and tough, and when pure, a good insulator. It would be an admirable material if it were not for the fact that the elasticity is due to water, and when this dries out it becomes brittle.

As regards an organic artificial rubber, I have very little doubt but that it will be made as soon as it is understood by chemists that its properties are due to structural and not chemical causes.

Armature windings.—The present methods of using mica leave little to be desired. The writer might mention, however, one novel method he used in a case where very heavy currents were to be carried. Asbestos and silicate of soda, as is well known, form a good coating, but is, however, poor mechanically. The armature bars were wrapped with asbestos string and then coated with the silicate. This made when dry an extremely firm covering which could only be removed with a hammer. Though at first a bank of 100 lamps could be lit up through the insulation, after a little running it dried out to quite a high figure and the machine did good service, at one time running several hours as I am informed on good authority, under such an overload that the carbon brushes were red hot.

In cases where cloth is to be treated, we have a very different question. There are two ways of using cloth, first, as a backing merely, by coating it on the surface with some substance which is supported by it, as plaster on lathing. Many substances work well in this situation, but the fact that little tubes of cellulose are very apt to stick up through the coating, as was pointed out to me by Mr. F. R. Upton many years ago, and that if moisture gets in at the edge it spreads all over, renders it not the best kind of insulation. Rubber is sometimes applied in this way to cotton tape, but though of very high resistance and insulation at first, it rapidly deteriorates. In general it should be said, that where a permanent result is desired, rubber should never be used unless kept in the dark, and out of contact with air. If these precautions be neglected, the life is very short. The other method is to saturate the whole cloth with some substance which will penetrate every crevice; but when this impregnating substance has solidified, it must continue to fill these crevices and capilliary tubes. For this reason no substance which is dissolved in anything else can be used. If, for instance, we try a varnish dissolved in alcohol, it will be found that the strength of the solution in the capillary tubes is much smaller than outside, for the same reason that sea water filtered through sand becomes fresh.* Consequently on drying these capillary spaces are not filled up and let water in. Therefore, unless we adopt the first method and plaster the insulator on thickly and deep enough so that it does not matter whether the support insulates or not, we must use melted solids or drying oils. Unfortunately but few solids which melt are *elastic*, since this elasticity is obtained by a structure which is destroyed by melting, and those solids which melt into thin liquids and remain *flexible* when solid do not preserve this property except within narrow limits of temperature, as can be easily tested by holding under a cold water tap and striking the specimen sharply. Soft paraffin can be used in some cases if the cellulose be well dried and thoroughly saturated. The asphalts cannot as a rule be used, as they never get sufficiently fluid on melting. There is, however, one notable exception: uintaite or, as it is commercially called, gilsonite. This substance I found many years ago had the peculiar property that, when melted, like paraffin or oil, it will pass into the the pores of cellulose or cloth. Having a very high melting point, nearly 300° if I remember, and mixing perfectly with paraffin in all proportions, it gives mixtures which are admirably adapted for induction coil work as these compounds can be made to have high melting points and to penetrate a coil thoroughly. I also, some years later, in 1891, used this material in combination with linseed oil for transformers, the process at first proposed being boiling in vacuum, but it was found that even without this saturation was complete. I understand that this method is still used, though modified in form, by the company for which I first devised it. Of the drying oils, with the exception of some foreign oils as Chinese wood oil, and an African oil whose name I cannot recollect or ascertain, linseed and the drying nut oils are the best. Linseed oil has the remarkable property of expanding on drying. This enables it to fill up all pores. Its durability is evinced by the good condition of old oil paintings. The varnishes crack and go, but the oil

* *Elec. World*, Aug. 8th and 22nd, 1891.
† *Phil. Mag.*, Dec., 1892.
‡ Molecular Physics, Franklin Inst., September 18th, 1896.

* J. J. Thomson, "App. on Dyn. to Phys. and Chem.," p. 190.

remains. Its insulation is not injured up to very high temperatures at which shellac, rubber, &c., would be worthless. This material was used a great deal by the Edison company in its early days, but it often broke down. The trouble was traced to the lead drier, and after many experiments Mr. Marshall, who had charge of this work, finally settled upon the use of pure raw oil. This gave excellent results, and was long used, but took some time to dry, and the writer finally, after many tests, found that borate of manganese drier got rid of the trouble, while, as is well known, it gives a very quick drying varnish. This was used by the United States Company in Newark on their machines, with the result that in 1890, after use for a year, the former reported only two armatures so treated as returned for repair (they were injured by lightning), and no fields. This material was also used by the Stanley Company for transformers. Another advantage of this borated oil is, that it always retains a slight stickiness, and so gives a good joint when wrapping around wires, &c. Many substances so used are not sticky, and let moisture in through the joints. Where a smooth surface is required, it is readily obtained by dusting on a little talc, a method first suggested, I believe, by Mr. Edison. It can also be given a coat of Japan on the outside. Varnish gums should never be used with linseed oil, as they are brittle, and the dried oil is only just flexible enough. Consequently, when the oil has dried the resultant varnish is always very brittle. A temporary elasticity is given at first by the fact that when the solvent has dried off the oil is still fluid and undried, and as the varnish gum keeps the air from getting at it rapidly, it sometimes remain flexible for a year. Such mixtures also crack when cold.

Sample *c* is a specimen of borated oil saturated cloth, which is now between eight and nine years old. It will be noted that it is still fresh and flexible, and a recent dielectric strength test showed up very high, 7,000 volts if I recollect. The pure raw oil is boiled at about 200° with ½ per cent. of borate of manganese for several hours till it begins to be thick.

Non-inflammable materials can be made, as I have pointed out elsewhere, by taking out the hydrogen atoms of hydrocarbons and substituting chlorine. Even paraffin can be thus treated if kept warm, and first turns to a fluid and then to a solid. At one time it seemed as if this process might be valuable, but the use of enclosed conduits has done away with the greatest source of danger from fire.

I will conclude by describing a couple of devices which I have found useful in preventing insulation from being spoiled. Soldering acid, as commonly used is a solution of chloride of zinc. If this falls on cellulose it turns it to a paste. It never evaporates and always takes up moisture from the air, and will gradually eat its way through quite a thickness of insulation. Whether it is acid or neutral makes no difference so far as its action on the insulation is concerned, though the neutral solution does not corrode the wire. Resin has the disadvantage that it is not a fluid, and is clumsy to handle. I have found that by shaking up powdered resin in very strong ammonia, an ammonia soap is produced which works well in most cases. The ammonia dissolves the copper oxide and evaporates afterwards, leaving the powdered resin which is an insulator.

Apparatus can be protected from overheating by putting in the apparatus a small glass tube filled with carnauba wax. This melts near the danger point, but remains quite hard up till then, so that by imbedding a spring and contact in the wax, when the apparatus gets too warm the wax gives, and the spring expanding causes a short circuit, which blows the fuse.

The largeness of the subject must be my excuse for the fragmentary nature of this paper. After I had begun it I found I had made a mistake; what I should have undertaken was to write a book. I trust, however, that some of the points I have developed may prove of interest.

NEW PATENTS.—1898.

Compiled expressly for this journal by W. P. Thompson & Co., *Electrical Patent Agents,* 322, *High Holborn, London, W.C., to whom all inquiries should be addressed.*

8,988. "Improvements in electrodes for accumulators." C. Alker and P. Mennesseier. Dated April 18th.

9,002. "Improvements in, or connected with, apparatus for the manufacture of potassium chlorate or sodium chlorate by electrolysis." J. Brock and The United Alkali Company, Limited. Dated April 18th.

9,047. "Hanger for trolley wires of electric railways." W. A. McCallum. Dated April 19th. (*Complete.*)

9,070. "Improvements in contact shoes for electric railways." W. M. Brown. Dated April 19th. (*Complete.*)

9,071. "Improvements in, and relating to, telegraph and like cables." J. A. L. Desblove. Dated April 19th.

9,077. "Improvements in enclosed arc lamps." G. Thomas-Davies. Dated April 19th.

9,091. "An improved connector for electric wires and cables." T. E. Taylor, jun., and J. Collings. Dated April 19th.

9,105. "Improvements in apparatus to be used in connection with the electro-deposition of metals." F. Greenfield. Dated April 20th.

9,122. "Improvements in, and connected with, line selectors for telephones." H. Oppenheimer. Dated April 20th.

9,154. "Improvements in electric lamps." T. S. Hill and Peto and Radford, Limited. Dated April 20th. (*Complete.*)

9,178. "Improvements in electro-motors." J. T. Robson, C. H. Marsden, and H. W. Headland. Dated April 20th.

9,197. "Improvements in, and relating to, telegraphic transmitting apparatus." F. G. Creed Dated April 21st.

9,213. "Improvements in electrical heating and cooking." W. B. Spikins and A. H. Mayes. Dated April 21st.

9,218. "Improvements in secondary batteries." G. E. B. Pritchett, T. W. Pritchett, and A. G. Gold. Dated April 21st.

9,237. "Improvements in holders for high tension incandescent electric lamps." G. E. Heyl-Dia. Dated April 21st.

9,292. "Improvements in electrical igniters to be used with gas or oil engines, or for similar purposes." W. Baines, Jun. Dated April 22nd.

9,299. "Improvements in or relating to overhead trolley wires for electric traction overhead electric cables or other wires." R. Hacking. Dated April 22nd.

9,317. "Improvements in electric igniting devices for cycle lamps." G. M. Bauer and F. Kriegner. Dated April 22nd.

9,330. "Improvements in controllers for electric motors." R. Belfield. (The Westinghouse Electric and Manufacturing Company, United States.) Dated April 22nd.

9,339. "Improvements in electrical switching apparatus." H. Edmunds. Dated April 22nd.

9,340. "Improvements in electric safety fuses or cut-outs." Verityss, Ltd., and L. J. Steele. Dated April 22nd.

9,380. "Improvements in and relating to alarm clocks and electrical alarms." H. G. Campbell. Dated April 23rd.

9,394. "A process for electric heating and furnace for realising same." A. Roufaut. Dated April 23rd.

9,425. "Improvements in or relating to electrical cut-outs." J. W. Manley. Dated April 23rd.

9,436. "Improved means for electrically heating second-class electric conductors serving as incandescence bodies for imparting to them the requisite conducting power." M. Deri. Dated April 23rd. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free,* 9d. (*in stamps*).

1897.

19,230. "Improvements in a system for the electrical protection of safes." I. Freed. Dated August 19th, 1897. This relates to a protection system comprising of a closed electric circuit; the safe forming a component part of the circuit. On the interruption of the circuit there is a means for sounding an alarm bell. There is an electromagnet and its armature forming an integral part of the circuit, but arranged outside the safe. There is also a structure provided with a recess; with lugs fixed in the walls of the recess. There are a series of spring pawls fixed to the safe and adapted to engage in the lugs and lock the safe in the recess. 9 claims.

19,518. "Improvements in electric arc lamps." T. Spencer. Dated August 24th, 1897. This relates to an arc lamp adapted to be operated by an alternating current; and consists of a combination of opposed solid carbon electrodes with an enclosure for their proximal ends. There is a choking coil in electric circuit with the electrodes, and an automatically movable core for the choking coil. The core is connected with one of the electrodes so that a reciprocatory movement of the core may be imparted to the electrode. 1 claim.

18,934. "Improvements in automatic electric alarms." P. V. Vandevelde. Dated August 16th, 1897. This relates to an alarm device for use in ordinary window sashes provided with counter balance weights. Below the usual grooved pulley are placed two spring arms fixed to the casement one above the other. They are insulated from one another and connected with a battery. The top one is longer than the other and comes in contact with the weight when the sash is down. As soon as the sash is raised the weight is lowered and the end of the spring arms are so arranged as to spring together; which completes the circuit and operates the alarm. 2 claims.

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CONTENTS:

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PARLIAMENTARY ELECTRICAL ENERGY COMMITTEE.

IT seems to have been the general opinion of counsel and of all others engaged in the Parliamentary Committee, whose proceedings we have reported at considerable length, that the matter was carried through at a great rate, and that the issues were much confused. It is pretty clear that there has not been time to sift the whole matter, and that whatever the report of the Committee, it will scarcely be final. If the Committee are prompt in their report, and there is time to draft a Bill embodying their recommendations and get it through the House this session, enough may be done to relieve the almost absolute block which there is at present; but it is perfectly evident that there are a number of other questions which are rapidly ripening for solution, and it is greatly to be desired that the electrical industry, as a whole, should begin to consider this carefully and organise themselves with a view to getting their case more strongly and authoritatively placed before Parliament than has been possible on the present occasion, mainly because of the short notice and rapidity with which the matter has been carried through. We think it is very desirable to urge the importance of the recommendations of the Committee being given effect to by Parliament this session, as another year's block, whatever is done in the end, would leave us another 12 months behind our foreign rivals.

We are hopeful from what was gathered of the general tone of the members of the Committee and the evidence, that, at any rate, some of the discouragement to which private enterprises are subjected at present may be removed. We doubt if very much will be done directly to this end in the Committee's report, in fact, we do not know whether from the nature of the reference to them they can do much, but the evidence was strong in favour of the old political economic dictum that officials favour officials, and that although the Board of Trade were supposed to have a discretion to give private enterprises at any rate a fair chance, yet that in practice their powers had so been used as to put a complete stopper on it. Sir Courtenay Boyle practically acknowledged this himself, and we think most people will agree that it is so, and to a greater extent than appears on the surface, since a certain number of companies did get through in the earlier stages, and when private individuals felt less hopeless than they do now of carrying out any enterprise. We believe it will be found to be a fact that notwithstanding the enormous increase of electrical enterprises in other countries, the *rate of increase* in this country is not progressing. In fact, we are not sure if apart from the manufactures carried out to supply Corporations and what may be called purely private work it is not diminishing, although both in Germany and America it is progressing by leaps and bounds.

In connection with this we might refer to the reports from Berlin in the *Financial News*, and the large space which is

D

given very frequently to particulars of electrical enterprises, whereas in the same paper the reports on English enterprises are at most three or four lines, and these deal almost entirely with London companies.

Again, we would point out the unfairness of the matter to those engaged in the electrical industry. Of course, now private enterprise is pretty well snuffed out for ordinary undertakings; but, at the same time, it is true that the teaching of the local authorities, the bringing forward of facts and new ideas, and their education, has almost entirely been done by private individuals, often at great expense both of money and time. Although such men deserve well of the nation, and it is on the labours of such men in other departments that the greatness of England has been built; in the case of the electrical industry, owing to the state of the law, and the action of municipalities, they have not only received no reward or encouragement, but have been pushed aside often with contempt, and left to bear heavy loss and discouragement.

If our rivals in America and Germany were pursuing the same course as ourselves the matter would not be so serious, because we and our trade rivals would be in the same boat, and one would have no advantage over another; but that is not so, and we think it is acknowledged on all hands that both our great commercial rivals have got a considerable start of us in this matter, and the encouragement there is for them to proceed with further developments will undoubtedly enable them to keep ahead of us, and probably to increase their lead, unless strong measures are taken to put the members of electrical industries in this country in at least as favourable a position for the development of enterprises as are our industrial rivals.

We hail with satisfaction the activity which has characterised local bodies for some years; at the same time we cannot help thinking that often, not being very well instructed, there is far too great a tendency amongst them to conclude that what is sauce for the goose is sauce for the gander in all cases, and that because such towns as Manchester, Edinburgh, and some other municipalities of large area, and where commercial intelligence of a high order can be secured on the Town Council, have done ostensibly well, that consequently it follows that comparatively small towns of a different character, and where the majority of the members cannot usually have the same business experience, can produce similar results.

The Candle-Power of Arc Lamps.

In a recent issue of the *Electrical Review* of New York, Mr. Marks, of enclosed arc lamp fame, replied to the question of a correspondent who asked, "What is the candle-power of an arc lamp using 45 volts and 10 amperes?" by detailing the reasons which make it impossible to answer this query with any degree of accuracy. Although it has been common knowledge for many years that any statement of the candle-power of an arc lamp was certain to be misleading if unaccompanied by full details of the conditions under which the test was made, yet it is probable that the extent of the possible error is not so generally known, and the figures given by Mr. Marks will therefore be of interest. It is said that there are five different candle-power values which are used at various times, viz.: (1) Nominal candle-power, the value of which, according to the definition adopted by the National Electric Light Association, is 2,000 for a 450-watt lamp. (2) Horizontal candle-power which has been given by different experimenters at figures varying from 227 to 456. (3) Maximum candle-power which has been given at figures varying from 1,080 to 2,000. (4) Mean spherical candle-power which has been given at figures varying from 425 to 653. (5) Mean hemi-spherical candle-power below the horizontal plane passing through the arc, which Mr. Marks gives as 600. But if it is decided that results shall be given in one particular value of the five named above, say, for example, in mean spherical candle-power, and if full information is given concerning the globes or reflectors used and whether the test is made in a dark room or at the place where the lamp is in service, there still remain variations due to quality and size of carbons, shape of the carbon points, and personal errors of observation. Mr. Marks says that it has been found that the substitution for one carbon of another of different quality has made as much as 80 per cent. difference in the mean spherical candle-power, and that with carbons of the same quality there may be a difference of 30 per cent. in the candle-power according to whether the carbon is $\frac{7}{16}$-inch or $\frac{5}{8}$-inch diameter. With regard to personal error, a test is quoted where with 10 observers a variation of about 13 per cent. was found between the highest and lowest results obtained; and we are finally reminded that there are three important standard candles which may be referred to, viz, English, German, and French, and that there is a difference of about 15 per cent. between the values of the first and last named. After reading the article in question, it is strongly borne in on us that the only safe answer to such a general question as that of our contemporary's correspondent is, that the candle-power can best be represented by x, as tests can be quoted to show that it has any value between about 200 and 2,000 according to the conditions of test; and that in comparing the efficiency of arc and incandescent lamps for lighting purposes, it is necessary to reckon on 1 to $1\frac{1}{2}$ watts per candle for an arc lamp instead of on the lower figures which are often used.

Rayleigh on Stokes.

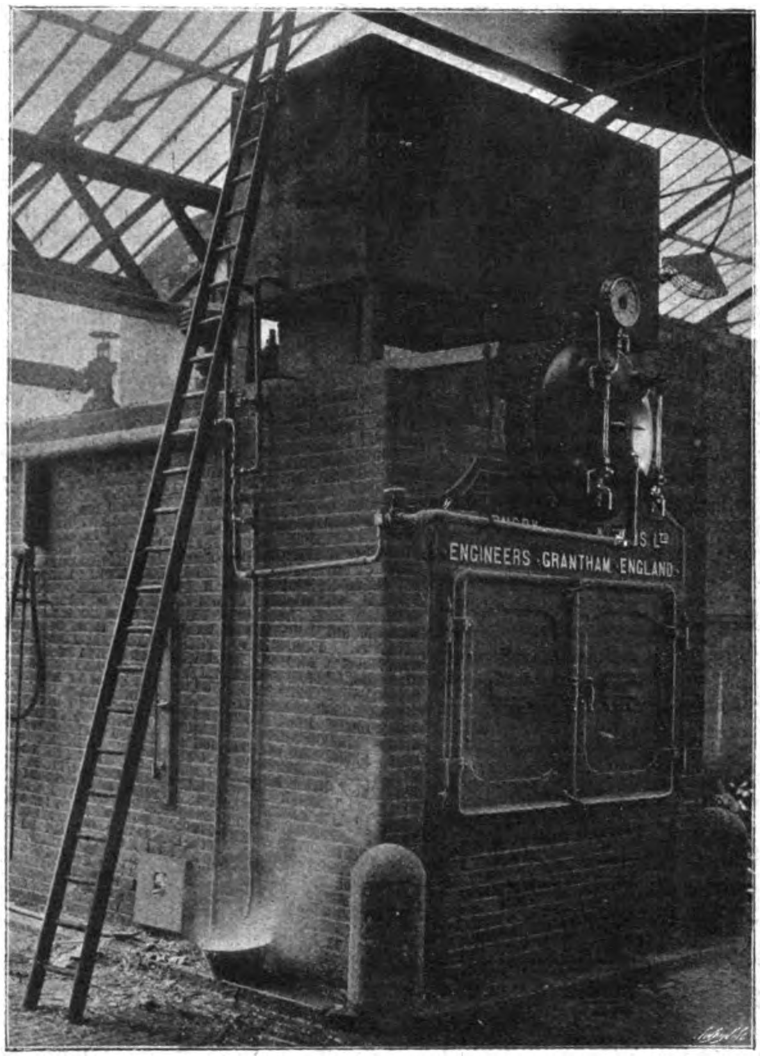
Sir G. Stokes, about two years ago, suggested a theory of the Röntgen rays, according to which the Röntgen rays were regarded as aperiodic electro-magnetic waves caused by the impact against the anti-cathode of the charged particles in the cathode stream. This theory has recently been developed by J. J. Thomson (*Phil. Mag.*, Vol. 45, p. 172, 1898), and has come much into favour with other authorities. In *Nature*, April 28th, however, Lord Rayleigh raises a protest against the acceptance of this theory. He says it has certainly much to recommend it, but he cannot see that it carries with it some of the consequences which have been deduced as to the distinction between Röntgen rays and ordinary luminous and non-luminous radiation. The conclusions of its supporters "that the Röntgen rays are not waves of very short length, but impulses," surprise Lord Rayleigh. From the fact of their being highly condensed impulses, he would conclude, on the contrary, that they *are* waves of short wave length. He asks what becomes of Fourier's theorem and its assertion that *any* disturbance may be analysed into regular waves? The view that the vibrations of ordinary light are regular, and thus distinguished from disturbances made up of impulses, he says, is an exploded idea, in the theory of light. A curve representative of white light, if it were drawn on paper, would show no sequence of similar waves. Rayleigh favours the view that Röntgen rays differ from ordinary light only in the shortness of their waves.

THE ST. PANCRAS DESTRUCTOR WORKS.

WE illustrate below a side view of the Hornsby water-tube boiler which has been fitted up at the St. Pancras Vestry destructor works, and is fired by the waste gases from the destructor.

The rating of the boiler, if fired by coal, is 118 H.P. (1 H.P. = 30 lbs. of water evaporated per hour) working pressure 120 lbs. per square inch, number of tubes 59 (seven deep, three rows of nine wide and four rows of eight wide), 18 feet long and 4 inches diameter. The steam drum is 39 inches diameter × 28 feet 10 inches long, and is provided with a patent separator to ensure dry steam; it is fixed over the uptake tube from the front header. The headers are provided with a hand-hole opposite each tube, and each hand-hole is provided with a mild steel internal safety cover. The mountings consist of one deadweight safety valve, high steam and low water, with whistle alarm; one 2-inch deadweight safety valve; one steam stop valve; one steam gauge dial 10 inches diameter; one check feed valve $1\frac{1}{2}$ inch diameter; one blow-off valve 2 inches diameter. The boiler is made throughout of mild steel, no cast-iron or cast-steel being used in its construction.

We are informed that the boiler has done excellent work and given every satisfaction.



THE ST. PANCRAS BOILER.

THE TEMPERATURE OF INCANDESCENCE LAMPS.*

I HAVE already described† a purely electrical method of measuring the temperature of incandescence lamps, and more generally, of any radiating body whatever. This method consists in studying: (1) the variation in the resistance of the lamp as a function of the difference of potential at the terminals; (2) the variation, as a function of the time, in the resistance of a lamp which is cooling. From this we can easily deduce the curve of the watts radiated as a function of the time, and consequently, the total number of joules or small calories given off by the lamp. The filament is then weighed, and from M. Violle's formula:—

$$Q = \cdot 355\, t + \cdot 00006\, t^2$$

we deduce the temperature t (assuming that the filament is made of pure carbon).

This method was applied, under my directions, by Messrs. Gindre and Fréauff-Ozeune, then pupils at the Ecole Supériure d'Electricité ‡; the first measurements were taken with the aid of an amperemeter and a voltmeter and presented no difficulty; the subsequent ones were more difficult; they were carried out in the following manner:—

A special interrupter enables the following operations to be performed:—

1. At the time zero, the current of the lamp is broken.
2. Immediately after, the lamp is introduced into an auxiliary circuit including an accumulator and a resistance box.
3. At the time t, an instantaneous contact brings the two terminals of the lamp into connection with the plates of a condenser.
4. This condenser is discharged through a ballistic galvanometer. These various operations are executed by a slide which moves in a direction parallel to itself between two grooves; the intervals of time are measured by a tuning fork which inscribes its vibrations on smoked paper; it is evident that at these high temperatures the cooling is very rapid, and that it is necessary to be able to measure accurately fractions of a second. A simple calculation then enables us to find the resistance of the lamp at any given moment.

The experiments were carried out on four lamps, A, B, C, D, of 65 volts and 10 candles. I will call t the temperature, R_o the resistance of the lamp to the ordinary temperature, R_t its resistance to $t°$, p the weight of the filament expressed in milligrammes, E the tension at the terminals. These are the results obtained:—

Lamps.	E	p	R_o	$\frac{R_t}{R_o}$	t
A	65	6·3	175	·53	1,720°
B	65	5·35	170	·54	1,610°
C	65	5·2	170	·52	1,630°
D	65	4·8	170	·53	1,620°

We see that the results relating to the lamps B, C, D are very similar; the lamp A, for some reason or other, gives a somewhat higher temperature.

However this may be, the above results are of some importance when we consider the differences in the figures of the various writers that have treated this subject. H. F.

* Note presented to the Académie des Sciences, March 7th, 1898.
† See *L'Electricien*, Vol. xii., p. 323.
‡ The experiments were made at the Central Electrical Laboratory.

Weber, in fact, mentions these temperatures as hardly exceeding 1,300°, whereas M. le Chatelier gives 1,800°.* It will be seen that our results more nearly approximate to the latter estimate, especially as we have reason to think that our lamps were less *over-run* than those of M. le Chatelier; these are the variations of resistance given by him:

t	$\frac{R_t}{R_0}$
15°	1·00
700°	·75
1,000°	·66
1,400°	·57
1,800°	·49
2,100°	·44

At the temperature of normal working, the ratio $\frac{R_t}{R_0}$ was ·49 for M. le Chatelier's lamps, whereas this same ratio attained to ·53 in our experiments; now, at this value ·53 corresponds exactly to the temperature 1,600° in M. le Chatelier's table.

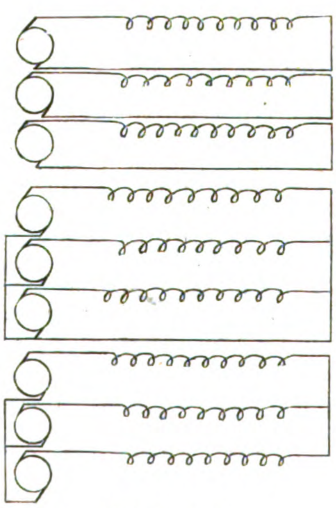
The principal cause of error in the above experiments lies in the light weight of the filament; it would be easy to remedy this by working with low voltage lamps. We can, in fact, easily show that, with an equal lighting power the weight of the filament of a lamp varies in inverse proportion to the two-third power of the difference of potential at the terminals.

From the above experiments we can deduce curves of the variation of the total radiation as a function of the temperature, but this question is too important to be entered upon here.

THREE-PHASE MACHINERY.

The *Western Electrician* for April 9th, 1898, contains an interesting article on three-phase machinery by W. M. Venable, in which some of the principles underlying three-phase working are expressly stated in a very simple manner for the benefit of those who are not able to make a thorough study of the subject and yet who require a good general knowledge of it.

If three alternating-current generators, supplying three separate circuits as in fig. 1, are connected together at one terminal only, the operation of the machine will not be affected. Such a connection merely brings the three terminals to a common potential, and does not affect the difference of potential between the two terminals of any one



Figs. 1, 2, 3.

machine. There will, therefore, be but little effect on the operation of the machines if a common wire is run for all, as in fig. 2.

If now we can arrange the circuits and construct the dynamos so that there will never be any current in the common return wire, we can dispense with that wire altogether. This condition is satisfied when the currents in the three remaining wires are 120° apart in phase and equal in intensity.

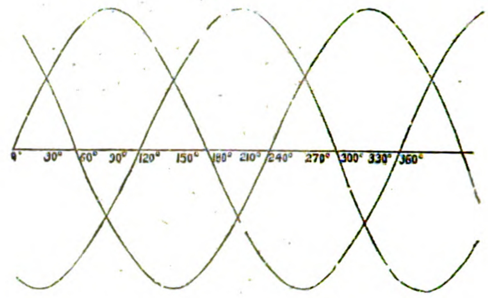


Fig. 4.—Sine Curves of Three-Phase Circuit.

Fig. 4 represents three equal sine curves 120° apart, and shows that the algebraic sum of the ordinates at any instant is zero. We have, then, the arrangement shown in fig. 3, and if the loads in the three branches are equal, three line wires only are needed. The easiest way to keep the machines 120° apart in phase is to combine the three machines in one, that is, to put three windings on one armature. Such machines are called three-phase alternators. A simple one can be made of a Thomson-Houston arc dynamo by bringing the terminal wires to collector rings instead of to the three commutator segments. The fields have to be separately excited.

Fig. 5 is a diagram of such a winding.

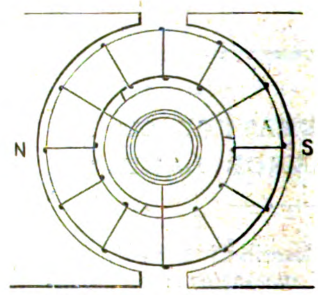
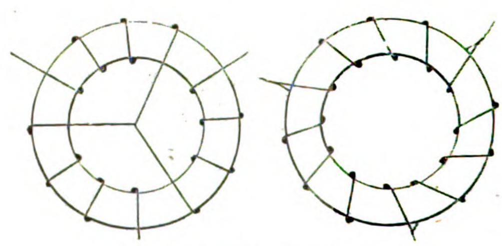


Fig. 5.—Three Phase Winding for Two-Pole Machine.

The number of poles can, of course, be increased, just as in an ordinary alternator, increasing the frequency of alternations.

There are two ways of connecting the armature coils of a three-phase alternator. One of these, known as the star connection, is shown in fig. 6; the other, known as the mesh winding, is represented in fig. 7.



Figs. 6 and 7.

One of the great advantages of three-phase working over single-phase systems lies in the fact that the energy transmitted can readily be used either for lighting purposes or for motive power. Three-phase induction motors are, as is well known, self-starting under a very considerable load, and are as simple, reliable, and as easily controlled as the continuous current motor. The induction motor is superior to the continuous current motor, in that its secondary winding is short circuited, and it is entirely devoid of commutator, collector rings, or any rubbing contact.

* *Journal de Physique*, 2nd series, Vol. i., p. 203.

Those readers who have not the time to study the subject deeply, will be able to form some idea from the above of the nature of the generation and distribution of electrical energy by means of tri-phase currents. There is novelty and great simplicity in the method of showing how it is necessary to use only three wires in three-phase distribution systems.

THE RANGE-FINDER FOR DETERMINING THE DISTANCE OF A HOSTILE SHIP OR FORT.*

The accuracy of modern rifled guns is one of the wonders of engineering. Two experimental shots fired a few years ago at the same elevation from the same gun fell within 30 yards of each other, after traversing a distance of 12 miles. If a modern rifle is laid upon the target, with proper elevation and allowance for windage, it is safe to say the shot will find the mark.

The correct elevation of the gun can only be determined if the distance of the target is known, and the exact determination of the distance of a moving object is a problem that has worried the gunner ever since the day when round shot was first thrown from the sides of the wooden fighting ship.

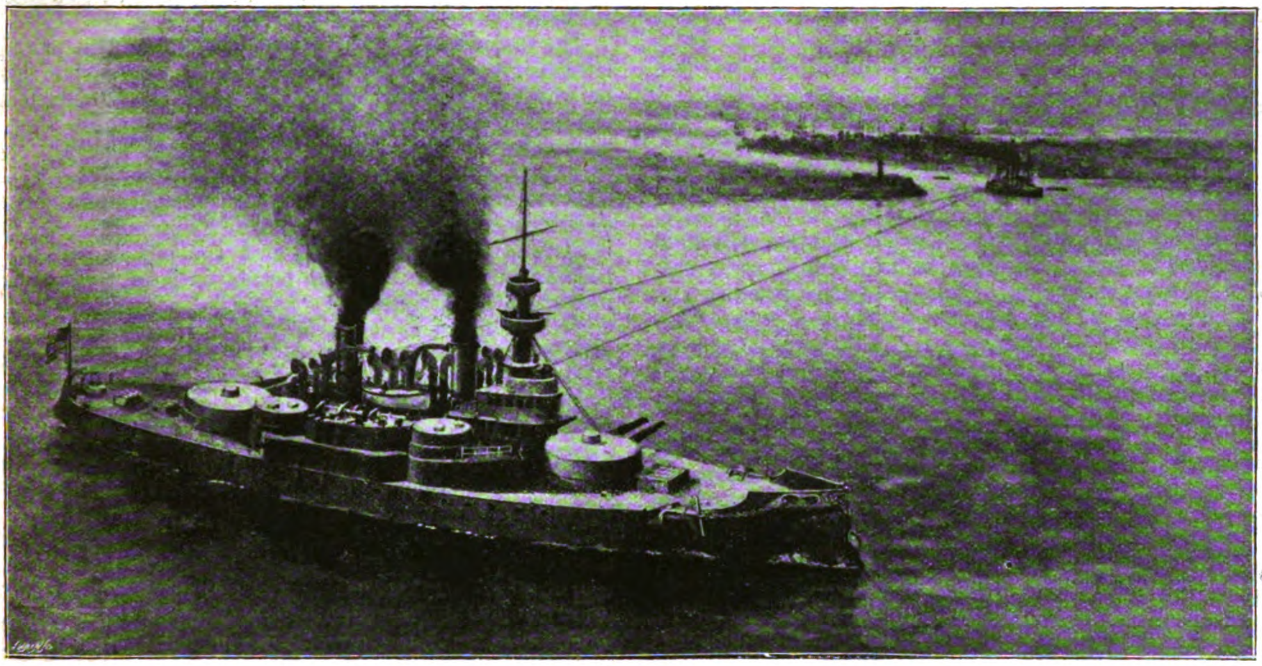
In the early days, the determination of the range was a matter of guesswork. The gunner assumed a distance, elevated his gun accordingly and watched the course of the shot. If it fell short, he increased the elevation, and if it passed over, he decreased it.

This was all very well in a day when the guns were too feeble to do much execution, except at close range, and a few dozen shots thrown away made little impression upon a ship's magazines. With the advent of modern ordnance, however, with its 60-ton guns and costly charges, the necessity of accurate fire became imperative, and ordnance experts set about devising some scientific method of finding the range at sea. The earliest and best known device of the kind was the invention of Lieut. Fiske, of the United States Navy, which has been installed on many of our ships and is widely in use in the various navies of the world.

The Fiske range-finder is based upon the well-known principles of land surveying with the transit and engineer's chain. If a surveying party came to a broad river whose width has to be determined, a base line is measured along the bank, and the angles which this line makes with a mark on the opposite bank are measured by the transit. Then, knowing the length of the base line and the two angles, the distance across the river can be determined by trigonometry.

Applying this to the range-finder, a base line is carefully measured between two points near opposite ends of the ship, and over each point a range-finder, answering to the engineer's transit, is permanently set up. If the telescopes of the two finders are simultaneously converged upon the same point on a distant object (ship, fortress, or city), the observers will be in possession of the trigonometrical data necessary to compute the distance, namely, the base and the two base angles.

In the din, hurry, and slaughter of a sea fight, however, it would be difficult to make the necessary calculations, as the distance between the ships, and, therefore, the observed angles, keeps changing, and in order to make the determination of the distance automatic, Lieut. Fiske placed his telescopes in the circuit of a Wheatstone bridge and caused their change of position to record the distance of the object on the graduated scale of a delicate galvanometer. All that was now necessary was for the observers at the two range-finders to keep the cross-hairs of the telescope upon the same point of the ship, and the electric current translated (as it were) the angles into distances and recorded them by



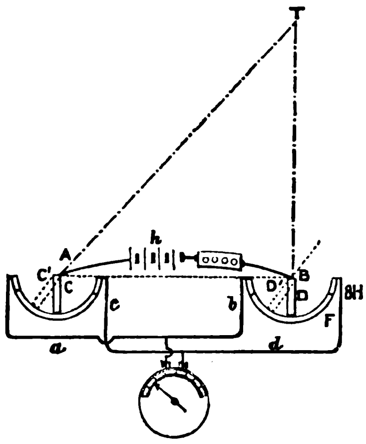
the movement of a needle over an arc graduated into hundreds and thousands of yards.

The above illustration will make the operation of this most ingenious instrument clear to the reader. It represents the *Indiana* about to open fire upon a hostile

* *Scientific American.*

ship. The converging lines are drawn from two range-finders, which are placed in elevated positions above either end of the superstructure deck. These finders are permanent fixtures, and the distance between them is accurately known. The smaller cuts show a range-finder and a diagram of the telescopes and the electrical connections.

The range-finder consists of a powerful telescope, which is



mounted on a standard and is capable of horizontal rotation above a graduated disc. Upon the disc, and extending an equal distance on each side of the zero point on the graduation, is a metallic contact arc. Fixed to the telescope standards is a contact strip, which rotates with the telescope and slides over the contact arcs. In the diagram A and B represent the centres of the discs on two range-finders, and C and D the arms that carry the telescopes and contact strips, which are shown sliding in contact with their arcs. The electric current from the battery, *h*, passes through the centres or pivots, A and B, and then into the arcs. From the right-hand arc it circulates in the wires, *b* and *d*, from the left-hand arc in the wires, *a* and *c*, and traverses the galvanometer.

When the two telescopes are parallel, the equilibrium of the Wheatstone bridge is complete, and consequently the needle of the galvanometer shows no deflection. This equilibrium occurs, moreover, whatever be the position of the telescopes on the dial, provided that they are perfectly parallel. But if the telescope, C, for example, be turned until it is in the position, C′, the parallelism being destroyed, and, along with it, the equilibrium of the two parts of the bridge, the needle of the galvanometer will be deflected. This deflection will increase in proportion to the length of the arc traversed by the telescope.

But since the arc, C C′, is proportional to the angle at A, which is equal to the angle at T, it follows that the deflection of the galvanometer will be proportional to the angle at T, or to the distance, A T. Hence, by graduating it in hundreds and thousands of yards, the distance of the ship or fort, T, may be read directly from the galvanometer. One of these galvanometers is placed in the conning tower and one at each of the principal gun stations.

It will be seen from the illustration that the operator, on applying his eye to the telescope, has opposite to his mouth a telephone transmitter, a receiver being clamped to his ear. By this means the two operators are kept in constant communication and the errors are avoided that would be caused by the reading of a deflection produced before one or other of the telescopes is well directed toward the point to be observed.

[More complete descriptions of the Fiske range finder can be seen in back issues of the Review.]

Personal.—We understand that Mr. Fred. J. Satchwell has resigned his position as manager to Messrs. Mackey and Mackey, electric lamp makers, Bermondsey, having been appointed superintendent in Mr. Hiram S. Maxim's electrical laboratory.

CARBONISATION OF FILAMENTS BY ELECTRICITY.

By Legh S. Powell.

The idea of carbonising filaments by electricity, in lieu of the common furnace method, must have occurred to many. It was widely reported some 10 or 12 years ago that the remarkable "adamant" filaments, introduced by Woodhouse and Rawson, had been subjected to intense heat by electricity, but no details of the process employed were ever noised about, or reached the ears of the writer; and it is believed that at the present time the carbonisation of filaments by means of electricity has not been practically adopted. As the subject is not without interest or economic possibilities, it has occurred to the writer to be worth while putting on record an electric method he devised for this purpose about five years ago, and a few particulars of certain rough and superficial experiments which were made at the time at a Continental lamp factory to test its practicability. It is hoped that some incandescent lamp experts, who care to test the plan further, and who are able to bring together the means and conditions needed for the investigation, will succeed in bringing this process, or one allied to it, to a successful issue.

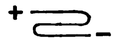
The features of the method in question and the principles involved, are very simple and obvious. The carbon blocks on which the cellulose threads are wound are conductors of electricity, and the plumbago powder in which they are packed is likewise a conductor. If a pile of blocks be therefore made with a layer of plumbago powder between each, and the whole be surrounded with suitable non-heat and electricity-conducting materials, whilst a current of electricity is made to pass, it is evident that the blocks will become heated, and grow hotter and hotter, until in time the filaments will be carbonised or "baked."

To bake filaments successfully by this method, it is naturally necessary to attend to several conditions. It is obviously of prime importance that the heterogeneous conductor be encased in insulating material of the best quality, and arranged in the most suitable manner. It is equally necessary to exclude the air, so as to prevent the burning of the filaments. Other considerations of more or less importance are: facility in packing and unpacking the containing vessel, the construction of the terminal conductors, the manner of applying the current, the duration of the operation, and the final cooling of the blocks.

As already intimated, the experiments that were made were in the nature of mere trials rather than a serious and persistent attempt to thoroughly ascertain the economic practicability of the method. Two experiments only were made; and as the notes taken of the dimensions, times, amperes, &c., were far from complete, and also by reason of the superficial nature of the trials, it is not proposed to describe them in detail. Suffice it to say that in the first experiment two parallel brick troughs were constructed on a brick platform covered with a layer of slag wool. The troughs, which were about a metre long, were packed with wound blocks, plumbago powder being sprinkled between each space. The current entered one trough by means of a stout terminal plate of carbon, flowed to the end, then across to the other trough by a long slab of carbon, and so on to the other terminal. The upper surface of the troughs was covered by slabs of earthenware, and the whole was surrounded with a thick coat of slag wool.

The current which was available for the operation had a pressure of 110 volts, and this factor was largely responsible for the arrangement of the furnace in manner described. The resistance cold was a little over 2 ohms, and the current at the start was 50 amperes. In an hour or so the current had risen to 150 amperes, when it was lowered to 50 amperes again by introducing an external resistance. At the reduced pressure the resistance of the circuit continued to decrease, and the current once more rose to 150 amperes.

On examining the filaments at the end of the operation they were found to be brittle and useless, a circumstance which was probably due to burning by access of air during cooling, to hasten which a considerable quantity of slag wool had been removed.

In the second experiment the length of the row of blocks was increased to about 3 metres in order more nearly to suit the current pressure; and instead of forming a simple  the course ran thus . To more effectually displace the air, a layer of plumbago powder, sprinkled with paraffin, was spread along the bottom of the troughs before charging them with the blocks. In this experiment the plumbago powder was more tightly compressed than in the previous one, the resistance cold being 3·8 ohms. For the purpose of raising the temperature more slowly at the commencement, an external resistance was included in the circuit, and the current adjusted to about 18 or 19 amperes. Instead of the resistance falling from the start, as in the previous experiment, it had a tendency to rise during about five hours. This increase, which amounted at the maximum point to about 25 per cent., may possibly have been due to the presence of the paraffin. By gradually cutting out the resistance, the current was caused to rise slowly to 25 amperes. In 10 hours from the start the current was only 30 amperes, in 12 hours it was 35 amperes, in 14 hours 55 amperes, and in 17 hours it had reached 65 amperes. The circuit was here interrupted for the night, but was again closed next day, after a lapse of 6½ hours, the current starting at 27 amperes. In six hours' time it once more attained 65 amperes. It is believed that the current was stopped soon after this, but the notes taken are not specific on the point.

The majority of the filaments obtained from this second operation were satisfactory in every respect, their flexibility and "colour" being good, whilst their resistance cold remained practically steady both before and after raising to incandescence in an inert gas.

The problem of baking filaments by electricity was allowed to drop, not because it was anticipated that the process could not be made to give satisfactory results, but principally because it was not considered to be worth while to arrange for a current of lower pressure and larger quantity to suit other and more convenient forms of apparatus, and also because it was supposed, by some, that the electric method would not prove to be more economical, or possess any striking advantage over the ordinary furnace plan. Without, however, ascertaining a good deal more thoroughly what degree of perfection can be attained, the data wherewith to form a sound judgment as to cost, &c., are not forthcoming.

To describe in detail the best manner of proceeding in order to construct suitable and efficient apparatus is not in the writer's power. Many materials and arrangements, however, naturally suggest themselves, and some of the more prominent of these may, perhaps, be mentioned.

It is patent that, in order to reduce the cost of the predominating item of expense, viz., current, to a minimum, it is imperative that the amount of matter surrounding the blocks, consistent, of course, with good heat insulation, should be reduced to utmost limit. In the experiments referred to, this condition was most imperfectly studied. A considerable mass of brickwork became heated to bright redness, at the expense of current, by contact with the blocks, and the extensive external brick surface was moreover very inadequately protected by the slag wool from the cooling influence of the surrounding air. The vessel in which the blocks are packed should, by preference, be either cylindrical or rectangular in form—the latter to suit the shape of the blocks—and of large enough dimensions, both in height and diameter, to be convenient for packing and unpacking the blocks. The vessel should stand in an upright position, and it should be made as thin in the wall as possible of a material which is practically impervious to air. Probably as good a material to use for the purpose as any would be the fire clay employed for making salamander crucibles. The vessel should be closed both at the top and bottom by a stout carbon plate or disc, the bottom one being cemented into position so as to admit no air at the junction with the vessel. The platform on which the vessel rests might, perhaps, best be made of the porous fire clay of which Fletcher's furnaces are made.

The question of how best to prevent the escape of heat at high temperatures is doubtless one in which a good deal of improvement might be made on attainments already arrived at, and it would form an interesting subject for investigation. Without possessing any special experience on the subject, the writer would propose that the vessel should be surrounded by two, three, or more (as may be found desirable) movable cylindrical covers of increasing dimensions, and made of the same material as the platform. Each cover, which must perforce have a small hole at the top through which the conductor, conveying the current, must pass, should be made as thin as practicable. The lower rims of the covers might fit into concentric grooves made in the platform, each groove being filled with powdered charcoal or lampblack. A series of air spaces would thus surround the vessel at regular intervals, and these would be likely to effect good heat insulation, whilst the actual mass of solid material employed would be reduced to a comparatively small cubical bulk. The arrangement would further possess the advantage of easily and expeditiously effecting the cooling of the blocks at the close of an operation by the simple removal of the covers or shades.

It may well be that better heat insulation and more conveniently arranged apparatus might be constructed on other lines. Many insulating materials packed round the vessel, such as asbestos, slag wool, lampblack, metallic oxides, &c., might perhaps be arranged to give excellent results. In the selection of such substances, it would be well to bear in mind the different specific heats which the various substances possess, although other properties and considerations may very likely far outweigh this one in importance.

All the world knows of the remarkable success which has attended Prof. Dewar in his experiments on liquid air and its preservation by means of exceptionally perfect heat insulation, effected by surrounding it with an intervening vacuum. The application of this principle to the form of electric furnace under discussion would doubtless be productive of highly successful results. The manner of constructing apparatus involving this principle is, however, not so very apparent, although it is a problem which would be well worth attempting.

Another principle, which might be made to give satisfactory results, would be that of heating the outside of the vessel by means of gas or otherwise, and so lessen the escape of heat generated by electricity. A loose outside fire-clay mantle might be arranged round the vessel, inside which gas was made to burn, or heated gases to circulate. The external surface of the case would not need such careful protection from the outside air, and the cooling down at the end of the operation could be easily effected. The total energy expended by this means of conservation of temperature would naturally be greater, but not necessarily more costly by reason of the difference in cost of heat produced by gas and that produced by electricity.

As regards the current needed for the generation of heat, it would doubtless be necessary to have the power of considerable variation of electromotive force. The amount of energy consumed would depend almost entirely upon the perfection of the surrounding heat insulation. With this very perfect, and with sufficient time, the temperature requisite for the proper carbonisation of filaments should be reached with a comparatively small current. The manner in which the current is applied and the duration of the operation to give the best results, are points which can only be determined by actual experience with any particular form of apparatus.

It may, perhaps, be idle to let the imagination run too freely on the advantages that are likely to result from the carbonisation of filaments by electrical means over methods of heating by fuel, before they have been actually demonstrated. Some advantages, however, are highly probable, and a few of them may be enumerated.

1. The wear and tear of the apparatus is likely to be appreciably less for the following reasons:—(*a*) There would be more regular heating and cooling of the apparatus; (*b*) there would be less lifting and moving about of the apparatus both in the heated and cold condition; (*c*) there would be an absence of fluxing material to destroy the apparatus.

2. The precision with which the current could be regulated ought to ensure greater uniformity in the quality and resistances of the several batches of filaments turned out in the regular course of manufacture. The defect inherent in the use of crucibles heated from an external source, due to the impossibility of heating equally all parts of the contents whilst raising the temperature would be wholly absent.

3. The labour needed to work the process would be of a much more agreeable and less arduous description.

In addition to these probable advantages, it is quite possible that the electric method might possess others of an important nature. The temperature of the furnace might be easily raised to a very high degree, and this condition might be conducive to producing filaments of a very dense and durable description. Further, by reason of the compact and isolated manner in which the apparatus might be arranged, it would be possible to perform the carbonisation under unusual physical and chemical conditions, such as in vacuo or under pressure in air or hydro-carbons, or other gases, by enclosing it in a suitable chamber. Such altered conditions might result in producing new and desirable results.

On the question of initial cost of apparatus and of the electric energy consumed, it will be prudent to venture no remark other than that both are likely to be in favour of electricity as compared with heating by fuel.

The electric furnace in various forms is now being employed in a number of industrial manufactures, both in the smelting of metals and in the preparation of substances such as carbide of calcium, graphite for electrodes, carborundum, &c., and there seems no reason why it should not be also successfully applied to the carbonisation of filaments.

ELECTRICAL ENERGY (GENERATING STATIONS AND SUPPLY).

(*Concluded from page* 638.)

At the sitting of the Joint Committee under Lord Cross on Thursday last week, Major Cardew, electrical adviser to the Board of Trade, said the Board of Trade regulations did not provide for the safety of the employés at generating stations, nor did they undertake any inspection. When, however, accidents had been reported to the Board, he had been instructed to inquire into the circumstances. As regarded general danger from high pressure, he did not think any danger could be apprehended by the public if laid in proper mains underground. In the case of overhead wires he was distinctly of opinion that danger increased with the increase of electrical pressure. In regard to interference with telegraphs and telephones, he considered that that could be avoided absolutely. Under the provisional orders of the Board of Trade, strong protective clauses were inserted. In the case of electrical powers for traction, where an uninsulated return was employed, some interference might be unavoidable. The clause settled by the Joint Committee should not be inserted in any Bill providing for general electrical power, since it permitted the use of uninsulated returns. The usual provisional order clause should be inserted. The Board of Trade sanctioned the use of the overhead system of electric traction in cases where no local objection was made. The danger to the public was not great. In 1889 the Board sanctioned a pressure of 10,000 volts for London, and that pressure had been in use since, without any injury to the public. He was quite satisfied that underground mains could be made perfectly safe.

The Chairman: You do not say the same of overhead wires?—Not at all. I am afraid that in the case of overhead wires there are possibilities of danger which can hardly be avoided altogether.

There have been accidents to employés?—Yes.

Can you suggest any regulations for their protection?—I think regulations could be made, and I have myself prepared some draft regulations; but it was rather a legal question as to how they could be protected, not being members of the public.

Mr. Kimber: Is the unsafety of overhead wires preventable?—I do not think you can say that it is entirely. We can make regulations, but in the event of these regulations not being entirely complied with at all times there might be accidents. Such things as gales and falling trees might affect the overhead wire which would not affect the underground wire.

What is the highest pressure which under any circumstances the Board of Trade will permit?—10,000 volts has been used.

Would they under any circumstances permit more?—I only speak as their adviser, and I think in some cases we should permit more in the case of underground wires. I do not think myself there can be laid down an exact limit beyond which it could be said the danger would become so appreciable that the thing should not be permitted.

Has any steps been taken by the Board of Trade to get statistical information with regard to the use of electrical energy in America?—We have not asked for information as to the working of these very high pressures.

Don't you think it would be advisable to do so; they are far in advance of this country in regard to the application of electrical energy?—In traction they are; I do not think they are in advance of us as regards the electric light.

Do you apprehend that there will be an increased demand for the use of power?—I think there will; I think it is coming.

You are aware that chemical works are being erected now in which as much as 4,000 horse-power is required?—Yes; that is a special industry which is kept very much to itself. The chemical industry opens a wide field for electrical energy.

Lord Balcarres: May I take it that your regulations have been sufficient to make it almost impossible for people who wish to carry energy to do it with overhead wires?—I should not have thought so.

Is it common in this country for energy to be carried overhead?—No; it is done in certain cases.

It would be cheaper to carry it overhead?—I do not think it would for any purpose of general supply. If you have to take off service wires to many different consumers work, with overhead wires would become impracticable.

But the same thing applies with underground wires?—There is a convenience for laying down a heavy mass of copper in underground mains which would be almost impossible overhead. The practice of the Board of Trade has been generally to discourage the use of overhead wires.

And you have been very successful in that direction?—It has not been much adopted.

By Mr. Ashton: He would not be prepared to advise any relaxation of the existing Board of Trade regulations for overhead wires.

The Chairman said that Mr. Kimber had asked for an answer to a question with regard to the price at which the Central Company of London had agreed to supply energy in bulk to the Westminster and St. James's Companies.

Mr. Balfour Browne: No price is fixed, but the basis on which it will be fixed is that in consideration of the two companies supplying the capital for and jointly promoting the Central Company, each shall be entitled to take as much energy as the other on terms to be agreed or otherwise settled, and that any excess taken by either company over what is taken by the other shall be paid for on the basis of the average cost price of the whole energy generated during the year, plus a reasonable profit.

Mr. Kimber: The effect would be that if the sliding scale principle of gas companies was applied to electric light companies, those companies would be able to make two profits?—No, I think not. If there is a difference as to what profit is to be allowed the Central Company, that is to be fixed by arbitration.

Mr. Pember, Q.C., then addressed the Committee, and said he appeared for companies whose interest it was to supply electricity for power and light inside their own districts. The main points he had to consider was, first, compulsory purchase, then power of breaking up the streets, power to supply within their district whether the local authority liked it or not, and even it might be in competition with the local authority. There were minor questions such as the sliding scale, notice to persons affected, and so on. As to the question of purchase, there had been evidence given of the great difficulty at present of obtaining land, and in the case of the Chelsea Company, the company were asked to buy adjoining property at a cost of over £30,000. That was but one instance of hundreds, which showed the necessity of having compulsory powers of purchase. He asked what real distinction there was between giving compulsory powers to railways than to electric lighting companies? but, of course, it went without saying that the lands should be specified. All that was necessary to be done in that regard was provided by the standing orders of Parliament now. It was perfectly clear that unless the compulsory power was given an individual could absolutely prevent the public enjoying in a particular locality the comfort and convenience of either electric light or electric power. Evidence had been given of the prohibitive prices put upon the only available sites, and there was also the nuisance clause, which interfered greatly with the supply. There was no doubt that it was shown from experience in the use of electricity that the nuisance clause was a mischievous one, and ought no longer to be left in the hands of any man. He would assimilate the practice of Parliament with regard to electric light with that of ordinary railway schemes. Each case should be considered on its merits, and Parliament should reserve all power to itself and not hand it over to any other body. With respect to notices being served on residents in the neighbourhood of land to be acquired for a generating station, that was a most expensive operation, and he contended that notice should only be given to the owner of the land, and that the local companies should receive notice and have a *locus standi* to object. If energy was to be generally available, it must be cheaply supplied, and if it was to be cheaply supplied it must be supplied in large quantities, and that meant by single undertakers in very large areas, and that again meant over the districts of several local authorities. There they were met by the jealousy of the local authorities, which applied to the sale to individuals within the districts. And next as to the breaking up of the streets. He asked the Committee to refuse to say that only the local authority should have an order in a district; but, of course, it would be for Parliament to pronounce hereafter as to any Bill. An absolute veto by the local authority should be removed, and he would give them a *locus standi* in place of veto. With respect to purchase, he saw the greatest difficulty in accommodating the power of purchase to local authorities for schemes for the supply of electrical energy over large areas. He would say, "Don't make an attempt to accommodate the present powers of purchase to undertakings in these large areas." In conclusion, he would suggest compulsory power of purchase, and the sweeping away of local veto with regard to the laying down of pipes and the general supply of energy for light and power. At the same time he would provide for a liberal *locus standi*, so that every case might be thoroughly well decided on its merits before Parliament, and every fact brought forward and every interest represented.

Mr. Balfour Browne, representing new companies desiring compulsory power for purchase of sites in order to supply in bulk, said he objected altogether to giving the local authority an absolute veto, either as to a site, or with regard to the breaking up of streets. He saw grave danger to the public in giving the authorities that power, and the result of their present powers with regard to tramways did not seem to be satisfactory. The consent of the local authority should be subject to an appeal to the Board of Trade; but the Board of Trade should not regard the opinion of the local authority as the main consideration. At present it was true that the Board of Trade could dispense with the consent of the local authorities, but they never did so. The Board had such a respect for the local authorities, that in 60 cases he knew they had refused consent to companies. They had not the slightest objection to the local authorities undertaking the work; but what the local authorities were seeking to have recognised was a right in streets which they had not got by law. As to the conditions to be laid down on an electric light undertaking, such as he represented, he considered the powers of the local authorities were large enough at present. He asked what would be the condition of the gas and water supply had it not been for private enterprise. Local authorities would not touch such things unless there was a profit to be made out of it. At the present time electric light was not supplied in many districts, because it was known that as soon as a profit was shown, the local authority would step in and say it was time to purchase it. He asked the Committee to leave out the purchase question altogether in companies such as he represented.

Mr. STEVENS said he represented the existing London companies other than the promoting companies. Following on an inquiry by Major Mandarin, the principle which had been acted upon was to confine a company to a definite area, and allow a limited competition. Speaking broadly, the endeavour of the Board of Trade had been to secure in every district two companies and no more. It was a remarkable fact that there had been an entire absence of evidence before the Committee that the present system had given cause for complaint. The further development of electrical energy could only be effected by the mode in which Parliament dealt with those who had already invested their money. He agreed that there should be compulsory power of purchase, and that an existing company should have power to go outside its area for a site for a generating station. But it was also asked that new companies should be allowed to come into a district and supply anywhere free entirely from the conditions imposed upon the existing companies. That was a distinct revolution in the principles which had heretofore been applied. If it was agreed that those new companies should be exempt from purchase, it would be the commencement of a new system diametrically opposite to all Parliament had already done.

Lord CROSS: Do you contend that under the existing system the development has been all we could wish, and that we are bound to this system?—No; all I ask is that whatever is done shall not be unfair to existing companies.

Mr. WORSLEY TAYLOR addressed the Committee on behalf of a number of Corporations, who, he said, were largely interested in the matter, for local authorities had invested $3\frac{1}{2}$ millions of money in electrical enterprises. On the question of compulsory purchase the Corporations were entirely in agreement with the companies, for it was as necessary to the Corporations as the companies. On the question of nuisance they were also in agreement. On the question of the control of the streets, that was the matter with which the Corporations were most vitally interested. *Primâ facie*, it should be admitted that there should be a perfect control over the breaking up of the streets by the Corporation, but it should be subject to appeal to the Board of Trade. Then assuming their consent was dispensed with, they should have power over the route and the way the work was to be carried out, and they should have power to undertake the work themselves.

Mr. COWARD, representing the London County Council, contended that the Council differed from all other authorities inasmuch as they were the controlling authority over the electric lighting companies, whereas the vestries were the local authorities. Under these circumstances they contended that the Council was the authority in whom the ultimate power of purchase should be vested.

This concluded the evidence and addresses, and the Committee adjourned till Monday for the consideration of their report.

The further sittings will be private.

LONDON COUNTY COUNCIL.

AT the weekly meeting on Tuesday the following electrical matters were considered:—

TRANSFER OF LIGHTING POWERS.

Mr. B. F. C. Costelloe (chairman of the Local Government Committee) obtained the sanction of the Council to the postponement of the report of the Committee in regard to the recent conference with representatives of the London vestries and district boards to consider what powers now vested in the Council should be transferred to those local authorities. That portion of the report of interest to our readers is as follows:—

"The Conference proposed: 'That the powers of the Council under Electric Lighting Provisional Order Confirmation Acts, as regards the appointment of inspectors, provision of testing stations, and exercise of powers with reference to price and energy of the supply of electricity in a district, should be transferred to the local authorities.' We are of opinion that it is most essential that these powers should be exercised by one authority, having regard to the additional cost that would of necessity follow a transfer of the powers to the local authorities, in connection with testing stations and plant, and also having regard to the necessity of a general supervision and uniformity of treatment in these matters which involve more than local interests. We recommend that the powers of the Council under Electric Lighting Provisional Order Confirmation Acts, as regards the appointment of inspectors, provision of testing stations, and exercise of powers with reference to price and energy of the supply of electricity in a district, be not transferred to the local authorities."

"The Conference proposed: 'That power should be given to local authorities to alter or remove overhead wires in their districts in the event of the company refusing to do so.' We are of opinion that the London Overhead Wires Act, 1891, already gives to the local authorities all the powers sought for by the resolution."

LONDON UNITED TRAMWAYS.

The Highways Committee reported that, by the London United Tramways Bill, it was proposed to repeal Sections 17 to 28 of the London United Tramways Order, 1895, relative to the use of mechanical power, and to authorise the use of electric traction on the whole of the company's system within and without the County of London. The Council, whilst it had not offered objection to the conduit system, had consistently refused consent to the introduction of the overhead system, and had therefore petitioned against the London United Tramways Bill. In this connection the Highways Committee stated that they proposed that evidence in support of the Council's petition should be given by Mr. Baker (vice-chairman of the committee), by the chief engineer, by the chief officer of the fire brigade, and by an expert, whose evidence should be specially directed to the practicability of using the conduit system in London in conjunction with an overhead system, if established, on the company's lines outside the county. The Committee accordingly recommended that the Parliamentary Committee should take the necessary measures for supporting the petition against the Bill in the manner suggested. This recommendation was also opposed, and having passed the time limit was accordingly adjourned.

THE TELEPHONE QUESTION.

Pending the report of the Government Select Committee on Telephony, the Highways Committee expressed the opinion that it would not be well for the Council to proceed further with reference to the proposed agreement with the National Telephone Company in regard to the conditions under which permission had been given in certain cases for the placing of telephone cables underground. The Committee thought, however, that as under the conditional consents the company had executed certain works, the company should be required to enter into an agreement embodying certain conditions in regard to the works already carried out. The Committee, therefore, recommended that the telephone company should be requested to enter into an agreement undertaking (1) to alter any telephone line if and when required by the Council, and (2) that if and whenever the Council desire to adopt electric traction on any tramway belonging to or leased by or under the control of the Council, which passes along any street or part of a street in which any line of the company is laid, the Council may require the company to alter any such line, or portion of such line, or to remove the same to such position as the Council may require, and thereupon the company shall, without any claim for compensation against the Council or its lessees, proceed to make such alteration in the position of such line as no earth return but a complete metallic circuit is provided and used, the Council or its lessees shall not be liable to the company for any interference with, or prejudicial effects produced upon, the cables or wires or the working of the same, or upon the operations of the company, by reason of such use of electricity upon such tramway.

TRANSFORMER BOXES.

The County of London Electric Lighting Company having given notice of intention to construct 15 transformer boxes in Camberwell, the Highways Committee reported that the works mentioned in the notice were a repetition of those works which were expressly disapproved by the Council on January 25th. At that time the appeal of the same company to the Board of Trade against a previous decision of the Council, disapproving the construction of certain other transformer boxes proposed to be constructed by the company, was pending. The Board has since then, however, allowed the appeal, and authorised the company to construct the transformer boxes referred to, subject to the usual conditions. This decision was reported to the Council on March 29th last. The Committee were of opinion that, in view of the Board's decision, the Council could no longer withhold sanction to the construction of the transformer boxes referred to in the present notice; and should the Council adopt the alternative course of making no order with reference to the notice, the company could proceed with the works without any restrictions. The Committee therefore recommended, and the Council resolved, to conditionally approve the construction of the transformer boxes in question.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

MR. LEONARD ANDREWS, the engineer and manager of the Hastings Electricity Works, had an opportunity of describing the latest form of his alternating current non-return or discriminating switch and its uses at a meeting of the Institution of Electrical Engineers on Thursday of last week. The paper, entitled "The Prevention of Interruptions to Electricity Supply," was read in the hall of the Society of Arts.

Our readers will remember the description we gave nearly two years ago of the switch gear in the Hastings station, when the earlier pattern of the Andrews switch was illus-

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trated and described. Mr. Andrews has also given a full account of the device in a paper read before the Northern Society of Electrical Engineers last year. The present pattern of the arrangement differs from that before published in its mechanical details, the principle remaining much the same.

Mr. Raworth opened the discussion, and reminded his audience that he was a bit of an inventor in the field of discriminating switch gear himself. He could not allow himself, however, to say anything to detract from the credit due to Mr. Andrews by taking honour to himself who had done so little. Mr. Andrews had, he thought, hit the right nail on the head by using such discriminating fuses on interconnecting links on the distribution system. It was well known that when a generator went wrong it caused the fuses on the good machines to burn down first, and an example of this had occurred in the City of London station, where, on one occasion, every fuse in the station had gone, and the lights were all extinguished.

Some years ago Mr. Raworth designed a discriminating fuse arrangement, which was described in our columns. It was based on the principle of two paths for the current; a little transformer sucked current through one of these, which formed a bye-pass to a thermal fuse-wire, when the energy was passing out; but when a reversal of flow took place, the transformer caused the current to be diverted through the fuse, which melted and opened the circuit. Much time and money was spent on this device, and at last it was got right; but the time element interfered with its utility, as the time taken by the fuse to melt was often sufficient for the machine to burn out.

Mr. Andrews had done well to go in for the mechanical arrangement, and had shown very great ingenuity in carrying it through a great variety of alterations in detail design, until at last it had reached the form exhibited. Its great merit is that it can't be joggled into working, but must be tickled. While some engineers will say, "Oh! we have no interruptions to our supply," an apparatus of this kind may be termed an apparatus for relieving the mind of the electrical engineer from anxiety. Even with machines of large self-induction there is another point to consider; one cannot always guarantee or be sure that a fault will come on in the end coils, and if an intermediate coil proves faulty, the self-induction of a few will not cut the current down materially. The switch had been tried under very trying conditions, and large currents could be broken under water without appreciable spark. Mr. Raworth thought he had designed more switches than any other living man, but he was not going into competition with Mr. Andrews on this switch, which he congratulated him upon as not merely a switch or fuse, but a device which had been worked out into a system.

Mr. Chattock thanked the author for his paper, as he had made one or two attempts at a similar switch himself, and hoped this summer to perfect. All station engineers would confirm what Mr. Andrews had said as to the unreliability of fuses. This switch meets the necessity of the case. With regard to fig. 7 of the paper, a short-circuit on the connecting main between the two sub-stations would be likely to blow both feeder fuses. Mr. Andrews afterwards explained that he would in practice place thermal fuses at each end of this connector.

Mr. Lawson did not go so far as Mr. Andrews would go, as he thought it undesirable to have any sensitive mechanism, and on switching on the switch might give trouble. With reference to double feeders to sub-stations, he thought this very reliable, but rather expensive. He also was of opinion that some of the saving in the Hastings coal bill might reasonably be attributed to an improved load factor. In his reply, Mr. Andrews pointed out that while the coal per unit might go down from this cause, it could hardly be expected that the *total* coal bill would be diminished.

Mr. Raphael believed that while Mr. Andrews suggested that consumers' fuses should blow only at 300 per cent. overload, the fire insurance offices would insist upon a lower figure. He considered that leakages to earth and "shorts" should be dealt with in different ways, and to guard against the considerable danger that might arise from the flow of a leakage current of only a few amperes, he had devised an arrangement which would cut off the wiring from the supply where an iron pipe conduit system was installed. This consists, briefly, of a fuse in the earth wire to the metal conduit. On the fuse melting by leakage current, a lever is let go, which falls and short-circuits and earths the wiring blowing the house fuses. There was, however, no chance of this system being adopted, as it would cost a few shillings, and in these days of cut prices contractors were not inclined to take up anything that would increase the price of work. Even without such safeguards, any system of wiring is a better risk for insurance companies than gas.

Mr. Bathurst reiterated certain arguments in favour of the adoption of electric-proof pipes or insulated conduits, which are probably not new to the majority of our readers, although ably put by the speaker.

Mr. Weekes drew attention to the want of novelty in the principle of non-return or discriminating devices, and showed that such had been in use with continuous currents for some years, while Mr. E. K. Scott was understood to animadvert upon the design of certain of Mr. Raworth's switches and the troubles out of which the City Company have passed.

Prof. S. P. Thompson, who occupied the chair, pointed out that there is a long step between discriminating devices for continuous and alternating currents, that the wattmeter may be used—as Mr. Andrews practically does—to *discriminate* with alternating currents. While the apparatus confers a benefit on alternate current workers, a machine should not come to pieces if "shorted," or put in out of phase, and closed his remarks thus: "A fuse is a very excellent thing to do without."

Mr. Andrews replied by saying that his switch was just the thing for synchronising in a hurry; that one never knew what fuses would do; a circuit cannot be opened too quickly, and that often a short occurs which is not a case of two pieces of copper coming together. His extended remarks, delivered with enthusiasm of his subject, formed a further exposition of the interesting subject, and the meeting closed with a general feeling of gratitude to Mr. Andrews for a good discussion.

CORRESPONDENCE.

Ether and "Surface" of Matter.

A great many phenomena are endeavoured to be explained by motions of or in the ether. But considerations in regard to a decrease or increase of *surface* in changes of configuration of or in matter, appear not to be sufficiently appreciated in reference to motion, energy, &c. But it may be taken that wherever energy, so-called, in any form, is given out from any system of matter, that system must diminish in *surface* and *vice versâ*. It does not matter whether the mass under consideration be the sun, a watch-spring, ions, or what not, a simple or complex molecule, or the visible universe.

In some mysterious way the organs of our bodies appear to absorb and give out energy by such a change of surface. In fact, it is not by any means difficult to explain much of the phenomena of life and death by it. Most certainly thermal and electrical phenomena in chemical change can be explained on this basis. If the particles of any two or more bodies have together greater surface before combustion, association, combination, &c., than afterwards, then there will be a rise of ether pressure or potential or moving power upon the resultant matter surface.

The total change in *surface*, and the rate of increase or decrease of such change in surface, will explain and render clearer a great many thoughts about matter and motion. However, if we accept the idea of matter in all forms being charged (on its surface) with another something which we call the ether, then we should have no difficulty in imagining how, by a change in *surface*, there will be an *in*-rush or *out*-rush of this ether, which we may express by − or + sign respectively. *Surface* seems to be the key to it all. Tyndall asked (1862): "*May not the condensed ether which surrounds the atoms be the vehicle of electric currents?*" But if atoms dissociate [we must also suppose the ether itself capable of association and dissociation—Maxwell had the idea in his mind of a molecule of electricity] as to increase the surface, there will be a fall in the density of the ether, and if they associate (or aggregate) as to produce a decrease of surface, there will be a rise in the density of the ether, which may have explosive or gentle expansive *force*.

J. C. R.

London, *May* 10*th*.

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending May 10th, 1897.	£	s.
Albany	297	0
Amsterdam	225	0
Antwerp. Elec. fuses	361	0
Bangkok	772	0
" Teleg. mat.	913	0
Beira	64	0
Bilbao	14	0
Bombay	438	0
" Teleg. mat.	46	0
Brisbane. Teleph. mat.	721	0
Brussels	1,230	0
Calcutta	194	0
Cape Town	10	0
Colombo	322	0
Copenhagen. Teleg. wire	17	0
Durban	986	0
" Teleg. mat.	179	0
East London	98	0
Galveston	8	0
" Teleg. cable	2,800	0
Genoa	300	0
Hamburg. Teleg. mat.	1,229	0
Hong Kong	25	0
Madras	96	0
Marseilles	163	0
Mauritius. Teleg. mat.	120	0
Melbourne	61	0
Nagasaki. Teleg. cable	25,000	0
Passages	1,710	0
Port Elizabeth	130	0
Shanghai	823	0
" Teleg. mat.	80	0
Singapore	51	0
" Teleg. mat.	332	0
Sydney	314	0
Trieste. Teleg. mat.	330	0
Trinidad	13	0
Vigo. Teleg. mat.	268	0
Wellington	25	0
" Teleg. mat.	2,471	0
Yokohama	150	0
Total	£43,386	0

Week Ending May 10th, 1898.	£	s.
Algeciras	35	0
Amsterdam	235	0
Antigua. Teleg. mat.	11	0
Antwerp	32	0
Auckland	690	0
Bermuda. Teleph. mat.	10	0
Boca	16	0
Bombay	65	0
Boulogne	27	0
Buenos Ayres. Telep. mat.	20	0
Calcutta	26	0
Cape Town	289	0
Colombo	236	0
Delagoa Bay	44	0
Dunkirk	15	0
Durban	437	0
East London	725	0
Fremantle	671	0
Halifax	500	0
Lisbon	80	0
Madras	88	0
Malaga	90	0
Melbourne	30	0
Port Elizabeth	87	0
Rotterdam	35	0
St. Petersburg	85	0
Shanghai	190	0
Singapore	10	0
Spezzia	822	0
Stockholm. Teleg. mat.	118	0
Sydney	818	0
Wellington	327	0
Yokohama	100	0
Total	£6,964	0

Foreign Goods Transhipped.

	£	s.
Calcutta. Teleg. mat.	75	0
Port Elizabeth	38	0
Total	£113	0

	£	s.
Alexandria. Teleph. mat.	73	0
Barcelona. Electric tram plant	10,600	0
Malaga	276	0
Stockholm. Teleph. mat.	22	0
Total	£10,971	0

Books Received.—"Science and Engineering, 1837-1897." By Chas. Bright, F.R.S.E. Pamphlet, 24 pp., published by Messrs. Archibald Constable & Co, 2, Whitehall Gardens.

"Industrial Electricity." By A. G. Elliott. (Translated and adapted from the French of Henry de Graffigny. Published by Whittaker & Co., London. Price 2s. 6d.

"Alternating Currents of Electricity, and the Theory of Transformers." By Alfred Still, A.M.I.C.E. Published by Whittaker and Co., London. Price 5s.

Catalogues and Lists.—Messrs. Wimshurst, Hollick and Co., of Commercial Road, E, who have offices at 17, Victoria Street, S.W., send us a 16-page pamphlet in which the general utility of electric cranes and lifting gear is demonstrated. The letterpress shows that cranes driven by electric power and fitted with Hollick's patent gears and motors, are cheaper in first cost, in repairs, and in working, than cranes worked either by steam or hydraulic power. Some comments are made upon the general efficiency of cranes, and illustrated descriptions are given of Hollick's patent balanced friction gear electric overhead travelling crane, electric goods lift and warehouse crane winch, also of electric cranes in use at the West India Docks, and at the wharves and works of firms in different parts of the country.

The Nottingham Engineering Company, Limited, of Radford, Nottingham, have issued an illustrated catalogue of shafting, bearings, couplings, and other fittings, together with a cipher code for ordering by telegram. In tabulated form there are given sizes of shafting required for a given horse-power, and the number of revolutions; also graduated price lists, covering many pages, of bright turned steel and iron shafting. A great number of power transmission accessories, couplings, wall boxes, plummer blocks, brackets, hangers, pulleys of various kinds, &c., are included in this list.

Messrs. Heath, Snoxell & Co., Limited, of Birmingham, have issued a handy pocket list, which is a photographic reproduction, considerably reduced, of their larger catalogue, giving particulars of electric motors for all purposes, and dynamos for electric lighting stations, transmission of power, and electro-deposition of metals. There is a specification of standard continuous-current dynamos, also illustrations and tabulated details and prices. Prices and general particulars of motors, and ammeters and voltmeters are given.

Messrs. Chas. Jennings & Co., of 90, Cannon Street, E.C., have issued an illustrated list of isotropic iron magnet forgings and armature stampings, steel magnet castings, and transformer stampings. The results are given of some tests made by Prof. Ewing on steel magnet castings which were manufactured for Messrs. Jennings. This firm is also sole representatives for the United Kingdom of the extensive copper works known as the Usines Mouchel, Boisthorel, France, and, therefore, high conductivity copper is included in the list.

The Crystal Electric Lamp Company, Limited, v. Pearson.—This was a claim made by the plaintiff company at the Lord Mayor's Court last week to recover from the defendant, Mr. A. Pearson, a sum of £20 4s. for electric lamps supplied. The defendant said that a half-brother of his (Mr. Bundy) and a Mr. Roe started the business of the Decorative Glass Company. He had ordered the goods of the plaintiffs for that company, and had afterwards given the authorisation, on the condition that he should either receive the balance of the electric lamps or be given an authority to collect the accounts due to the plaintiffs for the lamps. The plaintiffs would do neither, and therefore he declined to pay for the lamps supplied. The jury found a verdict for the plaintiffs.

Electrical Exhibits in Manchester.—Messrs. F. H. Royce & Co., electrical engineers, Manchester, have supplied the dynamo and lamps for the fairy fountain at the Brewers' and Allied Trades Exhibition now being held at St. James's Hall, Manchester. They have also, at Stand No. 74, an exhibit of the transmission of power by electricity. The National Gas Engine Company exhibit a small electrical installation consisting of one 5-H.P. brake National special high speed electric light engine, with various fittings, and driving dynamo. They have also specimens of electric light lamps and fittings. An electric piano is shown by Messrs. Guldman, Market Street, Manchester.

Electricity in Cork.—The Cold Storage Company, Limited, have decided on getting rid of their gas engines, and in a very short time electric motors will replace them. The order for the motors was given to a local firm.

Embezzlement.—L. A. Longley, accountant, was charged at the Guildhall Police Court, last Saturday, with embezzling £4 11s. received by him on behalf of his employers, the Electric Light Insurance and Maintenance Company, Limited. Prisoner blamed his betting habits. He was remanded.

Forthcoming Book.—Messrs. Emmott & Co., Limited, have in preparation an entirely new work by Mr. C. N. Pickworth, Wh. Sc., entitled "The Indicator Handbook: a Practical Manual for Engineers."

The "Ideal" Engine.—Messrs. Daniel Adamson and Co., of Dukinfield, near Manchester, have brought out an exceedingly neat list in the American style, of their "Ideal" high art engine. This steam engine, which is described and well illustrated, is automatic and self-oiling, and is said to be specially adaptable for direct connection, because of its range of speeds, quiet running, absolute regulation, perfect balance, compactness, and automatic lubrication. The advantages claimed for the "Ideal" engine are briefly stated, and there are some general remarks on the importance of good lubrication. The "Ideal" tandem compound engine is described, and there are some comments on the economy in compounding, also on the governor and the "Ideal" throttle valve. Tables of dimensions and powers of the engines are given. The list has been very well put together. Mr. Frank Jordan, of 15, George Street, Mansion House, E.C., is London agent for Messrs. Adamson.

Langdon-Davies Motor.—The increased facilities for manufacturing now available at the new works of the Langdon-Davies Motor Company, referred to in our last issue, have already enabled them to effect a reduction in prices, particulars of which are given elsewhere.

Private Telephone Systems.—Mr. R. S. Blackburn is putting in an extension of the Long Eaton Co-operative Society's telephone system, connecting various additional branches with the head shop. He is erecting a system of fire and ambulance telephone call stations for several out-districts and 14 firemen's houses for the Urban Council of Long Eaton, and is also laying down a complete telephone system for the Blackley Co-operative Society.

Reavell v. Brotherhood.—This was an action brought before Mr. Justice Grantham and a special jury by Mr. William Reavell against Mr. Peter Brotherhood to recover damages for wrongful dismissal and for breach of contract. Mr. John F. P. Rawlinson, Q.C., and Mr. Whatley (instructed by Mr. Percy J. Nichols) appeared for the plaintiff, and Mr. Bucknill, Q.C., and Mr. Alfred Lyttleton (instructed by Messrs. Cope & Co.) for the defendant. Mr. Rawlinson stated that the action had been settled on the terms of the defendant paying to the plaintiff the sum of £1,000 damages and costs (in addition to the sum of £519 4s. already paid into Court), the defendant also fully withdrawing all charges of every kind pleaded as a justification for the dismissal of the plaintiff. Mr. Bucknill for the defendant assented.

The Shannon Power Scheme.—The proposals of the Shannon Electrical Power Syndicate were again before the Shannon Fishery Conservators last week. Mr. Fuller, the engineer, submitted a tracing showing the proposed canal. Various questions were drawn up for the syndicate to answer in regard to the general details of the undertaking.

The Smoke Nuisance.—There has been a correspondence on this subject in the *Westminster Gazette*. One writer says that ever since the South Wales coal strike commenced the big chimneys of the electric lighting works in East Street, Manchester Square, and Davies Street, Grosvenor Square, have been vomiting forth—both by day and by night—volumes of the blackest and foulest smoke.

South African Electrical Notes.—The May issue of the *British and South African Export Gazette* contains the following items of electrical interest:—

A trial indent of 12 sets of railway carriage electric lighting apparatus has been placed with Messrs. J. Stone & Co., Deptford, S.E., by the Cape Government Railways, to be followed by the necessary orders for a general introduction of these fittings should the experiment prove successful.

The Kimberley electric lighting scheme having been approved, orders may shortly be expected to be placed for the needful material.

Tenders for arc lamps and insulated cable were called for last month by the Johannesburg Town Council.

The electrical motor driving the central mill at the Transvaal Gold Mining Estates Mine having completely broken down, the order for a new motor in substitution for it will be immediately placed.

A power plant has just been installed at the York Gold Mine, comprising two belt-driven 50-H.P. three-phase inductor type generators, running at 750 revolutions per minute and supplying power to two 24-H.P. motors coupled to belt-driven pumps; also a 3-H.P. motor connected to a centrifugal pump; and several small motors for various kinds of machinery, including one of 9-H.P., coupled direct to a continuous current dynamo of 15 volts 300 amperes output, for cyanide work.

An electrical plant recently sent out to the Vogelstruis Gold Mine by the General Electric Company, Manchester, consisted of two 150-k.w. three-phase generators, belt-driven at a speed of 300 revolutions per minute, a frequency of 30 cycles and a pressure of 950 volts; three triplex single-acting pumps, with plungers 6½ inches by 8 inches, coupled direct to 35-H.P. motors, running at 360 revolutions.

The generators of the General Electric Power Company, Johannesburg, were made by Messrs. Brown, Boveri & Co., Baden, Switzerland, and their fly-wheels by Messrs. Yates and Thom, Blackburn, the shafts of the fly-wheels being supplied by an American firm.

An electric lighting plant, manufactured by Messrs. Thomas Parker, Limited, Wolverhampton, has been installed at the British South Africa Mills, Bulawayo.

Spain.—The *Consular Journal* says that although the demand for cables and other electric appliances is increasing in Spain, English manufacturers are not benefiting at all by it. An opening for a large supply of water, electric light, and gas, materials will be afforded by the proposed formation of a company to provide the town of Oviedo with water, electric light and gas, for a term of 99 years. The capital has been already subscribed.

S. Z. de Ferranti, Limited.—Messrs. S. Z. de Ferranti, Limited, late of Charterhouse Square, London, have now transferred the manufacture of meters to their new works at Hollinwood, Lancashire. The London works are closed, but a depôt has been opened at 29, St. John's Square, Clerkenwell, for dealing with their meter business in London and the South of England. All communications for that district should be addressed to St. John's Square. The remaining business will be dealt with from Hollinwood.

The "Underground."—We have received a small leaflet by Mr. Ernest Callard discussing the question of the ventilation of the Metropolitan Underground, which has been receiving so much attention lately.

ELECTRIC LIGHTING NOTES.

Alloa.—The Alloa Public Baths and Gymnasium, which Mr. John Thomson Paton has just handed over to the town of Alloa, is fitted up with electric light throughout. The work was carried out by Messrs. Mavor & Coulson, Limited, whose patent concentric watertight system has been installed.

Bath.—The new generating plant is ready to be put in position as soon as the building contract is completed. Seventy-five of the new arc lamps have been fixed.

Belfast.—When the report of the Electric Committee came before the Corporation last week, it was stated that the engineer had reported that the Acme Gas Engine Company had refunded £1,593 5s. 6d. in respect of the three engines which were to be returned. The Town Clerk said the Acme engines were not found to come up to the undertaking given by the company, and it had been agreed to take them back and repay the money. There was a passage in the report relating to the subject of electric traction, but Councillor Andrews was absent. The matter is under consideration. The engineer reports that for the past quarter's working, there was an increase in the receipts of about 50 per cent., and an increase of the output of about 55 per cent., as compared with the corresponding period of last year.

Bloemfontein.—Definite conclusion is about being come to, says a London contemporary, with regard to the long-mooted electric installation for the Orange Free State capital. According to last advices, it has now been decided to submit the plans and the several tenders to an engineer in Europe for report. The tenders sent in varied in amount from £12,000 to £30,000.

Bournemouth.—At the Town Council on Wednesday last week it was recommended by committee that the Council should generate the electricity necessary for lighting the pier, pleasure gardens, and winter gardens, and invite tenders. The town clerk stated that in 1895 the Local Government Board gave sanction for the borrowing of about £4,500 for the purpose, any amount decided on to be repaid within seven years. The Board had now written asking if anything had been done by the Corporation, and if not, and the Council did not propose to act on it, that the sanction should be given up. The scheme the Committee recommended was to take up sanction to the amount of £1,600 for the material and wiring, and £900 for generating electricity, and the surveyor had prepared a scheme to utilise the present pumping stations and light the pier, winter gardens, and pleasure gardens; but the sum would have to be repaid in three years, that being the limit of the original period of sanction. The scheme was agreed to after a discussion on arc v. incandescent lights. The tender of Messrs. Cash, Robinson & Co. was accepted.

Bridlington.—The Council has resolved to light the parade on Sunday nights with gas instead of electricity.

Cardiff.—Complaints have been made to the Lighting Committee of alleged erratic measurement of the current, consumers considering that they are charged for more than they use. The Lighting Committee is referring the matter to a Local Government Board inspector, and is writing to other towns to know whether similar complaints are made there.

Cheltenham.—The minutes of the Lighting Committee which were adopted by the Council last week, state that the electrical engineer reported that the new steam alternator, No. 6, had been started, and had run very satisfactorily for about 10 days on the town mains; the buildings were nearly complete, and he hoped to get the battery of accumulators into place shortly. He recommended that a small part of the extension to the arc lighting mains included in his estimate of extensions in February should be carried out, at a cost of about £120. In consequence of two faults on high pressure cables on Saturday evening, the 16th ult., the town supply was interrupted for periods of eight and 18 minutes respectively, at about 7.20 p.m. and 10.50 p.m. The earlier fault was due to breakdown of a rubber insulated cable forming a service in Lansdown Terrace, and the second fault occurred on one of the two main feeders and at the junction of the St. George's and Gloucester Roads. At this place the cable had been several times disturbed by openings made by the gas company, and the Highways and Waterworks Departments, and he thought it likely it had suffered some rough usage; the fault, however, was very much burnt up, and at that time he could give no definite opinion as to the cause of the trouble. Both faults had been repaired. The estimate of expenditure on street lighting for the current year was £3,750 for gas and £2,550 for electric lighting—total £6,300.

Chiswick.—The District Council last week passed the following resolution:—"That a statement of the dealings of the late District Council with the Bourne and Grant Electricity Supply Company, Limited, and a copy of the correspondence between the said parties, together with a copy of the agreement originally entered into, be supplied by the clerk to each member of the present Council and also to the public press, and that all necessary steps be at once taken to re-acquire the electric lighting power of the parish."

Conisborough.—The Parish Council will oppose the General Power Distributing Company's scheme.

Country House Lighting.—According to an Aberdeen paper, Mr. George Farquharson, of Whitehouse, has just utilised the water-power which has been hitherto running to waste on Donside for electric lighting purposes. A pipe conveys the water down the hillside to a turbine which drives the dynamo. Every part of the mansion house is lighted electrically, and the long winding avenue is also illuminated by lamps hung from the trees. During the day the current will be used for driving the threshing mill, corn-bruising machine, turnip and chaff cutters, &c. The turbine house is about 100 yards from the mansion house. The electrical work was carried out by Messrs. Middleton & Co. The dynamo was supplied by the Electric Construction Company, and the turbine by Messrs. W. Günther & Co.

Coventry.—The quarterly statement of the Corporation Electric Light Department shows a considerable advance upon the corresponding quarter last year. The amount of current supplied was 30,090 units, as compared with 21,516 during the same quarter last year. The rentals amounted to £891 4s. 5d., as compared with £547 6s. 5d., while the number of consumers increased from 76 to 112.

Clay Cross.—The District Council is considering the scheme of the General Power Distributing Company. There is a good deal of feeling in favour of the proposal, but the matter is to be investigated by the Highway and Lighting Committee.

Devonport.—An offer to provide the town with one of Willoughby's refuse destructors, capable of dealing with from 70 to 100 tons of refuse per day, has been referred to the Sanitary Committee, with the assistance of the Electric Lighting and Tramways Committee. If the destructor is approved, it could be purchased at the end of three months for £2,000.

Dundee.—The Town Council last week unanimously passed the recommendation advancing the salary of the borough electrical engineer, Mr. Tittensor, by £50 per annum. There was a general discussion in the Council, on the suggestion of the engineer that lamps should be placed in certain streets, and it was moved that the engineer should draw up a big scheme, embracing the central and principal streets of the town. It was stated by others that they had already had a big scheme from the engineer, which was delayed until the tramway question was settled. The proposals for lamps to be put up in certain streets were referred back to the Gas Committee.

The electricity rental during the past year came to £6,279 odd, an increase of £736 odd compared with the previous year.

Eton.—The District Council has appointed a Committee to obtain information *re* electric lighting from other towns.

Fulham.—We understand that at last week's Vestry meeting the Electric Lighting Committee recommended the appointment of Mr. F. H. Medhurst as consulting electrical engineer.

Germany.—The United States Consul at St. Gall, in a report to his Government, states, according to the *Board of Trade Journal*, that in the following cities in the German Empire the municipal authorities own and manage the electric works that supply light and power: Bremen, Barmen, Cassel, Darmstadt, Düsseldorf, Elberfeld, Hanover, Cologne, Königsburg, Lübeck, and Pforzheim. All of these cities, with the exception of Hanover, also own the gas works. The following cities have constructed the electric works for the purposes of light and power, but have leased the management of the same to private operators: Aix-la-Chapelle, Chemnitz, Frankfort, Strasburg, and Stuttgart, all of which, with the exception of Chemnitz, are cities where the gas works are under the management of private corporations. In the following cities, private companies have established electric works with the agreement that, under certain conditions, the municipal authorities shall have the privilege of securing absolute control and ownership by purchase: Altona, Dessau, Gera, Hagen, Heilbronn, Leipsic, Mülhausen, Stettin, and Zwickau. Of these cities, the gas works are under private control in Dessau, Hagen, Mülhausen, and Zwickau.

Glasgow.—The Electricity Committee last week generally approved of the report, mentioned in our last issue, recommending a large electric lighting scheme, involving half a million expenditure, for the municipal area.

Glossop.—The Town Council is engaging a Manchester engineer to report on an electric light scheme.

Godalming.—On Tuesday last week a Local Government Board inquiry was held with reference to the Council's application for a £1,500 electric lighting loan. Evidence as to the scheme was given by Mr. Cousins, electrical engineer, representing the firm of Kincaid, Waller & Manville, and the Mayor and other residents spoke in favour of electric lighting, and stated that the gas was at present bad, and much too dear. The town clerk explained that a station site had been purchased for £400 near the pumping station. The number of lamps within the compulsory area is 32.

Govan.—The Police Commissioners have adopted the recommendation of the Electric Lighting Sub-committee that steps be taken to put the electric lighting powers into force, and the matter has been referred back to the Committee to consider and advise as to system, site, and other details. It was considered that an electric supply undertaking was a municipal necessity.

Hampstead.—On Thursday night last week, for the first time, the lower part of Heath Street, with High Street and Haverstock Hill, were lighted with electric arc lamps. There will now be a straight continuous line of arc lamps from the fire station to Oxford Street.

Hastings.—The electric light machinery for the Corporation works at Waterworks Road is in working order, and the requisite one month's notice has been given to to the Hastings Electric Light Company of the desire of the Council to determine the existing agreement with the company for the lighting of the electric lamps on the front line. The Public Lighting Committee has reported to the Council that the Board of Trade had issued the provisional order authorising the supply of electricity by the Council. Section 3 of the order, providing that the order shall not come into force or have effect, notwithstanding the confirmation thereof by Parliament, until such date as the Board of Trade fix a date for the commencement of the order when they are satisfied that the Council has completed the purchase of the undertaking of the Hastings and St. Leonards-on-Sea Electric Light Company, Limited, in accordance with the agreements entered into by the Council with the company, and that as from the commencement of the order the orders previously granted to the company and to the Corporation shall be revoked. The necessary application has been made to the Local Government Board for the sanction to the borrowing of the money required for the purchase of the company's undertaking.

Hull.—There is a proposal to construct a subway, and the gas engineer has sunk a trial bore with a satisfactory result. It is suggested that the Waterworks and Electric Lighting Committees should lay their mains in the subway and take part in the cost (£4,000). The Council is to consider the matter.

Ilfracombe.—A Bill to confirm the Ilfracombe Provisional Order granted by the Board of Trade came before the Examiners of the House of Commons last week.

India.—The erection of the electric light at the Golden Temple, Amritsar, has been completed. There are altogether 16 lights put up round the sacred tank, and one large globe on the tower of Baba Atal. The Sikhs would not allow the interior of the temple to be lighted by electricity, on the ground that it would be contrary to the doctrine expounded by the Guru. The temple authorities have, however, secured two large chandeliers for the inside of the temple, and are waiting to see a change in the views of their co-religionists, especially the Kukas, in the hopes of having them fitted inside the temple later on. The cost of the whole is about Rs.60,000.

Ipswich.—The tenders for the installation of the electric light at the new Workhouse were to have been opened at the meeting of the Board of Guardians on Friday, but the clerk said that he had only received three, and he had heard something mentioned as to there having been a misunderstanding. No tender had come in from either of the local firms. It was decided to defer the consideration of the tenders for a week.

Isle of Wight.—At the last meeting of the Shanklin District Council the members deputed to discuss with the Sandown District Council the question of the lighting of the two districts by electricity, reported having met representatives of Sandown. It was then explained that Messrs. Edmundson were prepared to form a company for the supply of electric light within the districts. The company explained its terms *re* charging, time of purchase by the Corporation, &c. The estimated outlay was stated to be £25,000, including an anticipated 10 miles of mains. A draft agreement had been forwarded, but the matter was not discussed, the clerk being instructed to confer with the solicitor to the Board and a representative of the company.

Islington.—The report of the Electric Lighting Committee shows that during the quarter ending March 31st the Vestry has made a profit, after paying all its liabilities on capital account, of £1,753. The sale of the light is increasing by leaps and bounds. In the corresponding quarter of 1897 the number of units sold, including public lighting, was 132,044, which produced a revenue of £3,213, but in the last quarter the supply had gone up 99 per cent., the total units sold being 263,502, or an increase of 131,458. The revenue was £5,917, or an increase of £2,704. The working expenses in the March quarter of 1897 were £2,035, or nearly equal to 3⅝d. per unit. During last quarter the expenses of production were £2,668, or nearly equivalent to 2½d. per unit. Thus the working expense only increased 31 per cent., while the revenue increased by 84 per cent. The net profit in March, 1897, was only £147, and £1,205 gross. Now the gross profit is £3,326 and £1,753 net.

Leith.—On Wednesday last week Bailie Manclark, the convener of the Electric Lighting Committee took out the first shovelfull of earth at the foot of Leith Walk, and the laying of mains was proceeded with immediately.

Leyton.—A Local Government Board inquiry is to be held on 20th inst. *re* the Council's electric lighting extensions loan. The electrical engineer has reported as follows:—Units generated in March, 23,451; units sold, 14,506; maximum current, 390; lamps installed, 828; total lamps installed to March, 6,788·6; total applications to date (April 5th), 126; total customers connected to date (April 5th), 116; less customers disconnected, 4; net total, 112; largest number of lights on at any one moment, 3,900, being about 58·3 per cent. of the total connected. The tender of the General Electric Company for dynamos, for the sum of £647 16s. 6d. has been accepted, instead of that of Messrs. Siemens Bros. & Co., who could not undertake to deliver the dynamos until the expiration of eight instead of three months, as provided by the specification.

Lincoln.—In a few weeks the Corporation will commence to lay electric mains for the supply of electricity, and we understand that an arrangement has been made with the National Telephone Company to lay their underground cables at the same time, the company bearing the cost of the trenches, &c.

London.—The clerk to the St. Giles Board of Works reported at the last meeting that he had, with the surveyor, attended the inquiry held by the Board of Trade into the supply of electricity to the district, and they had been successful in all they had contended for. Mr. Doll: That is, in two years we are to have a competitive supply.

Long Eaton.—The Co-operative Society has asked the District Council for permission to take electric cables along the streets from the old gasworks to their property in Main Street. The subject stands deferred.

Lowestoft.—The Corporation is considering the advisability of providing electric light, and a provisional order has been obtained. One clause would have empowered the authority to supply electrical fittings and fixtures, but to this the Board of Trade objected. At a meeting on Monday, May 10th, the Council decided to press the Board for the retention of this clause, or a modification. It is intended to work the electric light in conjunction with the Horsfall destructor.

Ludlow.—The Town Council last week formally resolved, on the recommendation of the Lighting Committee, to give the £20 prize offered for the award of best electric lighting scheme to Mr. Enwright, of Kensington. The Committee were much disappointed to find that the mill power was not sufficient to drive an electric light plant. Of the 10 schemes received only two exclusively dealt with the water-power, and these in such a way as to interfere with the Waterworks power. They could not entertain a scheme which would interfere with the water supply. Mr. Enwright's scheme proposed to use gas for driving power. The idea was to erect a Dowson's patent gas apparatus to provide its own gas, and to lay down two engines of 54 horse-power, which would be sufficient to provide light for six or seven hours a day for the whole borough. It was proposed to erect the plant in the Cattle Market, with a main feeder to the Butter Cross, from whence the mains would be distributed. The total expenditure for this scheme was £5,000, the estimated annual cost to the Corporation was £650, and the estimated annual revenue £1,300, yielding a profit of £500 or £600 a year. Mr. Enwright also stated he would find a contractor to carry out the work at the figures named.

Luton.—Over three years ago the Council obtained an electric lighting provisional order, and has since obtained an extension of it for one year. An electrical engineer recently submitted a report on a scheme, and a deputation inspected systems in various places. A few days ago the party went to Brighton, and were shown round by Mr. Arthur Wright.

Malvern.—Messrs. C. Santler & Co. are lighting up the Arts and Industries Exhibition at Malvern from May 3rd to 10th at the Assembly Rooms. There are three arc lights of 1,000 H.P. each, and a number of incandescent lights on exhibition stalls of 8 and 16 C.P. each. There is no public electric lighting in Malvern.

Manchester.—At the monthly meeting of the Manchester Corporation on Wednesday last week, Alderman Higginbottom, in moving the adoption of the minutes of the committee, explained the circumstances under which he and the deputy chairman had been appointed to give evidence before the Special Joint Committee of the House of Lords regarding the supply of electrical energy by Corporations and others, and this was a matter which affected that Corporation and other authorities. The Joint Committee was appointed because of a difficulty that had arisen between Lord Morley, chairman of the Lord's Committee, and Sir Courtenay Boyle. The important principle was involved as to whether companies were to be allowed to compete with Corporations and other authorities within their own areas. If this were so, the Manchester Corporation would be placed in a serious position. The Manchester Tramways Company had a Bill before Parliament, and if the principle he had spoken of were granted, the company might have power not only to work the tram lines electrically, but also to compete with the Corporation in the supply of the electric light to consumers. He could not conceive that the Joint Committee would report in opposition to the interests of Corporations. If they did, the Corporation would have to take steps to be heard before Parliament in another matter. He could assure the Council that he, and those co-operating with him, had done their best to defeat a very wrong thing indeed. The estimate of the electricity department in Manchester for the current year amount, on expenditure account, to £7,000, the current for public lighting absorbing £1,500, and lamps and connections £5,500.

Monmouth.—The local papers are full of a report of last week's Council meeting, which lasted for three hours, the greater part of the time being passed in a discussion regarding remote points in the drainage and electric lighting scheme. The matter really seems to refer more to the drainage works than to the electric lighting affairs, there being some disagreement between the consulting engineer and one of the contractors; but wherein the electric lighting scheme is affected is the resignation of the chairman and another member of the Electric Lighting Committee, the former having been actively connected with the combined scheme all along.

Montrose.—The Asylum House Committee has had under consideration the renewal of the electric lighting plant of the main building of the institution. The report of Mr. Young, engineer, Glasgow, had been considered, and, on his suggestion, it was agreed that the type of engine should be the Belliss. After consultation with Mr. Young, it was agreed to accept the offer of Messrs. W. Dickson & Co., Glasgow, to carry out the installation, their offer being in every respect the lowest.

Morecambe.—In connection with the installation of electric light at Morecambe, tenders are invited for supplying a wrought-iron water tank, 5,000 gallons capacity, by Mr. C. F. Parkinson, the engineer. It was expected that the work would be completed for Whitsuntide, but it has been delayed, and will not be finished before the latter part of the season. When the front Promenade is first lighted is is intended to hold a *fête*, which will take the form of a "Battle of Flowers." The District Council some time ago took over the works of the private company.

Newcastle.—At last week's City Council meeting Mr. W. Smith presented the report of the special committee appointed to consider the desirability of the Corporation undertaking the provision of electricity, recommending that the committee be authorised to negotiate as to terms upon which the electric light companies will transfer their undertakings to the Corporation.

Ossett.—The Town Council has resolved to visit and inspect the electric lighting plant and refused estructor in Shoreditch, with a view to ascertaining the practicability of combining the two objects in Ossett.

Perth.—The Board of Trade have issued a provisional order to the Police Commissioners in connection with the electric lighting of the city.

The Police Commission has received a letter from the Mutual Electric Supply Company, Brighton, stating that if the Commissioners were disposed to delegate the powers under their provisional order for electric lighting, they were prepared to offer terms for consideration. The Commissioners have replied that they are not yet in a position to entertain a proposal, but that it would be considered at the proper time.

At the monthly meeting of the Police Commission on Monday, discussion took place regarding an account of £15 15s. tendered by Mr. Thomas Barton, Blackburn, for a report on the electric lighting scheme. The Lord Provost Dewar said Mr. Barton offered to come and give them the benefit of his advice, but it was on the understanding that they were not to be committed to him either for advice or in the appointment of an electrical engineer. The country, his Lordship continued, was swarming with gentlemen of this kind, who were willing to go here, there, and everywhere, to advise those interested in electric installations. They were in the position of gentlemen who had something to sell, and they meant to take the opportunity of selling it. The Corporation paid Mr. Barton's expenses, and it was on the distinct understanding that there would be no other claim that Mr. Barton was allowed to give advice at all. One or two other gentlemen had been employed on the same terms, and it would be a dangerous precedent to admit this claim, even to the extent of five guineas, as was proposed. He objected to paying every gentleman who volunteered his services to the Commission. It was agreed to deny liability.

Peterborough.—The local company which was hoping to undertake the electric lighting of Peterborough in the event of the Local Government Board persisting in its refusal of the application of the Town Council for raising a loan, is, of course, disappointed at the Board's last step in granting powers to the municipality. The Peterborough Electric Lighting and Power Company seems to think that the Board will neither revoke its order nor grant the application, yet it is considered that the Board would not allow two orders to be worked, as the area is not large enough to justify that step.

Plymouth.—At the meeting of the Town Council on Monday there was an animated debate previous to agreeing to the large increase in the rates, *i.e.*, 11d. in the £. Naturally the electric lighting and traction scheme came in for some criticism. Mr. Bellamy, one of Plymouth's foremost men, and who is connected with the gas company, agreed that the town was badly lighted, and that something should be done. But with gas at 1s. 9d. the 1,000—the cheapest in England—that was, he considered, not a town to go in for a luxury like electric light. He believed there would be a loss on the electric light and work generally of £1,500 a year.

Poplar.—The following took place at a recent meeting of the District Board of Works, and is reported in a Whitechapel paper:—The County of London Brush Provincial and Electric Light Company wrote asking for the name of the member who accused the company of "touting" for the company, and saying that unless it were given proceedings in another quarter would be taken. Mr. Marks: Who was the letter addressed to? The clerk replied that the first letter was addressed to himself, and it appeared to be a personal application to him, because the letter said, "I shall be glad to hear from you." Mr. Marks: Then the letter is a private one, and we have nothing to do with it. The clerk explained that he had placed the letters before a special committee, who would have nothing to do with the matter. Mr. J. R. Smith: I shall move that the communications be laid on the table. Mr. Purdy seconded the motion, which was unanimously agreed to.

Rathmines.—Mr. Robert Hammond is to furnish a supplemental report on his proposed scheme for lighting the town electrically. The secretary of the Electric Light Committee has reported having taken legal advice as to the extent of the obligation thrown on the Tramway Company by the 15th section of the Electric Power Act, 1897, to light the road, and Mr. Fitzgerald is of opinion that that section required the company, where pillars are erected in the centre of the road, to light the whole width of the road to the satisfaction of the local authority.

Sheffield.—There is a proposal before the City Council to appoint a Special Committee to take into consideration the desirability or otherwise of proceeding further with the separate electric power station, seeing now that the Corporation are owners of the present electric station, where there is sufficient room to put all that is required for the tramways for a considerable time to come, and, in the meantime, to make full investigation into how far the waste heat of all the destructors and water-power might be used in the future for generating electricity, and report.

The Parliamentary Committee has expressed its approval of the steps taken by the town clerk in conjunction with the representatives of other towns in the district to oppose the Bill of the General Power

Distributing Company, and also with reference to the Joint Committee of Inquiry which has just been considering electrical matters in London.

Shoreditch.—On 5th inst. the Electric Lighting Committee issued its first report, showing the results of the first nine months' working. There is stated to be a profit of £2,063 0s. 4d.

St. Pancras.—At the meeting on Wednesday the Vestry resolved to reduce the charge for current for public street lighting from 5d. to 4d. per unit, the alteration to come into force on July 1st. It was also decided, commencing on the same date, to reduce the charge to private consumers to 6d. per unit for the first 1½ hours' daily consumption, and to 3d. per unit for all current used afterwards. The Vestry sanctioned an expenditure of £790 for additional condensing plant for the King's Road station. The Elieson Lamina Accumulator Company, 4, Greenland Place, N.W., has consented to lend the Vestry a motor dust van on trial, provided that the local authority would supply the current for charging purposes free of expense. The Dust Committee has accepted the offer.

Swinton.—Last week a meeting of ratepayers and owners resolved to oppose the General Power Distributing Company's scheme.

Teignmouth.—The Gas Committee of the District Council recommends that information be obtained showing the probable cost of a provisional order for lighting the town by electricity.

West Hartlepool.—Tenders are shortly to be invited for the erection of the lighting station. The Sub-committee has submitted its report to the Corporation on dust destructors. After visiting Bradford, Oldham, Shoreditch, Leyton and St. Luke's (London), it is recommended that a six-cell destructor be obtained for West Hartlepool at a cost of about £5,000 or £6,000.

Westgate-on-Sea.—A Board of Trade inquiry will be held by Major Cardew to-day (Friday) in the matter of the Isle of Thanet District Council's application for a provisional order.

Wick.—The Harbour Trust had recently under discussion a proposal to light the harbour with electricity, the motive power to be derived from an overflow stream which falls into the outer basin. Owing to shortness of funds the proposal is to be held in abeyance in the meantime.

Wigan.—Circulars were recently issued to ratepayers *re* electric lighting; 69 were in favour of an installation being laid down, and 61 undertook to use the current. 85 were not in favour of an installation, and did not undertake to use the current. 29 were in favour of an installation, but would not undertake to use the current, and 69 gave a provisional undertaking. The Gas and Electric Lighting Committee recommended the Town Council to appoint a sub-committee to make inquiries into the subject of electricity generally, and for that purpose to visit six towns where public electric lighting has been established. This resolution was the subject of a discussion at the monthly meeting of the Council on Wednesday last week. Mr. Laycock said he desired to take exception to the resolution which was passed at the meeting of the Gas and Electric Lighting Committee the previous day. He failed to see the advisability of appointing another Sub-committee. They all remembered that in March of 1894 a Sub-committee, consisting of 14 members, was appointed. They had practically a roving commission given to them to make inquiries all over the country, and he was inclined to think they even went out of the country to get information upon that matter. At the end they issued a report, and they advertised and succeeded in getting tenders for the laying down of plant, but although they had got much information, and spent, he believed he was right in saying hundreds of pounds of ratepayers' money in getting that information, yet they did not recommend whether the high or low tension should be adopted in Wigan. Even in asking for tenders they left it for the electrical engineers to say whether they would recommend high or low tension. He thought that was purely an engineering and a technical matter, and he thought the better course to adopt would be to get the opinion of an expert before they appointed another committee. An expert would recommend a proper system, and give them places where it had been adopted, and the Committee would be able to recommend the Council to adopt a particular course. To give the Committee power to roam about as the other Committee did would be a waste of money. Mr. Ashton said that the minute was put on the book to get the feeling of the Council as to whether they were in favour of the electric light or not. Personally, he thought it ought to go forward in Wigan. After further discussion the minute was withdrawn.

Wimbledon.—At last week's District Council meeting Mr. A. H. Preece submitted his report and plans on the question of the combination of the refuse destructor in the boiler house of the electric light works. The total estimated expense was £4,650. Mr. Preece was extremely anxious that the interest and sinking fund of the destructor should be kept distinct from the electric lighting accounts. The electric lighting undertaking should also be paid at least 1s. per ton if it was to undertake the working of the destructor. The Council resolved to apply to the Local Government Board for sanction to a loan of £5,000. A number of tenders were recently obtained by the surveyor from certain firms for the electric wiring of the depôt buildings in Queen's Road, but the Council has resolved to return these tenders, and advertise generally for estimates. The cost is about £150.

Wolverhampton.—At Monday's meeting of the Town Council the Lighting Committee presented a report, in which they proposed to make a reduction in the average number of hours per day during which the maximum demand is to be used from 2 hours to 1½ hours. The Committee recommended "That as and from July 1st, 1898, the price for energy for lighting purposes be fixed at 6d. per unit, on a maximum demand of an average of 1½ hours per day, and 3d. per unit for all energy consumed in excess." The Council adopted the resolution.

Worcester.—Mr. Ruthven Murray, the borough electrical engineer, has, in accordance with the instructions of the Council, issued his report upon the working of the generating station for the past year, dealing with the various matters in the abstract of accounts issued by the committee some months ago. He calculates, says a local paper, the additional cost for coal, by reason of extra cartage to the works, at £127 on the 1,702 tons consumed in the 12 months, and he points out that this represents 6 per cent. on £2,100. He estimates the revenue derived from water-power at £1,880. Dealing with the question of the charge to be made to consumers, he says: "The lowness of the average price obtained is not proof that we are supplying under cost, as has been urged, since, whether a profit or loss is made depends entirely on the length of time the supply is used or the number of units consumed per maximum lamp demanded. The units sold at 6d. cost 8d. and upwards, whilst those sold at 2½d. cost under ⅞d. I am strongly in favour of an alteration in price, but such alteration must be to charge the short hour user somewhere nearer the cost of the supply, so that the loss incurred on such shall not be borne by the profitable consumer, as is now the case." He proceeds, also, to explain how so great a loss as 25 per cent. of the current generated is occasioned, viz., by the performance of work in the system, either by magnetising iron in transformers or meters so as to increase the sensitiveness in registering a very small proportion of their full load current, or in overcoming the resistance to the transmission of energy in the mains or other conductors. The lost power generated by water represents 55·26 and by steam 44·74. Of the total power generated during 1897, water-power represented 46·60 against steam 53·40.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Belfast.—It will be remembered that the Tramway Company has informed the Corporation that it cannot establish electric traction upon its lines unless its lease is extended. Last week there was a proposal before the Corporation to make the Law and Electric Committees into a Special Committee with a view to inquiring into the whole question, but after a lengthy discussion the matter fell through, the meeting being counted out before a vote was taken.

Birkenhead.—The report of the Special Tramways Committee, which we gave briefly last week, was adopted by the Town Council on 4th inst., without binding itself to the detail of the routes suggested. In the discussion upon the report there was some opposition, and it was urged that having regard to the contemplated outlay, namely £200,000, the matter should be dealt with by a full meeting of the Council, whereas only about half the members were present at the meeting. However, the report was adopted by a large majority.

Birmingham.—The old tramway controversy is agitating the minds of the City Councillors, who, it will be remembered, blocked the way for enterprise by declining to allow the Tramway Company to use the overhead trolley system. Mr. Ross's statement, which appeared in our "City Notes" last week, to the effect that the company at one stage of the negotiations received permission to use the trolley system, is denied by members of the Council, and the Town Clerk is communicating with Mr. Ross on the subject.

Dublin.—The Clontarf and Hill of Howth Tramroad Bill was before a Select Committee of the House of Lords last week. The tramway will run along the foreshore of Dublin Bay and terminate at Howth. It will form a connection with the tramways of the Dublin United Tramways Company, which are worked by electric power. The overhead electric trolley system is proposed. Mr. Fraser, M.I.C.E., engineer to the scheme, gave evidence.

The Dublin Southern District Tramways Bill in relation to the speed allowed on their lines was before a Select Committee of the House of Commons last week.

The Drumcondra Commissioners have decided that the Dublin United Tramways Company be charged wayleave for being allowed permission to run electric trams through the township, first payment to commence at the end of 10 years from the obtaining the order from the Privy Council, and the amount to be paid to be then arranged by arbitration between the Town Commissioners and the company, the line of rails to be placed on the centre of the road, and the extension to be completed within five years.

The Kingstown Commissioners are endeavouring to induce the Dublin United Tramways Company to undo some of the damage to the township, which the Southern Districts Company, with the full assent of the same Commissioners, inflicted. The company, according to *Freeman's Journal*, is proving amenable, and in its own interests. For if the double lined tramway has added enormously to the difficulties of business men in the main thoroughfare of Kingstown, the delays of the cars in getting through have detracted very seriously from the attractions of the tramway service.

Dudley.—At last week's Council meeting the mayor, moving the adoption of the report of the Railway, Tramway, and Electric Lighting Committee, remarked that in the matter of the proposed tramway to Cradley Heath they wished to work harmoniously with the Rowley Regis District Council. If the Rowley authority would not construct a line in their district and would give Dudley the power the latter would do it. The Rowley people, however, had decided to do it themselves. A report is being drawn up of the deputation's visit to the Worcester Electricity Works.

Dudley-Stourbridge.—Last week an active start was made with the alteration of the permanent way to permit of the introduction of electric traction. The rolling stock is being made as quickly as possible, so as to effect an early completion of the undertaking.

Dundee.—The Coporation Tramway Bill under which power is sought to work the lines in Dundee and district, was before a Select Committee of the House of Lords last week.

Ealing.—Various electric tramway matters were under consideration at last week's District Council meeting. There was a letter from the Simplex Electric Traction (Conduit) Company, setting out the advantages of the company's system of electric traction for tramways, and inviting the Council to see it in operation at Prescott, and also a communication from another firm anxious to acquaint the Council with the merits of its electric traction apparatus. The scheme of the London United Tramways Company was discussed, and the voting was 7 in favour of the following resolution and 8 against:—"That this Council withdraw its opposition to the London United Tramways Bill, subject to terms and conditions being arranged, and that Mr. Clifton Robinson be requested to meet the Council in committee with the view to the adjustment of such terms and conditions." The motion was accordingly lost. One member and the chairman did not vote.

Electric Power Schemes.—The Notts and Midland Traders' Association has passed a resolution expressing the opinion that it is desirable to encourage the introduction of electrical power into the towns and villages of Nottinghamshire, Derbyshire, and district, as it would prove of the utmost practical utility in aiding agriculture, village trades, and general manufactory purposes. This was in connection with the General Power Distributing Company's scheme.

Glasgow.—The Tramway Committee recommended, and it has been approved, that it be remitted to the sub-committee on the Springburn route to make arrangements to have poles, &c., put up on the High Street line, at present being constructed, and which had unusually steep gradients, so that it might be worked with electric power in connection with the Springburn line.

Grimsby.—The tramway track is out of repair in some places, and the company is delaying remedying the defects in view of the probable adoption of electric traction very shortly. The Highways Committee, however, has requested that the lines be put into repair at once.

Hastings.—The scheme of the Hastings, Bexhill, and District Light Railways (Electric) Company is to be again considered by the Town Council. The Council's own scheme was not passed by the necessary two-thirds majority, hence the re-opening of the negotiations with the company. Mr. Murphy will attend a special meeting of the Council to confer *re* the company's proposals.

Italy.—It is reported that Messrs. Siemens & Halske, of Berlin, have submitted to the municipal authorities of Alessandra and Valenza a proposal to construct an electric railway between the two towns, a distance of about 40 kilometres. It is proposed to utilise the water-power of the river Po in the generation of the necessary electrical energy.

Johnstone.—The British Electric Traction Company have lodged an application with the Town Council soliciting their approval of their scheme for constructing a tramway in the burgh connecting with Paisley. The application raised a lively discussion at the monthly Council meeting. The Council wants further information of the scheme.

Kidderminster-Stourport.—Successful trial runs were made over this electric line on Tuesday and Thursday last week. Tuesday's trial was merely to test the accuracy of the gauge, but on Thursday electric power was used. The official inspection is fixed for Monday next, May 16th.

Leeds.—The question of providing electric cars on the Wortley route was considered at a meeting of the Leeds Highway Sub-committee on 9th inst. A deputation presented a petition signed by about 400 ratepayers, entering an emphatic protest against the decision to extend the electric system of traction to the four routes mentioned, to the exclusion of Armley and Wortley. The objection which the committee have to deal with on the Wortley route is that the cars would have to be turned in Boar Lane, a proceeding which would cause considerable inconvenience to the traffic in one of the most crowded thoroughfares of the city. Some means of overcoming this difficulty, it was said, must be found before the electric system can be extended to Armley and Wortley. The committee, however, agreed that it was desirable that the system should be extended to the Wortley route at an early date, and will probably deal with the question as soon as the work upon which they are entering is completed. Dr. Hopkinson was again appointed consulting electrician in connection with the extensions, and was instructed to prepare plans and specifications for the four routes decided upon, and to submit them to the committee when ready.

Liverpool.—It seems that Sir Arthur B. Forwood has actually severed his connection, not only with the Tramways Committee but with the City Council. The circumstances which led to this were briefly stated in our last issue.

London to Oxford.—The *Financial News* says:—"The Light Railways Act possesses possibilities to which commercial men are waking up. We are told of a dream of England one vast network of tramways. It will probably remain a dream; for the world has not leisure to travel slowly nowadays. But there is talk of a scheme more practicable—the establishment of a road tramway from London to Oxford. It is not hoped to secure much through traffic, but to link the towns and villages together in one whole, and thus to develop local traffic. We presume that electric traction will be aimed at, and that the overhead wire is deemed the best system. That gives a rather appalling idea of what rural England may become in time."

Manchester.—The recent conference which took place last week between the Manchester Corporation and representatives of the local authorities interested in the tramway service failed to bring about a satisfactory arrangement in view of the expiration of the Carriage Company's lease, the Tramways Committee of the City Council have, according to the *Manchester Guardian*, reconsidered the subject, and now submit the following scheme, subject to Parliamentary sanction:—1. The several authorities outside the city shall, at their own cost, acquire and place the lines in their respective districts in a condition suitable for electric traction. 2. The several local authorities shall, either by themselves or by arrangement with the Electricity Committee of the Corporation or other local authority, provide electric energy and necessary equipment for the working of the tramways in their districts on the same system and at the same voltage as proposed to be adopted in Manchester. 3. Each authority shall fix the fare in its own district, and the same shall be placed to the credit of such authority. 4. Each authority shall be debited with the following and such other charges, not included under these headings, as may be incurred in the working and management of the tramways in the districts of such authority, all such charges to be ascertained on the car mileage principle:—(*a*) Traffic expenses; (*b*) management expenses; (*c*) repairs and maintenance of car sheds, workshops, &c; (*d*) repairs, maintenance, and renewals of rolling stock; (*e*) interest on capital expended on rolling stock, car sheds, workshops, &c.; (*f*) sinking fund in respect of same; (*g*) depreciation in respect of same; (*h*) electric energy in cases where the Electricity Committee of Manchester Corporation supply the same; (*i*) a charge of 5 per cent. on the total working expenses incurred by the Corporation under the above-mentioned items, exclusive of electric energy. 5. The net receipts in each district after deductions as above indicated to be handed over to the local authority. 6. The repair and maintenance of the permanent way in each district shall be undertaken by the local authority at their own cost. 7. This arrangement to be subject to revision at the end of three years' working. These terms are receiving consideration from the local authorities.

A conference took place in Manchester on Tuesday between the Manchester Corporation and representatives of local authorities interested *re* the suggestions made by the Manchester Tramways Committee. After discussing the matter in all its bearings, the various representatives failed to arrive at an agreement, and it therefore remains in abeyance. The Manchester Corporation, have, however, intimated their intention not to renew the lease with the Manchester Carriage and Tramways Company unless horse traction is abolished.

Middlesbrough-Stockton.—Work is stated to be so far advanced on the electric tramways that a trial trip is to be made in a day or two, and the lines may be opened by Whitsun week. The cables are laid and there are at the depôt 8 or 9 cars each to carry 60 passengers. The engines are being put in position in the power house. The car shed is almost completed and the battery room is progressing. A model truck in wood has been tried over a part of the track.

Norwich.—The promoters of the Norwich Electric Tramway Bill came before the Examiners of the House of Commons the other day for proof of compliance with the standing orders in regard to certain additions which it is proposed to make to the Bill as originally introduced. The necessary notices had not been given in time, so the Examiner decided that the Standing Orders had not been complied with. The matter is accordingly referred to the Standing Orders Committee.

Queenborough.—The promoters of the Sheppey Light Railway which is to be constructed at a cost of £52,000, in order to bring Sheerness into touch with Minster, have received notification that the Light Railway Commissioners will recommend the Board of Trade to issue an order empowering the construction of the proposed line from Queenborough to Leysdown.

Rochester and Chatham.—Although the inhabitants of Rochester and Chatham are naturally disappointed with the decision of the Light Railway Commissioners as to the proposal to introduce a system throughout the district of electric trams, still it is consoling to know that, after all, a very useful part of the scheme will yet most likely be carried out, as the whole scheme has not yet been set on one side by the Commissioners.

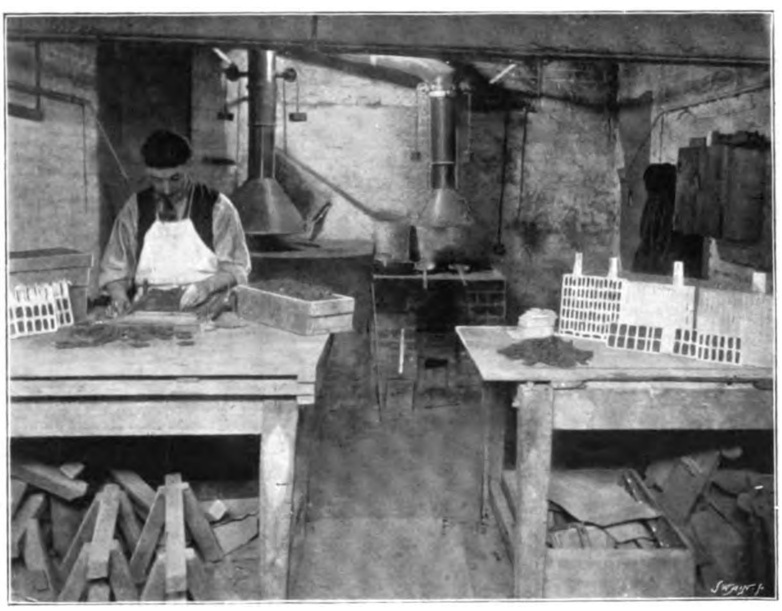
(*Continued on page* 661.)

THE MAKING OF LITHANODE ACCUMULATORS.

It will probably form an interesting addition to the series of articles on the manufacture of accumulators if we give some account of the process of making Lithanode cells. The company which is now associated with this type of battery is the Lithanode Electric Storage Company, Limited, which was formed some two years ago to acquire and work the rights and patents appertaining to the manufacture of lithanode accumulators. It is hardly necessary to say that the original application of lithanode for secondary battery purposes was due to Mr. Desmond FitzGerald, and his patents, as well as those of Mr. J. T. Niblett, are now vested in the Lithanode Electric Storage Company. The following description of the construction of this cell is taken from Mr. Niblett's recent paper :—

Making Lithanode Paste.

"Lithanode is not compressed peroxide of lead, as is sometimes supposed; for, however strongly this lead peroxide may be compressed, the resulting mass will disintegrate when immersed in a liquid electrolyte. It is produced from litharge made into a pasty mass with a solution of sulphate of ammonia, which causes the material to 'set,' so that it will no longer disintegrate when placed in a fluid. The 'forming,' according to the original idea, was performed in a bath of sulphate of magnesia. In ordinary practice the elements are made up of a number of small slabs of lithanode, whose outer edges are V-shaped. These slabs or pellets are arranged in a casting mould of any suitable dimensions, and are placed at such a distance apart and from the edges of the casting frame as to allow of sufficient space for the requisite quantity of metal to run in and impart adequate mechanical strength to the completed element. After the pellets have been arranged in this manner, an alloy of lead and antimony is run into the interstices, and thus a complete plate is formed.



Casting Frames.

"Before being cast up the positive pellets are converted into peroxide of lead in a forming bath; those for the negative plate are simply dried and cast up direct, the lithanode in the latter case being reduced to a condition of spongy lead by the ordinary electrolytic method.

"Where lightness is a desideratum, as in the case of a traction cell, the pellets in the positive plates are made larger, while the negative plate is constructed of lead gauze, having its outer edge strengthened by a rim of lead. The gauze is filled in with the prepared litharge which entangles itself in the thin lead wire, and thus produces a plate of great lightness, and one little liable to fall to pieces.

"Lithanode may be obtained in varying degrees of porosity. For high discharges it is made of a highly porous nature, the porosity being produced by incorporating in the material crystals of some salt, which is practically inert, and which is dissolved out during the forming operation.

"The rate of discharge obtainable from lithanode batteries varies between very wide limits, and is regulated by the character of the lithanode, whether made hard, medium, or soft. The ordinary working rate of discharge is $\frac{1}{14}$th of an ampere per square inch of lithanode plate, but owing to recent improvements very much higher rates of discharge can be obtained. The electrical capacity of lithanode, when discharged at the above rate, is almost exactly 1 ampere-hour per ounce, so that in a lithanode element weighing 1 lb. a current capacity of 16 ampere-hours is obtained. In practice, however, this high capacity is never reached."

It is generally thought that the chief direction in which lithanode has been applied is in small and portable forms of batteries; while, of course, a great measure of success has been achieved by the company in the manufacture of the smaller class of cell, this is by no means the limit of the company's operations, because lithanode cells have been made for purposes demanding heavy outputs. An instance of the company's work in the way of large batteries is one of 240 cells, which was supplied some time ago for Vera Cruz, this being probably the first storage battery ever erected in Mexico. This battery is employed in the town lighting of Vera Cruz, and reliance is placed on it both for lighting and power purposes.

We have already alluded to the success achieved in exploiting lithanode cells for small work. X ray operation for surgical and hospital work has called for a reliable and compact secondary battery, and the Lithanode Company seems to have created a great reputation in this direction, and both in this country and on the Continent great use has

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been made of the lithanode cell for this class of work. Among medical men the productions of this company are held in great repute, and their accumulators are being used not only in cautery work but also for driving small motors such as are used in dentistry and surgical work.

We have quite recently had an opportunity of witnessing some of the operations necessary in making lithanode batteries at the works of the company, situate at Mann Street, Bermondsey, where a large factory has been completely remodelled for the manufacture of accumulators.

Fitters' Shop.

The basement of the building is given up to the pasting of plates, the casting of the grids or frames, the forming of the plates; and here is also the drying rooms. One of the series of illustrations which are here reproduced, shows the operation of making up litharge into a paste. The operator takes the dry powdered litharge and reduces it to the required pasty condition, by means of sulphate of ammonia; the next operation is to shape the material into

Lead Burning.

slabs or pellets as required, which are then taken to the drying rooms, where they remain till sufficiently dry and hard for treatment. Following the course of the pellets a little further, we find that those destined for the positive plates are placed in a forming bath to be converted into peroxide of lead, lithanode, of course, forming the basis of both positive and negative plates, but the pellets for the negative plates are dried and cast up direct. In the casting operation, of which an illustration is given, the operator arranges the pellets on the lower half of a mould, and after closing it pours molten metal round, the pellets, as we have before observed, being placed at a slight distance apart in order to permit the metal setting round.

The process of forming employed needs no special remark, it being the usual electrical one. In order, however, that the forming action be continuous without running plant at night, a battery of accumulators is employed which continues the formation process after the machinery has been shut down. The ground floor is devoted mainly to lead burning and fitting the plates together.

One of the illustrations shows the process of burning a set of plates together. The next floor is set apart as a fitters' shop, and here are made all the fittings necessary for the portable lamps. Then there are the carpenters' shop, the theatrical department of which we shall have more to say subsequently, and what is termed the sealing-in shop. When the batteries are assembled, they are taken to the sealing-in shop, and there sealed in and filled up ready for charging purposes.

Electrical power is obtained on the premises from a Crompton dynamo, which is driven by a horizontal steam engine, and in addition there is the storage battery, to which allusion has been made.

The following information concerning one of the lithanode cells has been used before, but it may be interesting to reproduce it here:—

Data of Complete 30 Ampere-hour Lithanode Batteries, including Wood Cases.

No. of cells.	Outside dimensions of battery.			Open E.M.F. of battery.	Approximate gross weight of battery.
	Length.	Width.	Height.		
	Inches.	Inches.	Inches.	Volts.	Lbs.
1	3·75	7·00	6·37	2	8¼
2	5·12	7·00	6·37	4	16
3	7·27	7·37	7·00	6	22¼
4	9·50	7·37	7·00	8	29
5	11·60	7·37	7·00	10	36
6	13·75	7·37	7·00	12	43
7	15·78	7·37	7·00	14	50
8	18·00	7·37	7·00	16	56¾
9	20·12	7·37	7·00	18	63¾
10	22·24	7·37	7·00	20	70¾
11	24·36	7·37	7·00	22	77¾
12	26·50	7·37	7·00	24	84½

Detailed Particulars of Cell.

Vulcanite containing cell ... ... { 6·25 inches long. 2·12 " wide. 5·25 " high. weight, 10 ozs.

Positive element ...	Two plates in each cell, 5·9 inches long. 3·9 „ wide. 0·25 inch thick. weight, 1 lb. 1½ ozs.
Negative elements ...	Three plates in each cell, 5·9 inches long. 3·9 „ wide. 0·13 inch thick. weight, 11½ ozs.

Weight of connectors, 3 ozs.
Weight of cover, vent plug, sealing, and separators, 2 ozs.
Quantity of electrolyte, 15·5 fluid ozs.
Gross weight of complete cell, 6 lbs. 7 ozs.
Normal charging rate, 3 amperes.
Normal discharging rate, 3 to 4 amperes.
Maximum safe discharging rate, 9 to 12 amperes.
Approximate internal resistance, 0·015 ohm.

In adapting electric lighting to the many and varied requirements of theatrical work, the Lithanode Company have had unique experience, not only in supplying accumulators, but in devising special theatrical effects. We have before alluded in these columns to the different theatrical productions with which this company and its predecessors were associated. To instance the wide field covered in this direction, we might mention that during the last Pantomime season the Lithanode Company, in addition to provincial work, were associated with no less than seven in London, among them being those at Drury Lane, Brittania, Hoxton, and Standard Theatres. Of the effects created at Drury Lane and the Brittania, we can give personal testimony, and it is no exaggeration to say that the electrical portion of each entertainment was probably the most striking and attractive feature.

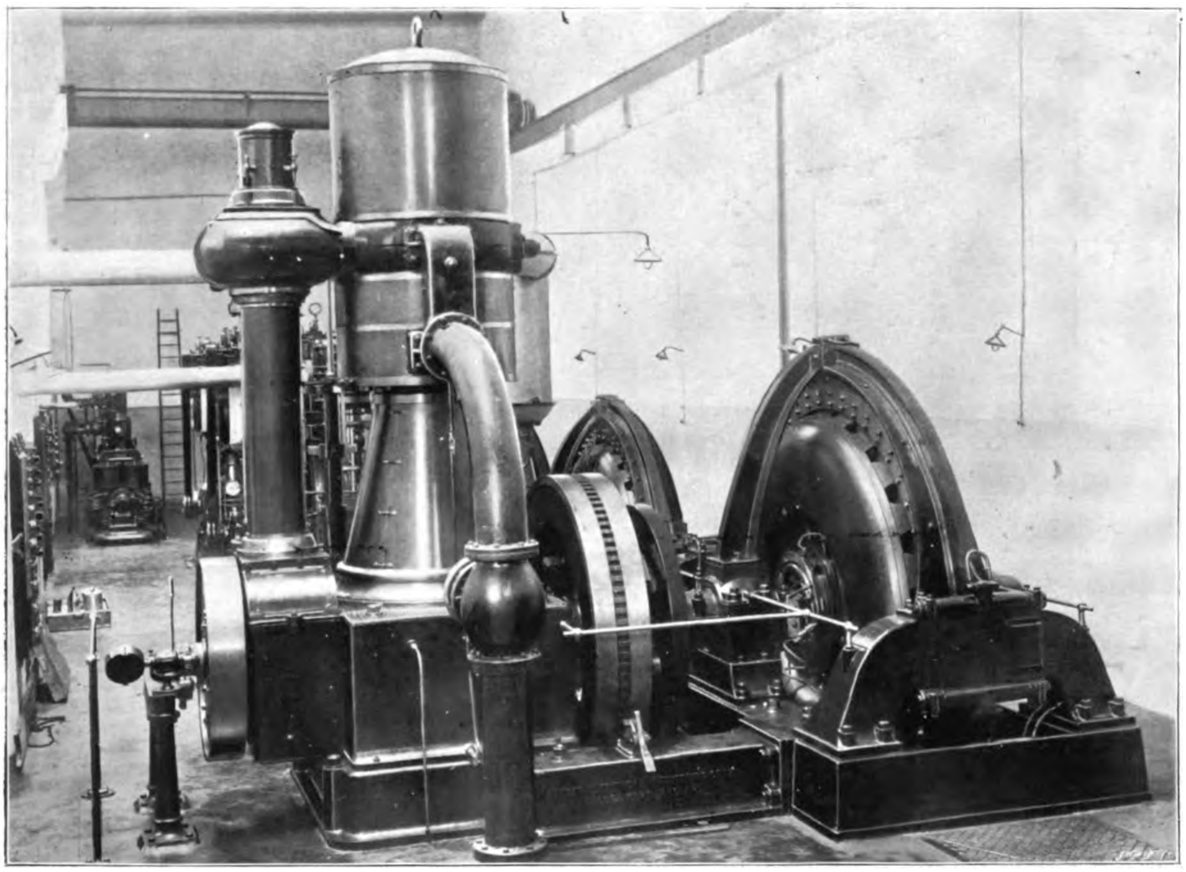
EXTENSION OF THE MALTA LIGHTING SYSTEM.

With a view to extending the electric light in Malta, a 200 kw. plant consisting of a Mordey alternator and Universal single-crank engine has recently been installed by the Brush Electrical Engineering Company. The illustration shows the plant in position. The installing of this unit raises the capacity of the station to 575 kw., disposed as follows:—one 200-kw., three 100-kw., one 50-kw., and one 25-kw. A 200-H.P. boiler of the Babcock-Wilcox type has also been erected, making a total of four boilers, all of the same capacity.

The station, which has been already described in the Review, has been running a little over 16 months, and started from the first with a paying load.

The streets of five towns, including the capital Valetta, are lighted with incandescent lamps of 32 C.P. About 65 arcs of the B.V. type are used for lighting the Grand Harbour and some of the principal thoroughfares in Valetta. These lamps have their own transformers, lowering the voltage from 2,000 to 35. The lighting on this system has given every satisfaction. The above represents about 150 kw. of load for street lighting, which is practically maintained the whole night through.

Beyond this, nearly the whole of the War Department buildings and barracks of these towns are connected on to the mains, being equivalent to about 2,500 8-C.P. lamps.



The Extension at Malta.

These lamps are alight practically the whole evening, till 10.15 p.m., when they come off simultaneously. There have been numerous applications for private consumption, and, now that the new plant is ready, they will be considered, all wiring being carried out by the Maltese Government.

A further extension, to a town called Sliema, will be carried out this year, about four miles away. The streets here will be lighted with incandescent lamps, with a few arcs along the sea front. Several of the forts and barracks at this place will no doubt be installed with the electric light. The price charged for current for lighting is 6d. per unit.

BASTIAN'S ELECTROLYTIC METER.

Mr. C. O. Bastian is probably, in the minds of many, mostly associated with the penny-in-the-slot meter; but he has lately completed arrangements with the Penny-in-the-Slot Electric Supply Syndicate, Limited, for the manufacture of an electrolytic meter, which has some very distinguishing features. The whole subject of electrolytic meters will doubtless be discussed after Mr. Gibbings's paper, which deals in a great measure with Mr. Bastian's meter.

The question of meters that will register small currents with accuracy is an important one to electric lighting systems, but the matter of initial cost of a meter is equally important. It is obvious, however, that there is little prospect of either the motor or clock type of meter being produced at a much lower cost than at present obtains, and it would seem that one must look in other directions to find a cheap means of registering small currents.

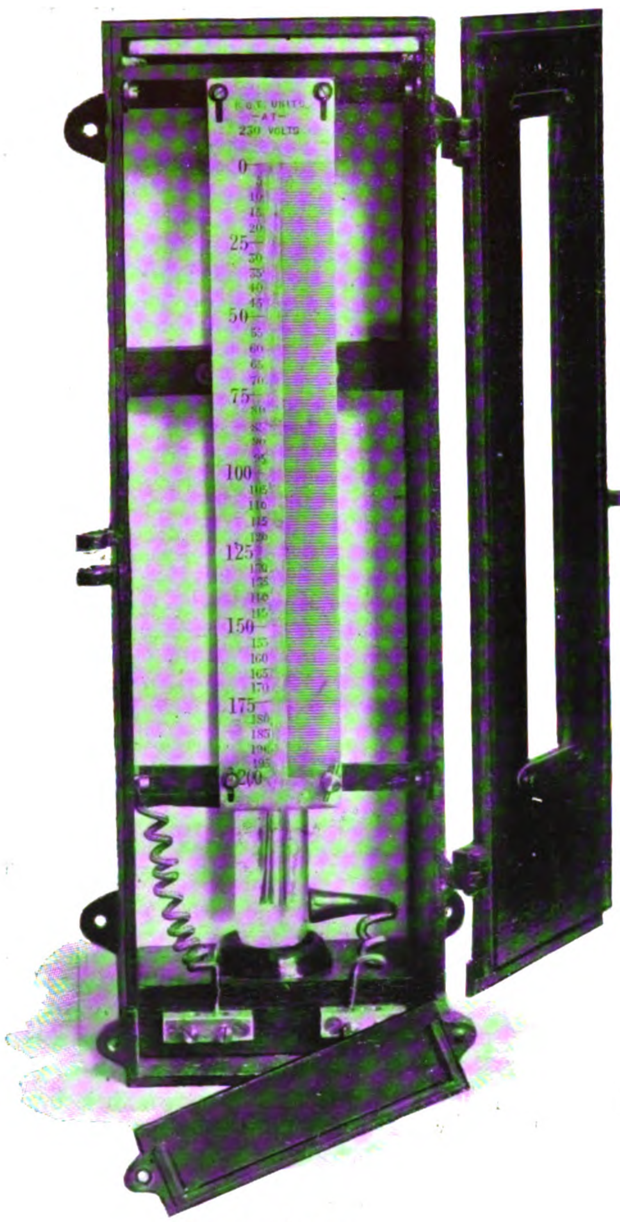
Not long ago we should imagine that the suggestion of using an electrolytic meter to surmount these difficulties would have been regarded only in the light of a last resource, but the Bastian meter is claimed to be sucha distinct advance on all previous electrolytic meters, that there is probably little reason to doubt that it will meet many of the requirements of both central station engineer and consumer.

Mr. Bastian has designed something new in electrolytic meters, which is not only said to be an accurate instrument for measuring small currents, but one which will probably cost half that of the ordinary meters on the market. The most notable electrolytic meter that has been used on supply circuits is that of Edison, the principle of which was that the current passing through a solution deposited metal at a certain definite rate, but the trouble that arose in weighing the plates and figuring out the current used, soon rendered it unsuitable for extensive systems. The direction in which the Bastian meter constitutes a departure from other electrolytic instruments may be obtained from the following details :—

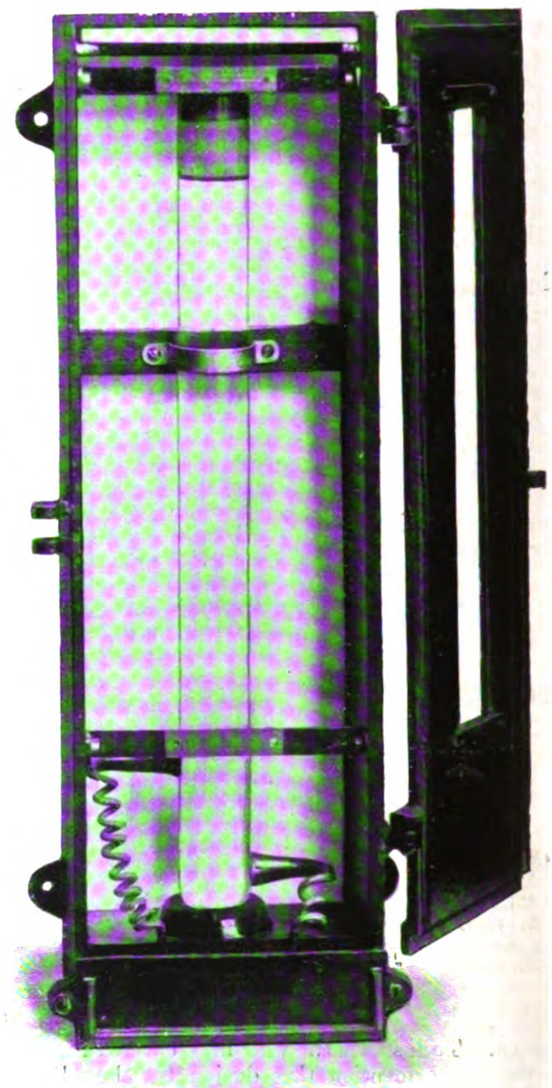
The main feature of the instrument is the registration of an electric current by means of electrolysis. The passage of an electric current through a dilute solution of sulphuric acid decomposes the liquid, and the difference in level is a measure of the current that has passed through.

The apparatus consists of a glass tube, at the bottom of which platinum foil electrodes are placed. The lower end of the tube is sealed, the top being open for the purposes of refilling with water and permitting the escape of the gases. In order to prevent ordinary atmospheric evaporation, a thin film of oil is poured on the top of the liquid.

The liquid is composed chiefly of water, rendered non-freezing to within 24° F. below the freezing point of ordinary water by the addition of sulphuric acid, upon which, however, the electric current has no appreciable effect.



Complete Meter.


Meter with Scale Removed.

It will be seen from the illustrations that the terminals of the electrolytic apparatus are in permanent connection to two other main terminals, which are mounted on a porcelain or ebonite block at the base of the meter. The whole apparatus is placed in a cast-iron case, which is fitted with a hinged door and a terminal door, which are provided with sealing arrangements.

The reading scale, which is marked directly in B.T. units, is placed in front of the tube, and is made of zinc or aluminium. It is so arranged that it can be adjusted to the extent of three-eighths of an inch up or down through the agency of an adjusting nut and thread at the lower end. This adjustment is provided in order to give an accurate zero when the tube is refilled with the electrolyte; it also precludes the necessity of extreme care when refilling.

The action of the meter decomposes the water, consequently, water only need be used when refilling the meter, for which purpose a very convenient form of funnel is provided by the makers. The necessity for refilling even the smallest meters does not arise until 200 B.T. units have been consumed.

It is interesting to examine the method followed in calibrating the instrument. As such a small amount of water is decomposed during the passage of 1 B.T. unit, it follows that a slight miscalculation as regards the bore of the glass tube might lead to a serious error, were the bore of the tube (as measured by calipers) taken as the sole basis for calibration. The actual method adopted admits of no such chance of error creeping in, and, moreover, requires no special calculation for individual tubes.

The makers of the instruments have calculated the quantity of water in cubic centimetres that is decomposed by the passage of 25 B.T. units at the usual pressures from 100 volts upwards, and knowing this, they proceed to calibrate the tube as follows:—The first operation is to fix the tube and blank scale into the meter case, and then fill the tube with water up to the bottom of the scale, which is arranged to be well over the top of the electrodes. This water level is marked on the scale, and then a quantity of water is poured in which will be decomposed by 25 B.T. units at the voltage of the circuit on which the meter is to be used. This second level is marked on the scale, and a second quantity of water representing another 25 units is poured in, and so on until the scale is marked right up to the top. Each of these divisions is then sub-divided into 25 equal parts, so that each division on the scale may represent a B.T. unit.

In this way, any error that might occur through a slight irregularity in the bore of the tube is prevented, and, moreover, it entirely does away with the necessity of using electric current during calibration.

The above method has been tested, and, we are informed, has proved absolutely accurate in practice.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

(*Continued from page* 656.)

Salford.—The Salford Highways Committee deem it essential that a clause be inserted in the new lease of the tramways to the Manchester Carriage Company enabling the Corporation to re-lay the tramways for electrical traction during the renewed term of three years on equitable terms. The Electric Light Special Sub-committee appointed to visit certain places to inquire into systems for the supply of current for lighting and electrical traction have also made their report. They have visited London, Leeds, Brighton, and Dover, and inspected the workings of various electrical stations, and had the advantage of observing the practical working of the plants with a view to the adoption of the best system for the proposed working of the tramcars by the Corporation. The Sub-committee make the following recommendations:—"(1) That the generating plant should be erected at one station with the employment of accumulator sub-stations, the latter being a satisfactory method of utilising the plant during the hours when it would be otherwise idle. (2) That, in view of the prospective great demand for current, the engines and dynamos at the new station should be of large dimensions to secure economy in capital and working expenses, as the current generated at one station would be sufficient for both purposes. (3) That what is known as the feeder system of supply should be adopted in connection with the proposed tramlines, so as to separate the same in small sections to receive such supply. (4) That in the matter of re-arranging the proposed tramlines for the borough it would be desirable that the rails should not be less than 120 lbs. in weight per yard, and the width of the tread not less than 2 inches, and that the distance between the trolley posts to be erected should not be more than 40 yards. (5) That the method of jointing the tramlines adopted at Dover should be employed in Salford, so as to avoid the jolting in passing over the jointed portions of the lines." The sub-committee have not entered into the question of the cost which will be incurred in so extensive an undertaking, which will, of course, be done when the plans are more matured. The details of the ground plan of the new generating station proposed to be erected in Strawberry Road was explained to the officials of the stations visited, and they expressed approval of the system proposed to be adopted.

Sheffield.—Mr. A. Llewellyn Fell, the Corporation electrical engineer, and Mr. L. S. Marsh, Corporation water engineer, have, according to the *Sheffield Independent*, presented to the Tramways Committee of the City Council reports as to the possibility of obtaining water-power from the reservoirs of the Corporation for the purpose of generating electricity for tramway purposes. Mr. Llewellyn Fell says: "I have carefully gone into the question as to whether the 'compensation water' in Sheffield could be used for electric tramway purposes. As you will see from the report Mr. Marsh has drawn up, the 'compensation water,' which was generally supposed to be wasted, is really being profitably used. The separate sources of supply are so small and so far apart, that they would be useless unless they were centralised; the cost of doing this would be out of all proportion to the value of the power gained. Apparently, if the water was collected from all the available sources, only 483 H.P. could be obtained, for which no less than £116,000 would have to be paid (this sum would not include the cost of the power house site, power house buildings, turbines, dynamos, switchboards, &c.); the interest on this sum would be a fixed sum, whether the tramways were not running or were using the full available horse-power. A great point with regard to generating electricity cheaply for tramway purposes is to obtain a plant which will work economically when the load is very small; the average load on a tramway plant is about 50 to 60 per cent. of the maximum load during the 5,720 hours per annum the tramways might be run, so that during, say, 18 hours per day at least, 40 per cent. of the water would be wasted, and during six hours per day the whole of the water would be wasted. If the power was generated by steam, coal would only have to be provided for 60 per cent. of 483 H.P.—289 H.P. The coal required to produce this power would amount to 1,471 tons, at, say, 8s. per ton—£588 12s., the water evaporated would be 3,160,306 gallons, at, say, 2d. per 1,000 —£27 11s., total, £616 3s. This sum does not include the cost of power house site, buildings, engines, boilers, condensers, &c. These would cost about £5,000 more for this plant than that required for water-power. The cost of labour would be rather less if water-power was used, as no stokers would be required. As the Nether Edge and Tinsley routes will require a maximum power of about 500 H.P., the available water power would hardly be sufficient to run this line alone." Mr. Marsh's first report is a detailed and technical calculation of the amount of water-power available, namely, 483 horse-power, and the cost of centralising it, £116,600; which figures form the basis of Mr. Llewellyn Fell's report. Mr. Marsh gave it as his opinion, as water engineer, that the water supply to the town could not be utilised as a generating power. The Traction Sub-committee discussed the report at full length on March 22nd, and adjourned without coming to any definite decision. They gave instructions, however, that further reports should be submitted, showing the water-power available immediately below the embankment of the Redmires and Rivelin reservoirs, instead of centralisation. Mr. Marsh, in his second report, says that as these reservoirs vary from top water to draw-off line at different seasons of the year, he fails to see how it can be expedient or economical to use such a variable motive power. However, calculations on the suggested basis show that 109 H.P. would be available. Mr. Fell agreed with Mr. Marsh that the power obtainable from the Redmires, Rivelin, and Rivelin compensation system sources of supply would not be worth transmitting, as it is so small. Thereupon the Traction Sub-committee instructed the town clerk to write to two experts, and ask what their fee would be for visiting the reservoirs, and reporting as to the water-power available, and he was also instructed to write to a firm of hydraulic engineers and ask whether a greater horse-power could be obtained by turbines than that estimated by Mr. Marsh and Mr. Fell. The Sub-committee again met on May 3rd, 1898, and having received replies from the two experts, decided to recommend that Mr. Frederick Nell, 97, Queen Victoria Street, London, be requested to come down to Sheffield and report upon the question of utilising the water-power of the city for generating electricity, at a fee of £2 2s. per day and out-of-pocket expenses. A letter was read from the firm of hydraulic engineers, that the Committee could not depend on any greater power than that indicated in the reports; and that, in their opinion, the power would be much more cheaply obtained by the use of steam engines. The general report of the Traction Sub-committee to the Tramways Committee was as follows:—"They recommend that the city surveyor be authorised to proceed with the concrete foundations for the power station building at Kelham Island, at an estimated cost of £500, using, as far as possible, the old materials on the ground, and that he be authorised to prepare estimates for the superstructure according to the plans produced, and to advertise for tenders, and it is recommended that the Committee be authorised to affix the corporate common seal to the contract for the building as soon as a tender is accepted. The city surveyor has presented a preliminary plan, showing how the present depôt at Tinsley could be utilised as a large car shed. This plan showed that by lowering the rails under the present shed, and slightly altering the buildings and extending the shed, 30 cars could be accommodated; that by removing the stables and foreman's house on the south-west of the present shed, and erecting another similar roof, 30 more cars could be accommodated, making 60 in all, still retaining space for the repair shops and the long range of stables on the north side of the site; that by removing the last-named stables space could be provided for 20 more cars (making 80), or larger repair shops, stores, and a foreman's house could be erected; also, that by acquiring about 1,100 yards of vacant land between the south boundary of the present depôt and Weedon Street, and removing the repair shop to the north side of the depôt, the number of cars provided for might be increased to 100. The sub-committee recommend that the chairman and the city surveyor be authorised to open negotiations for the purchase of additional land. Letters from the British Thomson-Houston Company show that the sub-contractors they propose to employ under the contract are as follows:—Messrs. Milnes, for car bodies and cars; Messrs. Brown, for boilers; Messrs. Allis, for engines; Messrs. Spencer, for poles and brackets; Messrs. Wheeler, for condenser, heater, and filters; Messrs. Pearn, for pumps; Messrs. Ludwig, Lœwe & Co, for electrical apparatus; the General Electrical Company, of Schenectady, for sundries; Davy Bros., Sheffield, water tank; Seebohm & Dieckstal, Sheffield, car wheels; Peckham Truck Company, truck frames.

The Tramway Committee recommended the City Council to authorise the city surveyor—on the advice of the British Thomson-Houston Company's representative—to obtain 10,000 yards of iron tubing lined with cement, required in connection with the tramway extension to Walkley, at an estimated cost of £725; also, that the tender of Messrs. Askham Bros. & Wilson, Limited, for the necessary points and crossings in connection with the extension to Walkley from High Street, amounting to £946 13s, be accepted; further, that an order be given to Messrs. George F. Milnes & Co. for 13 double-deck car bodies at £200 each, exclusive of truck and electrical equipment; and that price and designs be obtained from the same firm for 12 single-deck cars, all of which are required for the Walkley extensions; also, that a sub-committee be appointed to settle the principle as to street improvements and tramways construction.

South Staffordshire.—The British Electric Traction Company have had their plans passed by the Brierley Hill District Council for the erection of a generating station, car shed, &c., to equip the electric tramway from Hart's Hill to Stourbridge, which is to take the place of the existing steam tramway.

The Surrey and Middlesex Light Railways Bill.—The opposition to the proposals of the London United Tramways Company to construct a light railway, with electric traction, from Kew over Richmond Hill, thence to Ham, Kingston, and Hampton Court, has, this week, so far as Richmond is concerned, taken a more tangible form. On Friday evening, a well attended meeting of the Tradesmen's Association, at which most of the leading firms were represented, passed, by 47 votes to 1, a resolution opposing the scheme. Dr. J. E. Shuttleworth, a local resident, whose views are worthy of attention, has condemned the proposal on the grounds that there is ample communication with Kingston and Hampton Court by road, rail, and river, and the Light Railways Act was never intended to apply in such a case; that the landscapes of the hill will be destroyed, the residential value of the hill and its approaches affected, and that the working of the railway will be a source of danger. The Richmond Town Council, on Monday evening, on the recommendation of the Amenities and the Parliamentary Committee, decided by an almost unanimous vote to oppose; the Surrey County Council on Tuesday also decided in a like manner; and the Richmond Vestry has passed resolutions in opposition. Meetings of residents in some of the roads affected have also condemned the scheme. A party in favour of the proposal has come forward with the suggestion to cut a new road through some of the old and congested portions of Richmond, in order to bring the line from the terminus of the present tramway along under the hill and so on to Kingston, but this idea is also condemned.

Sydney.—In the course of the presidential address at the meeting of the Electrical Association of New South Wales on March 25th, Mr. Callender, in referring to electric tramways, said that the chief development affecting engineers during the year had been the extension of the system of electric tramways in Sydney, and when the large power house now under course of construction at Ultimo was completed, it would be seen that, although Sydney had waited long and hastened slowly in this matter, the works now being erected would be such as to challenge comparison with the tramways of any city in the world, and it was a matter for congratulation that the whole of the electrical details of the work are in the hands of members of the association.

Tunbridge Wells.—The Town Council has been approached by the Electric Extension Company with a view of establishing an electric tramway in Tunbridge Wells, and the application has been delegated to a committee to report upon the matter.

Walton-on-Naze.—Messrs. Lowden Bros., of Dundee, have been engaged to supply the apparatus for working the electric cars on the pier, and also for lighting the structure. For the present the dynamos will be placed on the wharf near the Pier Hotel.

Waterford.—The Corporation of the City of Waterford have just completed terms with a Dublin syndicate for the purpose of running an electric tramway through the city. The length of track will be about two and a half miles, starting from the Waterford, Dungarvan and Lismore railway terminus, and on the one hand going as far as the Waterford and Tranmore railway station, with a branch to the top of Newtown, one of the best suburbs in the city. The capital of the proposed company will be about £22,000, and the promoter, who is a Dublin gentleman, is very sanguine of success in his undertaking. The Corporation have agreed to give the space in the streets at a nominal rent of £1 per year for the first 10 years, after which period a percentage on the profits will be paid to the municipality. It is probable that the work of constructing the line will commence within the next three months.

TELEGRAPH AND TELEPHONE NOTES.

The Blantyre and Umtali Telegraph.—The Marquis of Salisbury has congratulated the British South Africa Company and the Trans-continental Telegraph Company upon the successful telegraphic connection of the British Central Africa Protectorate and of the company's territory north of the Zambesi with the rest of the world.

The Telegraph Wire Export Trade.—The fluctuating character of the export trade of this country in telegraph wire and apparatus connected therewith is well shown by the returns just issued for the month of April last, which show a total of only £64,883, as compared with £135,583 in the preceding month, and £75,688 in April last year. The exports during the four months ending with April, are behind those of last year, having amounted to only £313,671 as compared with £321,160 in the first four months of 1897. Trade was, however, better than in 1896, during the first four months of which year, the exports only amounted in value to £211,368.

Indian Telegraph Appointments.—Three appointments in the Indian Telegraph Department are to be offered to students who join the Cooper's Hill College in 1898.

Interruptions to Australian Landlines.—The *Empire* takes strong views on this subject, as will be gathered from the following quotation, which, however, does exaggerate the general feeling in this case:—"Speaking upon the incessant interruption of the telegraph service between Port Darwin and Adelaide, Dr. Cockburn, who has control of the telegraph lines in South Australia, stated that he was fully impressed with the necessity of making an improvement in the service, and as soon as he returns to Adelaide he proposes to make arrangements for running a second line between Adelaide and Port Darwin. The wire will be carried on the same posts as the existing one, but where the telegraph crosses a watercourse the lines will be separated—one being carried up or down the stream as the case might be, about a mile or two away from the other, to lessen the risk of both lines being taken away by the floods. The line thus diverted will be carried across the watercourse on strong stout posts to prevent their being easily washed away. This 'reform' of the cable scandal is farcical. It reminds one of the philanthropic youth who offered a blind man a pair of spectacles! A few miles of wire along a stream will not relieve merchants from the exorbitant tariffs, or prevent the delays which are constantly occurring. But it will enable the South Australian authorities and the Eastern Company to protect their private interests. That is all they care about."

Parliament and the Telephone.—In the House of Commons last Friday, early in the sitting, Mr. Swift MacNeill made reference to a notice of motion down on the paper on the part of the Government, which notice was to the following effect:—"That a Select Committee be appointed to inquire and report whether the telephone service is or is calculated to become of such general benefit as to justify its being undertaken by municipal and other local authorities, regard being had to local finance; and, if so, whether such local authorities should have power to undertake such service in the districts of other local authorities outside the area of their own jurisdiction, but comprised wholly or partially in the same telephone area, and what powers, duties, and obligations ought to be conferred or imposed upon such local authorities:—That the Minutes of Evidence taken before the Select Committee on the telephone service in the session of 1895, and the report of the Commissioner and the evidence taken before him in the inquiry recently held at Glasgow be referred to the committee for consideration in so far as they relate to the subject of the present inquiry:—That the committee do consist of 17 members, and that Mr. Bartley, Mr. Griffith-Boscawen, Sir Harry Bullard, Mr. Cawley, Mr. Cohen, Mr. Culville, Sir James Fergusson, Mr. Firbank, Mr. Fry, Mr. Hanbury, Sir Reginald Hanson, Sir Henry Howorth, Sir James Joicey, Mr. John Redmond, Mr. James Stuart, Mr. Tully and Sir James Woodhouse be members of the committee."—Mr. MacNeill wished to know whether the Government intended to persist in the nomination of Sir James Fergusson, seeing that he was a director of the National Telephone Company, and as such an interested party. Sir James Fergusson, interposing, explained that he had only allowed his name to be put down in consequence of a request made to him on behalf of the Government, but on further consideration he had decided not to accept the nomination. The matter then dropped. We now learn that Mr. Donald Nicol will take Sir James's seat on the Committee, which was duly appointed on Monday last.

The Surveys of the Pacific Ocean — English and American.—In 1887 at the Imperial Colonial Conference held in London, it was unanimously resolved that a survey for a cable to connect Canada with Australia should be carried out by Her Majesty's Government. This survey is only about two-thirds completed at present. On March 2nd, 1891, an Act was passed by the American Legislature "To enable the President to cause careful soundings to be made between San Francisco, Cal, and Honolulu, in the Kingdom of the Hawaiian Islands, for the purpose of determining the practicability of the laying of a telegraphic cable between these points." This survey was thoroughly carried out and completed in May, 1892; the distance surveyed being about half of that accomplished for the English Government during the last 10 years. We extract the following from an Australian paper, dated March 25th last:—"Surveying cruise of H.M.S. *Penguin*.—H.M.S. *Penguin* yesterday returned to port after a cruise of not quite a year, during which a great deal of hard work has been done. The *Penguin* is well-known on the station as belonging to that class of ships devoted to taking soundings, charting work, and the investigation or discovery of supposed or actual dangers to navigation. Since she left here in April of last year the *Penguin* has covered many thousands of miles of ocean. Her special duty was to test the route for a cable to connect Australia with England *via* America, and she carried out the work as far as Honolulu. The testimony of her officers yesterday was that from a practicable point of view the Pacific route for a cable offers no obstacles whatever. From Sydney she went to Fiji, running a line of soundings all the way; from Fiji to Fanning Island, one of the islands under the British flag. That island was thoroughly surveyed, and found to be suitable for a cable station. To Honolulu from this island the ground was found good for cable work. After refitting at the Sandwich Islands capital, the trip across from Sydney having occupied 14 weeks, a start was made for Palmyra. This island the Americans claimed, it having been discovered by the captain of the barque *Palmyra* in 1802, but was ceded to England in 1889. The island was entirely unsuited for a cable station however, having neither a landing place nor vegetation upon it—desolate in fact—so nothing further was done there. The *Penguin* then returned to Fiji, and made a six weeks' survey of reported dangers to the north and north-west of that group, fixing positions, &c."

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1898 ...	...
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Cayenne-Pinheiro ...	March 24th, 1898 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Cable beyond Gurupa ...	April 4th, 1898 ...	
Cyprus-Latakia	Feb. 10th, 1898 ...	...
Bolama-Bissao	April 12th, 1898 ...	...
Cape Town-Mossamedes ...	„ 14th, 1898 ...	May 5th, 1898
Maranham-Para	„ 17th, 1898 ...	...
Benguela-Mossamedes ...	„ 20th, 1898 ...	May 5th, 1898
Kotonou-San Thomé ...	„ 27th, 1898 ...	...
Hong Kong-Manilla... ...	May 3rd, 1898 ...	...
San Thomé-Loanda... ...	„ 4th, 1898 ...	...
Monte Video-Rio Grande ...	„ 9th, 1898 ...	...
Havre-Waterville	„ 10th, 1898 ...	...
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Cartagena-Barranquilla ...	July 4th, 1896 ...	...
Majunga-Tananarive ...	May 5th, 1898 ...	May 9th, 1898
Vladivostock-Khabarowka ...	„ 7th, 1898 ...	„ 7th, 1898
Saigon-Bangkok	„ 10th, 1898 ...	„ 11th, 1898

CONTRACTS OPEN AND CLOSED.

OPEN.

Belgium.—May 25th. The date for the receipt of tenders for the electric lighting plant at the railway station at Ghent (Gand-Sud) for the Belgian State Railway Authorities has been fixed for May 25th.

Belgium.—May 31st. The Municipal Authorities of Ixelles, a suburb of Brussels, are inviting tenders until May 31st for the exclusive concession for the supply of electrical energy for lighting and power purposes during a period of 26 years, that is, to September 1st, 1924. Tenders to be sent to the Secretariat de la Commune d'Ixelles, Brussels, from whence particulars may be obtained.

Blackburn.—May 17th. The Committee of St. George's Presbyterian Church invites tenders for the electric lighting of the Church. See our "Official Notices" last week for details.

Bury St. Edmunds.—June 13th. The Corporation invites tenders for the supply and erection of Lancashire boilers, three 60-kw. steam dynamos, transformer and booster, accumulators, street mains, and various other machinery and apparatus for the electricity undertaking. Consulting engineer, Mr. F. H. Medhurst, 13, Victoria Street, S.W. See our "Official Notices" this week.

Coventry.—June 7th. The Electric Lighting Committee invites tenders for electric mains, switchboards, arc lamps, posts and apparatus in connection therewith. For particulars of the several sections see our "Official Notices" this week. Mr. Gilbert S. Ram, city electrical engineer.

Dublin.—May 23rd. The Corporation wants tenders for the supply of high tension feeders and low tension distributors laid and jointed complete on a solid system, not including road work, but including the connecting up of existing consumers to the new mains. Also for transformers (20 to 50 kw., about 700 kw. in all) with instruments and apparatus in sub-stations erected and fitted complete. Particulars at the office of the city engineer; or from Prof. Kennedy, 17, Victoria Street, S.W. See our "Official Notices" last week for particulars.

France.—May 21st. Tenders are being invited by the French Post and Telegraph Authorities in Paris for the supply, in 10 lots, of 111 kilometres of paper-insulated electric cables. Particulars may be obtained from, and tenders to be sent to, Le Sous-Secretariat, d'Etat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris.

London.—May 17th. The Bethnal Green Board of Guardians invites tenders for the supply of plant, and installing the electric light at the new infirmary, Palestine Place. Plans, &c., to be obtained from the architects, Giles, Gough & Trollope, 28, Craven Street, Charing Cross, W.C. See our "Official Notices" April 22nd for particulars.

Russia.—May 27th. Tenders are being invited by the Municipal Authorities of Odessa for the concession for the construction and working of three lines of electric tramways in the town, the total length being about 39 versts. Particulars may be obtained from La Mairie d'Odessa, Russia, to whom tenders are to be sent.

Southampton.—May 18th. The Corporation invites tenders for the purchase of a Robey slow-speed horizontal steam engine. Particulars from the electrical engineer, Mr. J. H. Lee. See our "Official Notices" this week.

Sunderland.—May 27th. The Corporation invites tenders for the supply of steam and other piping, and water softener for the electricity works. Borough electrical engineer, Mr. J. F. C. Snell. See our "Official Notices" for particulars.

Victoria.—June 24th. The Council of the city of Hawthorne (Colony of Victoria, Australia) is inviting tenders for the supply and erection of buildings, boilers, engines, dynamos, transformers, mains, meters, arc lamps, poles; also running the plant for three years. See our "Official Notices" March 11th.

CLOSED.

Belfast.—The Corporation has given Messrs. Victor Coates & Co., Limited, an order for an additional Lancashire boiler for the new electricity station for next winter's load at £666 odd.

Germany.—Messrs. Felix, Singer & Co., of Berlin, have, it is reported, secured a contract for 20 4-wheel motor cars for the light electric railways at present in course of construction in the Mansfeld mining district. The cars, which are for a one-metre gauge, are to be of 40 H.P. each, the motors being on the Walker system.

Glasgow.—The following tenders have been accepted for the erection of a depôt at Springburn in connection with the tramways:—Messrs. John Porter & Sons, £2,500 for the brick and mason work; Messrs. William Shaw & Son, £529 0s. 6d. for the joiner work; Messrs. W. & D. Mailer, £145 13s. 6d. for the slater work; Messrs. P. & W. MacLellan, £336 10s. 7d. for the iron work; Mr. Matthew Sproul, £170 9s. 8d. for the plumber and gasfitting work; and Mr. Peter M'Kerracher, £38 15s. 1d. for the painter work.

Leith.—The Town Council has accepted the tender of the British Insulated Wire Company for the supply, trenching, and laying of the cables throughout the compulsory area with re-instatement of the roads and pathways, and also the supply and erection of the arc lamp-posts amounting to £7,917, in connection with the burgh lighting scheme. An endeavour was made in the Council last week to get rescinded the resolution recently passed by the Council instructing the Electric Light Committee to exercise the utmost economy. It was considered that such a motion hampered the work of the Electric Lighting Committee, and the recision seems to have been carried by six votes to five.

FORTHCOMING EVENTS.

1898.

Friday, May 13th, at 5 p.m.—Physical Society. Paper on "Galvanometers," Part II. By Prof. W. E. Ayrton and Mr. T. Mather.

Monday, May 16th, at 8 p.m.—Society of Arts. "Electric Traction," by Prof. Carus Wilson. Cantor Lecture III.—Energy diagrams—Sub-divisions of energy expenditure—Case when final speed is fixed — Possible ways of reducing the expenditure — Effect of series winding is to reduce the heat loss—Highest economy limited by the weight of the motor—How to find the best values of gear ratio and driving-wheel diameter—Example—The Baltimore and Ohio Railroad —Effect of reduction in train resistance—Use of roller bearings.

Wednesday, May 18th, at 8 p.m.—Society of Arts. "The Evolution of the Cycle," by J. K. Starley. C. V. Boys, F.R.S., will preside.

Thursday, May 19th, at 8 p.m.—Chemical Society, Burlington House. Papers to be read:—"The Action of Formaldehyde on Amines of the Naphthalene Series," by G. T. Morgan, B.Sc.; "On the Constitution of Oleic Acid and its Derivatives," Part I., by F. G. Edmed, B.Sc.

May 19th, at 12 noon.—Federated Institution of Mining Engineers' meeting to be opened at Burlington House, Piccadilly, London. Among papers to be read are:—"Roller Bearings," by Mr. W. B. Marshall; "Gas Power," by J. E. Dowson. Visit to the Central London Railway at 4 p.m.

Friday, May 20th, at 10.30 a.m.—Second day of the Federated Institution of Mining Engineers. Paper by Mr. W. T. Goolden, on "Coal Cutting by Machinery." Mr. W. Dixon's paper on the "Latest Developments and the Practical Application of Alternating Multiphase Machinery for Electric Power Transmission" will be open for discussion.

Saturday, May 21st, at 11 a.m.—Institution of Electrical Engineers. Students' visit to the works of the Electric Welding Company. Applications to join the party should be made at once to the Students' Hon. Sec.

NOTES.

Electrical Matters at Croydon.—The Corporation of Croydon, who have entered into the subject of electricity as applied to municipal purposes with much spirit, and who recently voted nearly £30,000 for the extension of their already considerable electric lighting plant, are likely to entertain, at no distant date, a suggestion to provide electric motive power for the Corporation fire engines. The suggestion emanates from Councillor T. W. Dobson, the chairman of the General Purposes Committee, which has control of the fire brigade, and it is known to have the support of, among others, Alderman Sir F. T. Eldridge, who is an influential member of the Electricity and Lighting Committee. Sir F. T. Eldridge, by the way, is chairman of a special committee appointed by the Corporation to consider the future of the Croydon tramways, the lease of which falls in in August, 1899. The present directors of the Croydon Tramways Company are preparing, in conjunction with Messrs. Kincaid, Waller & Manville, the electrical engineers, a scheme of electric traction for the trams, and are now carrying on private negotiations with the committee referred to.

Electricity in Warfare.—Our American exchanges continue, quite naturally, to devote a good deal of attention to the part being played by electrical men in the war with Spain. That American electrical men have come forward with a will is clear from the ease with which leading electrical companies and their officials have been able to get together various companies of skilled electricians for the purpose of home defence as well as for service in the navy. One contemporary discusses the effect of the war upon the electrical trade. It seems that the very urgent and heavy demands of the Government have led to the cancelling or putting aside of much of the usual business. It might be thought that these orders would make an excess of back work later on, and so keep electrical works fully occupied for a long time to come. Our contemporary thinks otherwise, and suggests that after the Government orders have been executed the electrical business will be in a bad way, as the unsettled state of affairs does not act as an incentive to new electrical enterprise.

Testing Gold Quartz by the Röntgen Rays.—An ingenious application of the Röntgen rays has recently been made, viz., to ascertain the presence of gold particles in quartz. The particles of gold in a paying gold quartz are often so finely divided as to be invisible to the naked eye. Since gold is much more opaque to the Röntgen rays than quartz, it is natural to suppose that some indication of the presence of gold in quartz would be given on the screen or the photographic plate when the quartz is traversed by the Röntgen rays. A physician in Los Angelos, California, is reported on accidentally photographing a lump of gold quartz to have found on the shadow of the outline of the quartz a number of very dark points. These points were due to the presence of particles of gold in the quartz. It is possible, therefore, to detect the presence of gold in quartz by the Röntgen rays, and it may sometimes be convenient in the laboratory, but it is not to be expected that the gold prospector will add a battery, an induction coil, and vacuum tubes to his kit.

The Manila Battle and the Telegraph Cable.—The American naval officers at Manila seem to have known what they were about in cutting the Manila-Hong Kong cable, thus interrupting telegraphic communication between Manila and the rest of the world. From what we have heard privately, they grappled and lifted the cable some miles off the town, in comparatively deep water, and buoyed both ends. They wished to stop the Spaniards from communicating from the Philippine Islands; but, as stated in the *Daily Chronicle*, they had no instruments of their own wherewith to establish communication themselves through the cable, and hence the great suspense and inconvenience which were felt in the United States pending the despatch of the *Hugh McCulloch* from Manila to Hong Kong some days later with news. We hear privately that Commodore Dewey sent ashore and endeavoured to borrow apparatus, and also to secure the services of a skilled operator; but both were refused to him by order of the Spaniards. Some interesting and important international questions are involved in the cutting of a submarine cable belonging to a neutral country in war time by a belligerent. In any case, the importance, from a practical point of view, of equipping every war vessel with the simple apparatus necessary for establishing communication through a cable, when need be, is more than evident. With the old marine galvanometer no readable signals could be obtained, but the Sullivan galvanometer, now used in our Navy, is adapted for both testing and signalling purposes, and with but a little practice, naval men should become expert in exchanging messages through cables, whenever the occasion may arise. We believe our war ships now have the means for grappling cables in shallow or moderate depths of water, as well as suitable electrical apparatus.

Wednesday's *Daily Chronicle* says that the "Eastern Extension Telegraph Company looks to the United States to compensate it for cutting the cable at Manila. But Admiral Dewey did not cut it till the Spanish authorities refused to allow the transmission of American despatches. Therefore the real interruption of the earning capacity of the cable was due to Spanish action, and Lord Tweeddale had better apply for compensation to Madrid."

The Parliamentary Committee.—A further meeting of the Joint Committee on the question of Electrical Supply and Electrical Generating Stations was held on Monday, at which the heads of their report were discussed. A section of the Committee are, according to the *Standard*, in favour of abolishing the present system, by which the power of purchase comes in at the end of 42 years, and of modifying it so that purchase may take place at a shorter period—perhaps 25 years—on the basis of the net profits of that time. This would lessen the burden on the companies by rendering it unnecessary that they should devote so large a part of their income to a sinking fund. Another point raised was the advisability of a sliding scale in regard to the profits of electric companies, like that provided for by the Gas Acts. It is probable that a recommendation in its favour will be adopted. A question has also arisen as to whether, within a fixed radius, a *locus standi* should not be given to adjoining owners to oppose the establishment of generating stations, and also as to whether compensation ought to be paid to adjoining owners in consideration of such nuisances as those which may arise from vibration, &c.

Glasgow Technical College.—The following candidates have been passed for the diploma in electrical engineering, viz.:—John S. Nicholson (Aberdeen), Geo. H. Van Corbach (Shanghai), Wm. N. Brand (Glasgow), J. Bruce Kingsmill (Ireland), Fred. Ussing (Copenhagen). Mr. Nicholson has been nominated for the Sir John Pender Gold Medal, and Mr. David Robertson, jun. (Uddingston), the previous John Pender medallist, for the Pender Scholarship.

The Royal Society.—Among the papers read before this society yesterday afternoon was one by Prof. Gotch, F.R.S., and Mr. G. J. Burch on "The Electrical Response of Nerve to a Single Stimulus Investigated with the Capillary Electrometer. Preliminary Communication," and one by Mr. S. R. Roget on "Effects of Prolonged Heating on the Magnetic Properties of Iron."

The Telephone Question.—There has been published in pursuance of the order of the House of Commons, copy of the agreements entered into on March 25th and 26th, 1896, between the Postmaster-General and the National Telephone Company for the transfer of the trunk lines. The features of greatest interest at the moment will probably be the exchange or "terminal" charges provided for under clause 8, where a telephonic message is transmitted over the trunk wires between an exchange of the National Company and an exchange of the Post Office or some licensee other than the National Company; and clause 18, which says that the agreement shall not prejudice or affect the right of the Postmaster-General to establish telephonic communication himself or license others to do so. The abstracts show that the transfer of lines amounted to nearly 30,000 miles of wire, and when to these are added the lines built by the Post Office themselves, it will be seen how important a branch of the Telegraph Department the trunk telephone lines have become.

Train Lighting.—In a communication to the *Railway World*, Mr. W. Langdon says that few will deny that, to the experiments in the electric lighting of trains carried out by the Midland Railway Company, the industry is much indebted. Those experiments dealt with the subject in such a comprehensive manner, as proved the applicability of electric lighting to the various demands of railway service, and although the circumstances which at that time attended the efforts were such that it was felt advisable to abandon the experiment for the time, the success attending those trials was quite as efficient from a lighting point of view, as that arising from the Stone system. The reason for their withdrawal was not so much one of cost as one of convenience. Mr. Langdon adds: "The rolling stock of a railway is no more exempt from wear and tear than other mechanical appliances, and from time to time vehicles must necessarily come in for repairs. Out of this arises one of two things, either the interposition of unfitted stock, and consequent severance of electrical connection, or the remarshalling of the train at any point at which such unfitted stock has to be interposed." He asks what advantage is possessed by Stone's system over that of the Midland or other systems? "It is based upon the same lines with the exception that whereas in other systems the varying speed is compensated by electrical adjustment, in Messrs. Stone's system it is met by the slip of the belt. There is no doubt that a self-contained system has attractive features from a traffic point of view—it disposes of the remarshalling question, and it is extremely convenient for trial purposes; but conceive a large system, such as the Midland, with all its passenger stock—some 3,800 coaches and vans—fitted with dynamos all arranged below the bed-frame of each vehicle, and set against this the number of electric generators, arranged above board, which would be required if the light were operated on the Midland system—*i.e.*, from one vehicle in each train—and say which ought to prove the most convenient and economical to maintain, 380 generators above board or 3,800 below board." The many trials which are being made by railway companies of Stone's system show how anxious they are to adopt electricity for carriage lighting if its cost is reasonable. That electricity is *the* illuminant for the purpose Mr. Langdon has not the least doubt, but whether it is to be done by fitting each vehicle independently rather than in groups, he considers is open to question.

Wireless Telegraphy.—A demonstration of the Marconi system took place on Thursday last week at the offices of the Wireless Telegraph and Signal Company, Limited, 28, Mark Lane, E.C. Amongst those present were the President of the Board of Trade, the Right Hon. Charles Ritchie, M.P.; Sir Courtenay Boyle, Lord John Hay, Admiral of the Fleet; Lord Kelvin, Sir William des Voeux, Lord Charles Beresford, Lord Stanley, Mr. C. Farquhar, Mr. E. Beaumont, Q.C., Admiral Compton Domvile, Mr. R. G. Hayes, Commander Evan Thomas, Mr. Charles Wilson, M.P., Colonel FitzGeorge, A.D.C., and Captain the Hon. C. Colville. Mr. Marconi was at the transmitting end, and Lord Charles Beresford read the messages printed on Morse tape in another room in the building, all of which were easily decipherable.

The Spiral Globe, Limited.—Since the brief notice in our issue of May 6th of "The Spiral Globe, Limited," we have given careful consideration to the claims advanced in the prospectus of the improvement in the illuminating power of an ordinary incandescent lamp by winding a glass rod spirally round it. The first point we considered was the report of the Electrical Standardising Testing and Training Institution, signed by Mr. Hugh E. Harrison. The net result of the experiments on which the report is based appears to be that if a set of annular glass pieces of circular section are disposed about an irregular source of light, the effect of reflection and refraction at the surfaces of the glass will be to intensify the radiation in both directions along the axis of the annuli, and in consequence, though this is not mentioned here, to reduce the equatorial radiation. Figures are given of four dispositions of such an arrangement about an ordinary incandescent lamp, involving seven experiments. From general considerations of the paths of the rays of light this result seems reasonable, though the disposition of the glass surfaces and the sources of light are too complicated to admit readily of a geometrical investigation. Now of the seven experiments, five, giving three comparisons, deal with the spiral globe in the form in which it is proposed to apply it, and all three show considerable increase of intensity along the axis of the lamp, no reference being made to the necessary consequent equatorial diminution of intensity at right angles to the axis. The other comparison deals with the spiral arranged so as to produce an increased equatorial intensity in one direction only—an arrangement which does not appear to be contemplated in practice, and has no bearing on the matter in question. It is not clear why this is introduced, but it might give an impression to an inexpert reader that the spiral globe increases the equatorial intensity as well as the axial. Consider the general action of lenticular arrangements. They are never introduced to increase the all-round, or average radiation, and must in every case reduce it by the opacity of the glasses and the dirt collected on their surfaces. Their sole purpose is to direct rays of light radiated in a useless direction along a useful one, at the expense of some loss. Now, though this prospectus claims an improved distribution, viz., an increased vertical and a reduced horizontal one, it gives no reason for claiming this to be an improvement, nor can anyone say, for an ordinary incandescent lamp, that any particular direction of radiation will be necessarily more useful to its future purchaser than another. So far as one can say anything, it is that it is not generally convenient to increase the upward radiation at the expense of the horizontal or oblique. To us the modification made does not commend itself. The prospectus further claims that the spiral globe "more than doubles the effective light emitted," "and insures a corresponding economy in the consumption of electrical current." The spiral globe does nothing of the kind. Its effects appear to be three. It will increase the illumination above and below the lamp, where it may or may not be wanted, and diminish it horizontally, with, on the whole, a loss. It will no doubt be a pleasanter and less intense light for rooms, but this advantage is got in many other ways. Its surface, inevitably more or less dirty, will reduce the general efficiency, and when the lamp is placed in an unfavourable position, so that dust accumulates, will do so very largely. It would be very difficult to clean. As far as we see every one of the seven advantages claimed for the globe in the prospectus is ridiculous, looked at from an investor's point of view. If this document is to be construed in the way most convenient to the promoters that its ambiguously qualified claims admit, we can only say it is not a very ingenious specimen of its class. If it is to be construed by the meaning it would convey to an intelligent inexpert reader, it is, to say the least, misleading.

Electric Traction Lectures.—Prof. Schwartz and Dr. D. K. Morris will commence their series of six lectures on "Electric Traction" at the South-Western Polytechnic, Chelsea, on Tuesday next, at 7.30 p.m. The lectures will deal respectively with:—1. Power stations; 2. Overhead conductors; 3. Conduit and surface contact systems—The permanent way; 4. Motors and rolling stock; 5. Accumulator cars; 6. Working expenses—Maintenance and depreciation.

Technical Education in Ireland.—The Dublin Corporation last week passed a lengthy resolution requesting the Government to appoint immediately a committee of eminent educational and scientific authorities, together with representatives of the manufacturing, industrial, and commercial interests in Ireland, to inquire into the question of the need of Ireland in regard to primary, secondary, and higher technical education. The Government is to be asked for a £100,000 grant for the purposes of the Royal College of Science for Ireland. The Lord Mayor of Dublin in a speech upon the subject said: "As regards higher technical education it was certainly little less than a scandal and disgrace to the Government that not a single chair of mechanical or electrical engineering, to say nothing of architecture, existed in the whole of Ireland."

Appointments.—The Glasgow Electricity Committee has passed a recommendation to the Council to appoint Mr. John Christie, of Londonderry, as station engineer, and Mr. J. C. A. Ward, of St. Pancras mains department, as superintendent of mains. The appointments are, of course, subject to confirmation by Council on the 19th inst., but the committee was unanimous in both cases.

Lecture.—Before the Ipswich Scientific Society on 4th inst. Mr. S. A. Norcutt lectured on "Phenomena of Electrical Discharge."

Self-Charging Motor Car.—Mr. L. Epstein has recently patented a new electric motor car, in which he claims to have overcome the difficulties presented by batteries becoming exhausted at a distance from a charging station. It is admitted that it is one of the great drawbacks of electric motor cars that the batteries require periodical re-charging, this necessitating the existence of charging stations, and considerable rough usage of the accumulators in taking them out for charging and putting back in position again. These drawbacks are said to be avoided by the Epstein motor car, which is self-charging, inasmuch as it is equipped with the necessary apparatus for automatically charging the cells whenever and wherever required, with very little difficulty. The car is equipped with Epstein cells of a special type, and an oil engine, and the motor can be reversed for use as a dynamo for the purpose of charging the cells. The extra equipment is stated to be responsible for an additional weight of only 3 per cent., compared with the ordinary electric motor car. The weight of a self-charging car, complete with all equipment and four passengers, comes out at something under 30 cwt. The accumulators weigh 7 cwt., and are considered sufficient for a 60-mile run on ordinary roads. We understand that Mr. Epstein now has one of the cars in course of construction.

Pacific Cable.—A daily paper says that the British ship *Penguin*, which had to take soundings and to investigate the bottom of the Pacific, with the view to the laying of a cable, arrived at Sydney on March 25th. According to the *Frankfurter Zeitung*, her officers declared that the soundings showed no obstacles.

Appointment Vacant.—The Stockport Gas and Electric Light Committee want a clerk of works at £3 per week. See our "Official Notices" this week for particulars.

The Electrical Press.—The number of journals partly or wholly devoted to electrical subjects amount in the total to 66. Of these 18 are published in France, 14 in the United States, 12 in Germany, 6 in England, 3 in Switzerland, 2 each in Austria, Belgium, Holland, Italy and Spain, 1 each in Canada, Japan, and Russia.

The Pender Memorial.—One of the two marble busts of the late Sir John Pender, G.C.M.G., executed by Mr. E. Onslow Ford, has now been received by the authorities of University College, London. The bust has been placed in the library. The likeness is stated to be a pleasing and striking one. The second bust is at present on view at the New Gallery, and will afterwards be sent to Manchester for exhibition.

Calcutta University.—The Senate of this University is considering the subject of degrees in science. The committee appointed to report on the subject considers, says an Indian journal, the institution of such degrees desirable for the encouragement of original research by the graduates of the University.

Dust Destructors in India.—The Vizagapatam Municipal Council has resolved to construct a Roberts's patent incinerator. An Indian exchange says that this will minimise the difficulty now felt by the Council in the proper disposal of rubbish, the present sites in town having been condemned by that officer.

King's College Old Boys.—We hear that Mr. W. H. Preece is to preside at the King's College School Old Boys' annual dinner at the Criterion Restaurant on Friday next, May 20th.

NEW COMPANIES REGISTERED.

Chilian Electric Tramway and Light Company, Limited (57,203).—Registered May 3rd, with capital £1,050,000 in £1 shares (550,000 preference), to adopt an agreement with the Allgemeine Electricitäts Gesellschaft, of Berlin, to acquire, equip, maintain and work by horse, electrical, steam, or other power, any tramways or railways in Chili or elsewhere in America, and to carry on the business of electricians, electrical engineers, suppliers of electricity, &c. The subscribers (with one share each) are:—E. F. Rouse, 1, Avenue Gardens, Mill Hill Park, W., gentleman; W. G. Turnbull, 95, Wood Lane, Shepherd's Bush, W., clerk; G. F. Barnett, 12, Weston Park, Crouch End, N., clerk; J. Jewell, 13, Richmond Crescent, Barnsbury, clerk; C. Field, 27, St. Margaret's Road, Brockley, S.E., clerk; H. A. Milner, 84, Effingham Road, Hornsey, N., clerk; W. MacGillivray, 368, Green Lanes, N., book-keeper. The number of directors is not to be less than six nor more than 12; the subscribers are to appoint the first; qualification, £500; remuneration as the company may decide. Registered by Ingle, Holmes & Son, 20, Threadneedle Street, E.C.

Silverton Ironworks, Limited (57,218).—Registered May 4th, with capital £50,000 in £1 shares (10,000 preference), to adopt an agreement with F. O'C. Prince for the acquisition of an invention for improvements in furnace bars, and to carry on the business of mechanical engineers, machinists, wood workers, builders, timber merchants, electrical engineers, chemical manufacturers, &c. The subscribers (with one share each) are:—T. Willson, 2, Christchurch Road, Hampstead; architect; H. Howe, 6, Epirus Road, Walham Green, S.W., gentleman; A. R. Stanes, The Limes, Surbiton, merchant; L. F. Clow, 8, Old Jewry, E.C., land agent; F. O'C. Prince, 37, Cursitor Street, E.C., engineer; E. J. V. Davies, 1, Harringay Villas, N., engineer; A. E. Bloxham, 17, Boveney Road, Honor Oak Park, S.E., agent. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first; qualification, 400 ordinary or 200 preference shares; remuneration, £100 each per annum (£150 for the chairman), and a percentage of the profits. Registered by N. L. Pocock, 16, Finsbury Circus, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Cambridge Electric Supply Company, Limited (36,457).—This company's annual return was filed on March 2nd; 9,413 shares have been taken up out of a capital of £100,000 in £10 shares; £8 per share has been called on 4,970, and £1 per share on the others, and £44,203 has been paid.

Telegraph Construction and Maintenance Company, Limited (1,147 C).—This company's annual return was filed on March 23rd, when the whole capital of £448,200 in £12 shares was taken up and paid for in full.

W. T. Henley's Telegraph Works Company, Limited (13,795).—This company's return was filed on March 18th. The capital is £180,000 in £10 shares (3,000 preference), 12,500 ordinary and 3,000 preference have been taken up, and £155,000 has been paid.

British Insulated Wire Company, Limited (52,285).—This company's annual return was filed on April 15th. The capital is £400,000 in £5 shares (40,000 preference). 20,000 preference and 40,000 ordinary shares have been taken up, and 5,530 preference and 29,935 ordinary are considered as paid. £2 15s. per share has been called on the others, and £67,471 5s. has been paid, leaving £55,203 15s. in arrears.

CITY NOTES.

The West India and Panama Telegraph Company, Limited.

The directors' report for the half-year ended December 31st, 1897, to be submitted to the shareholders on May 18th reads as follows:—The directors submit the accounts for the six months ended December 31st, 1897. The amount to credit of revenue is £32,228 11s. 8d. against £34,053 13s. 6d. for the corresponding half-year of 1896, and the expenses have been £19,772 15s. against £21,398 15s. 4d., leaving a balance of £12,455 16s. 8d., which, with £1,243 6s. 8d. brought from last account, and £1,000 transferred from reserve account, makes a total of £14,699 3s. 4d., with which it is proposed to deal as follows:—

	£	s.	d.
First preference shares—			
Dividend, six months to December 31st, 6s. per share	10,368	18	0
Second preference shares—			
Dividend, six months to December 31st, 6s. per share	1,400	14	0
Ordinary shares—			
6d. per share (free of income-tax)	2,208	0	6
Balance to current half-year's account	721	10	10
	£14,699	3	4

The traffic receipts for the six months show a decrease of £2,187 19s. 8d., as compared with the corresponding period, attributable to the causes mentioned in the last report, and to the depressed condition of West Indian trade. The expenses of repairing cables during the half-year are £1,386 15s. 3d. less than those for the corresponding period. During the half-year the company's two repairing steamers, *Grappler* and *Duchess of Marlborough*, have been surveyed and repaired in accordance with Lloyd's requirements. The new cable between Bermuda and Jamaica, alluded to at the last general meeting, was opened for traffic on January 31st. The contract between Her Majesty's Government and the new company provides for a subsidy of £8,000 per annum, and for a maximum tariff of 3s. per word between London and Jamaica, as against 5s. 10d. per word charged by the route as prescribed by the Legislative Acts of the Colonies, *viâ* Havana. The directors, however, decided to make corresponding reductions of rates to and from the West Indies on January 1st. With the view of aiding the plans of the Government in furtherance of West Indian trade, reductions of inter-colonial rates were also made on April 1st. Since the last general meeting the directors, with the object of maintaining and strengthening the duplicate system, have made arrangements to connect Grenada, St. Lucia and St. Croix, by a new line of cable in substitution for the old Chord line, which has proved to be beyond repair, and to duplicate the Trinidad-Grenada section. A contract has also been entered into for the manufacture and delivery in the West Indies of 160 knots of cable for stock. Owing to the financial crisis through which the Leeward Islands are now passing, Antigua and St. Kitts have reduced their subsidies from £800 to £600 each for the current year. Notice has also been received from the Government of Jamaica that the subsidy of £2,000 per annum, hitherto paid to this company, has ceased from March 31st. In accordance with the articles of association, Henry Holmes, Esq., retires at this meeting, and offers himself for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths and Co., also retire, and offer themselves for re-election.

The Great Northern Telegraph Company of Copenhagen.

The general meeting of this company was held at Copenhagen on April 30th, 1898, Mr. F. Zahle presiding.

The chairman and managing director, Commodore E. Suenson, D.R.N., in rendering an account of the working of the company during the year 1897, stated that the state of the cables in Europe had not been satisfactory during 1897, especially towards the end of the year. No fewer than 11 of the cables had been interrupted, the total number of interruptions being 32. These had nearly all been due to injury caused by the fishing vessels, especially by the steam trawlers, which are spreading more and more, not only over the North Sea, but also in the Skager Rack and Kattegat. On the other hand, the cables in the Far East had been comparatively free from injury, thanks to the extensive strengthenings and renewals which had been carried out during the last years, particularly on the Hong Kong-Amoy-Shanghai line. There had been only seven interruptions, affecting five cables. Unfortunately the Wladiwostock route had, as usual, been the weak link in the system. An altogether exceptional inundation of the Amur River had to a great extent destroyed the work of reconstruction carried on by the Russian Administration, and the work had to be done afresh. This reconstruction would, he hoped, put an end to the repeated interruptions of this route, while, as the construction of the railway in Siberia advances, the maintenance of the line would be facilitated. Their telegraph system in Europe would be improved in course of the present year, thanks to a measure contemplated by the Swedish Administration, viz., the building of bronze wires across Sweden. This would be of great advantage to the considerable traffic crossing that country between Gothenburg and Grislehamn. Similarly the Danish Administration had improved the lines across Denmark by the introduction of oil insulators; while the Russian Administration had built a new direct line between Moscow and Libau in order to accelerate the transmission of the telegraph traffic with the central and southern parts of Russia. The continued commercial and industrial development of China and Japan, and, during the last months of the year, the political events in the Far East had tended to increase the traffic. The friendly relations established with the Chinese Administration in 1896, by the convention concerning the traffic exchanged between Europe and China, which was mentioned in the last report, had been further consolidated by a similar convention concerning the limitrophic traffic between the Russian and Chinese Empires. In Japan they had had protracted negotiations with the Telegraph Administration, complicated by the introduction of the gold standard into that country. These negotiations eventually led to a tariff arrangement, which had also contributed to develop the traffic. Speaking of the projected Iceland cable, the Chairman said as the cable would render important service to Great Britain, France, and others, which every year send a number of fishing vessels to the coast of Iceland with crews numbering thousands of men, the company had provisionally approached Great Britain, France, and Russia in the hope of obtaining in return for the free transmission of their meteorological telegrams a fixed yearly remuneration which might contribute towards making up the deficiency in the receipts. The financial result of the year has been very satisfactory. The decrease in the receipts was only apparent, and was due merely to a change in the method of making up the accounts and balance-sheet. The interest on investments belonging to the reserve and renewal fund had been added direct to this fund, instead of being, as before, first entered in the working account. The latter method, which was less correct, was followed for so long a time, only with the object of enabling the employment of a larger amount for the amortisation of the debentures, but as the whole debt of the company would probably be extinguished in the course of another 12 months, the more correct method has been introduced this year. This alteration has not affected the extra dividend, which has been fixed as last year at 10s., making a total dividend of 10 per cent., or 20s., whilst the reserve and renewal fund has been increased by an amount slightly smaller than ordinarily.

The accounts were then adopted, and the retiring directors and auditors were re-elected.

The Eastern Extension, Australasian and China Telegraph Company.

The forty-ninth half-yearly meeting of the above company was held on Wednesday last at Winchester House, Old Broad Street, the Marquis of Tweeddale presiding.

The Chairman, in moving the adoption of the report, said: Gentlemen, the gross revenue for the half-year under review has amounted to £275,142, or a decrease of £50,263. Of this, £20,000 was caused by the falling off of the Australian traffic, which we have always pointed out to you is more or less of a temporary character, the remainder being due to reductions of tariff. When these reductions were made, it was estimated that there would be a loss of over £55,000, and it is most gratifying, I think, to find that the falling off in revenue from this cause has not been nearly so great as was anticipated. The working and other expenses have amounted to £102,844, showing a decrease of £3,426, which is due to the cost of maintenance of cables and expenses in connection with negotiations having been less in the past half-year than in the corresponding half-year of 1896. The usual interim dividends have been distributed during the past year, making, with a final dividend proposed to be paid to-morrow, a total payment of 5 per cent. for 1896; a bonus of 4s. per share, or 2 per cent. will also be paid, making a total distribution for the year of 7 per cent. The revenue balance, amounting to £57,444 13s. 10d., has been carried to the general reserve fund, which now stands at £803,667, after having been debited with £79,619 for the cost of the cable renewals, &c., carried out during the half-year under review. These renewals have been made in the Malacca Straits and China seas, and during the current year it is proposed to carry out several other much-needed renewals in various sections of the company's system. A further drawing by lot of the company's Australasian Government subsidy debentures (451 in number) took place on the 4th ult. for payment at par on July 1st next, when the debenture debt, which originally amounted to £640,000, will be reduced to £80,600. When I last had the pleasure of addressing you, I referred to the subsidy arrangement entered into with the Spanish Government for extending the company's system from Manila to the islands of Panay, Negros, and Cebu. During the half-year under review, this contract was completed to the satisfaction of the Spanish Government, and the cables opened for traffic. Unfortunately, however, through a further outbreak of the rebellion in the Philippines, one of the new stations in Cebu (Tuburan) has had to be abandoned, and is reported to have since been entirely destroyed, and until the rising is quelled, or sufficient troops can be spared to garrison the place, the working of the station cannot be resumed. Our Bolinao station, where the Hong Kong cable was originally landed, was also in the greatest danger a few months ago, owing to large numbers of the rebels having assembled in the neighbourhood, and demanded the surrender of the Spanish soldiers (11 in number) who had been sent to Bolinao to protect it. The Government landlines between Bolinao and Manila had been cut by the rebels, so that it was quite impossible for the station to communicate with the authorities at Manila by telegraph. For four days the station was entirely surrounded by the insurgents, who constantly threatened to attack it, and but for the timely arrival of a Spanish gunboat the station must have surrendered, with the result that the soldiers would doubtless have shared the sad fate of the other small garrisons in the district, who, after receiving promises of safety, were cruelly murdered. During this trying time the company's staff at Bolinao displayed the greatest courage and loyalty, and we understand that the Governor-General has recommended the Spanish Government to recognise their valuable services by conferring upon the superintendent and other principal members of the staff suitable decorations. The insecurity of the landline between Bolinao and Manila had long been recognised by the Government and mercantile community of Manila, and many proposals had been made from time to time for improving it, but without any practical result. The troubles, however, to which I have just referred were the means of bringing the negotiations between the company and the Spanish Government to a head, and a contract was entered into on March 30th for cutting the Hong Kong cable off Bolinao and extending it direct to Manila in return for certain concessionary privileges. The work was carried out within a fortnight of the contract being signed, and the Bolinao station and staff removed to Manila. They had not, however, been working from Manila many weeks before hostilities broke out between the United States and Spain, and on Monday, the 2nd inst., at 8 p.m., the cable was suddenly interrupted close to Manila, we believe by the order of the admiral of the American fleet. Should this prove to be the case, we shall naturally look, and with the utmost confidence, to the Government of the United States to compensate us for the damage caused to our property. Communication by cable between Manila and Hong-Kong will not be restored, I am afraid, until we are in a position to repair the cable, and until peace has been restored between the two belligerents, which, I am sure, we all hope will soon be the case. You will have seen from the newspapers that the proposal which the Eastern, Eastern Extension, and South African Companies submitted to Her Majesty's Government for establishing an all-British cable between this country and Australia *viâ* the Cape of Good Hope, has of late received a good deal of attention both in the colonies and on this side, but up to the present time the departmental committee has not made its report, and consequently no definite result has been arrived at. You will remember that at the last meeting a suggestion was made to the board that the services of the staff should be specially recognised in connection with the celebration of the Queen's Jubilee. This suggestion, after receiving the board's careful consideration, was adopted, by the granting of bonuses to the whole of the company's employés, and the expenditure incurred will appear in the accounts for the current half-year.

Mr. F. A. Bevan seconded the motion, and the report was adopted.

The retiring directors and the auditors having been re-elected, the proceedings terminated with a vote of thanks to the chairman and directors and to the staff.

American Bell Telephone Company.

The American Bell Telephone Company's report for the year 1897, gives the estimated number of exchange connections in the United States as 998 millions; the increase in the number of subscribers reported by the licensee companies was unprecedented in the history of the business, the gain in the last two years having equalled the aggregate gain of the previous six years. The number of exchange stations is 384,230, which equals, within a few thousand, the aggregate number of exchange stations in all of Continental Europe. The German Empire is reported to have 122,362 exchange stations (1896), and Great Britain comes next with 85,316. Conversation is now had by subscribers in the United States over distances of 1,800 miles.

West Coast of America Telegraph Company.

Mr. J. Denison Pender presided at a meeting of this company held at the offices of the company, Winchester House, on Tuesday last.

The Chairman referred to the death of Lord Sackville Cecil, one of the directors, whose seat at the board had been filled by Sir Albert J. Leppoc Cappel. The gross receipts for the year amounted to £25,773, being an increase of £2,268 of the previous year under the old company. The expenditure had been £19,476, or a reduction of £2,812, which was attributable to their having only one section of the cables interrupted during the year. The repairing steamer *Retriever* was only away from port five days during the 12 months, thus effecting a great saving in working expenses and maintenance of cable. Taking into consideration the depressed state of trade, the result of the first year's working of the new company could not be considered unsatisfactory. At the same time, the expenses had been abnormally small. The scheme of reconstruction took over the business, goodwill, property and assets, with liabilities of the old company, from December 31st, 1896. Of the share capital, 30,000 shares of £2 10s. each had been allotted to shareholders of the old company, and 15,000 of a similar amount had been allotted to the Brazilian Submarine Company. 8 per cent. debentures had been exchanged for 4 per cent., and £20,000 in 4 per cent. income bonds had been issued. The chairman referred to correspondence which had appeared in the financial press, and described the remarks of the writers as absolutely inaccurate.

Elmore's German and Austro-Hungarian Metal Company, Limited.

Mr. John MacFarlan (chairman) presided over the seventh annual meeting of the above company, held on Wednesday at Winchester House, and in moving the adoption of the report said the reduction of capital had been carried out and the amount standing as cost of patents was reduced from £139,940 to the more reasonable figure of £84,252. At the same time the period during which the preference shares had nine-tenths of the profits had been extended by two years in consideration of the additional sum of £10,000 put in the business. With regard to the Metall Company the result of the year's trade was disappointing as they fully expected the profit would have been sufficient to have paid a dividend. The explanation of the cause of their failure was a simple one. They got the Government contract and were told the requirements would be 100 tons per annum. They quoted a low price in view of the benefit they would derive by getting the contract. The result was that they received orders for more than three times the amount they expected at the lowest price. As soon as they got the Government order they were inundated on all sides with orders, but in consequence of the Government work they could not accept them. The contract with the navy was cancelled by them, and they had secured nearly the whole of the new one, only very small tubes going elsewhere, at prices very much higher than those of the old contract. The fact of their obtaining the new contract proved the esteem in which their tubes were held by the Government. They were informed by the Hamburg-South American Steamship Company that they had specified in their contract that only tubes of their make should be used. The most important fact of all was that they were now in a position to give orders for a very considerable extension of their plant, and they were now completing the erection of new plant which would enable them to about double the sales of last year. They had erected a very large draw bench shed, and filled it with draw benches, and they had built a very large double annealing furnace, which with the draw benches was sufficient to deal with the output. They were also deriving considerable benefit from the new arrangements with regard to the purchase of copper, and were now in the happy position of getting all copper free at Schladem at from 30s. to £2 a ton less than the value of Chili bar, and at the same time they paid nothing for the gold and silver it contained. They obtained 391·4 ounces of gold, which was sold for £1,692 3s. 6d., and 11,364·22 ounces of silver, which sold for £1,481 4s. 2d. That was a very important point, as that bye-product increased with increased output. On December 31st they had locked up in copper and book debts no less than £24,512 6s. That sum was considerably greater now, and it was impossible for them to carry out the extension without copper to fill the tanks. The debenture stock fell due for repayment on July 1st, and they proposed to make an issue of £60,000 to replace that. With the increase of business, they felt they were justified in reducing the interest from 8 per cent. to 6 per cent.

Mr. Heal seconded the adoption of the report, and it was agreed to.

Mr. Rawson stated that the shareholders would be glad to hear that the French Elmore Company would probably pay a dividend of between 10 and 20 per cent.

The Western and Brazilian Telegraph Company Limited.—The directors have decided, after placing £5,000 to the reserve fund, to recommend the payment of 6s. 9d. per share, making, with the interim dividend paid in November last, a total distribution of 3¼ per cent. for the year 1897. This will give 6s. 9d. to the ordinary, 6s. to the preferred ordinary, and 9d. to the deferred ordinary shareholders.

Stock Exchange Settlements.—Application has been made to the Stock Exchange Committee to allow the following securities to be quoted in the Official List:—Oxford Electric Company, Limited—10,000 shares of £5 each fully paid, and £35,000 4 per cent. debenture stock.

Forthcoming Prospectus.—The various daily and evening papers announce that the Great Northern and City Electric Railway prospectus will shortly be before the public.

New General Traction Company.—The meeting of this company, convened to be held yesterday, was not held, but was postponed until the 17th inst.

TRAFFIC RECEIPTS.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending May 6th, 1898, were £2,478 2s. 4d.; corresponding period 1897, £2,271 9s. 5d.; increase, £206 12s. 11d.

The City and South London Railway Company.—The receipts for the week ending May 8th, 1898, were £964; week ending May 9th, 1897, £957; increase, £7; total receipts for half-year, 1898, £19,721; corresponding period, 1897, £19,503; increase, £218.

The Dover Corporation Electric Tramways.—The receipts for the week ending May 7th, 1898, £130 11s. 8d.; total receipts to May 7th, 1898, £2,082 2s. 8d.

The Dublin Southern District (Electric) Tramways Company.—The receipts for week ending Friday, May 6th, 1898, were £461 0s. 2d.; corresponding week last year, £511 7s. 2d.; decrease, £50 7s.; passengers carried, 76,828; corresponding week last year, 78,961; aggregate to date, £7,[illegible] 17s. 3d.; aggregate to date last year, £8,166 11s.; decrease to date, £336 13s. 9d.; mileage open, 8 miles.

The Liverpool Overhead Railway Company.—The receipts for the week ending May 8th, 1898, amounted to £1,504; corresponding week last year, £1,316; increase, £188.

The Western and Brazilian Telegraph Company, Limited.—The receipts for the week ending May 6th, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,178.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, May 4th.	Closing Quotation, May 11th.	Business done during week ended May 11th, 1898. Highest.	Lowest
137,400*l*	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	...	...	100 —104	100 104	...	...
25,800	Amazon Telegraph, Limited, shares...	10	...	...	...	7 — 8	7 — 8	...	...
125,000	Do. do. 5% Debs. Red.	100	...	...	...	93 — 96	93 — 96	...	...
923,960*l*	Anglo-American Teleg., Ltd.	Stock	£2 9s.	£2 13s.	3 %	60 - 63	63 - 66	63½	62¾
3,038,020*l*	Do. do. 6 % Pref.	Stock	£4 18s.	£5 6s.	6 %	110½ 111½	113 114	114	111
3,038,020*l*	Do. do. Defd.	Stock	...	...	...	14 — 14½	15¾ -- 16¼	16⅜	14
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	7 %	7 %	15¾ 16¼	15¾ 16¼	16 1/16	15¾
75,000*l*	Do. do. 5 %, Debs., 2nd series, 1906 ...	100	5 %	...	...	112 - 116	112 116	...	...
44,000	Chili Teleph., Ltd., Nos. 1 to 44,000	5	4 %	4 %	...	3 — 3½	3 — 3½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	8 %	...	160 —170	160 170	...	...
918,297*l*	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	103 —105	104 —106	105	104
224,850	Consolidated Teleph. Const. and Main., Ltd.	10/-	1½%	2 %	...	1/16 — 3/16	1/16 - 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	7 %	6 — 7	6½ - 7½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	14 — 15	14½ - 15½	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 11	10 — 11	...	...
80,000*l*	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	4½%	103 —106%	103 106%	...	...
60,710	Direct United States Cable, Ltd.	20	2½%	2½%	...	10½ — 11	10½ 11	10½	10⅜
120,000	Direct West India Cable 4½% Reg. Deb	100	...	...	...	98 —101	99 —102	...	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	...	17 — 17½	17 — 17½	17⅜	17 1/16
70,000	Do. 6 % Cum. Pref.	10	6	6%	...	18 — 19	18 — 19	18⅝	...
89,900*l*	Do. 5 % Debs., repay. August, 1899	100	5 %	5%	...	100 —103	100 —103	...	...
1,302,615*l*	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4%	...	127 - 130 xd	123 —127	124	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7%	7 %	18 — 18½	18 — 18½	18½	18
25,200*l*	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5%	5 % 5 %	100 —104	100 —104	...	...
100,500*l*	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5%	...	101 —104	101 — 104	...	...
320,000*l*	Do. 4 % Deb. Stock	Stock	4 %	4%	4 %	127 - 130	127 —130	...	...
35,100*l*	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5%	... ...	100 —104	100 — 104	...	...
46,500*l*	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5%	...	101 —104	101 — 104	...	...
300,000*l*	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4%	...	102 —105	102 —105	...	...
200,000*l*	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4%	...	105 —108 xd	105 —108 %	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	...	11¼ - 11¾xd	11¼ — 11¾	11⅝	11⅜
180,042	Do. do. 6 % Pref.	10	6 %	6%	...	16¾ — 17¼xd	16¾ — 17¼	17⅛	16¾
150,000	Great Northern Teleg. Company of Copenhagen	10	10 %	10%	10 %	28½ - 29½	28½ - 29½	28 13/16	28½
160,000*l*	Do. do. do. 5 % Debs.	100	5 %	5%	5 %	100 - 103	100 —103	...	...
97,000	Halifax and Bermuda Cable Co., Ltd., 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	97 —102	97 —102	...	...
17,000	Indo-European Teleg., Ltd.	25	13 %	10%	...	50 — 53	50 — 53	52½	50
100,000*l*	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6%	...	106 - 109	107 —110	109	108
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	4 %	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5½%	5½%	6 %	3½ — 5¾	5⅝ - 5⅞	5¾	5⅝
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5½ — 5¾	5⅜ - 5⅝	5⅝	...
1,329,471*l*	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½ %	100 —105	99 —104	101½	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	⅝ - ¾ xd	⅝ — ¾	¾	...
100,000*l*	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	...	105 —108	105 —108	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	8 — 9	8 — 9	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	136 - 141	136 141	...	..
58,000	United River Plate Teleph., Ltd.	5	4 %	5 %	...	4 — 4½	4 — 4½	...	...
146,733*l*	Do. do. 5 % Debs.	Stock	5 %	...	...	105 —108	103 108	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	*nil*	...	3½ - 4½	3½ 4½	...	...
213,400*l*	Do. do. do. 5 % Debs.	100	5 %	5 %	...	99 - 102	99 102	100	...
64,269	Western and Brazilian Teleg., Ltd.	15	3 %	2 %	...	11½ 12	12 - 12½	12 5/16	11½
33,129	Do. do. do. 5 % Pref. Ord. ..	7½	5 %	5 %	...	7½ 8	7½ - 8	...	...
33,129	Do. do. do. Def. Ord.	7½	1 %	*nil*	...	4½ — 4¾	4½ — 4¾	4¾	4 7/16
389,521	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	105 —108	105 —108	105½	...
88,321	West India and Panama Teleg., Ltd.	10	⅜%	1 %	¾ %	½ — ¾	½ — ¾	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	7½ — 7¾	7½ - 7¾	7⅝	7 5/16
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	5 — 7	5 — 7	...	...
80,000*l*	Do. do. 5 % Debs. No. 1 to 1,600 ...	100	5 %	5 %	5 %	105 —108	105 —108	...	...
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7%	...	105 —110	103 —108	...	...
160,100*l*	Do. do. 6 % Ster. Bonds ...	100	6 %	6%	...	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	1895.	1896.	1897.	Closing Quotation, May 4th.	Closing Quotation, May 11th.	Highest.	Lowest
30,000	Charing Cross and Strand Electy. Supply	5	5 %	6 %	7 %	13 — 14	13 — 14	...	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	6⅜	6
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	6 %	9½ — 10½	9½ — 10½	10¼	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	4½%	4½%	4½%	115 —117	115 —117	...	...
50,000	City of London Elec.Lightg. Co., Ltd., Ord. 40,001— 90,000	10	5 %	7 %	10 %	26 — 27	26 - 27	26¾	26⅜
10,000	Do. do. Prov. Certs. Nos. 90,001 to 100,000 £5.	10	...	...	...	18 — 19	18 — 19	18½	18
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17½ - 18½	17½ — 18½	18¼	17 13/16
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	129 —134	129 - 134	...	...
30,000	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1— 30,000	10	*nil*	*nil*	*nil*	14 — 15	13½ — 14½	14 9/16	13¾
10,000	Do. do. do. Nos. 30,001 to 40,000 £4 pd.	10	...	...	...	8½ — 9	8½ — 9	...	...
20,000	Do. do. do. 6% Pref., 40,001—60,000	10	6 %	6 %	6 %	15 — 16	15 — 16	15¾	15 9/16
17,400	Edmundsons Elec. Corp., Ld , ord. shares 1—17,400 £4 pd.	5	...	...	...	4 — 4½	4 — 4½	...	...
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5			4 %	10 — 11	9½ — 10½	10⅝	9¾
10,000	Do. do. 7 % Cum. Pref. ...	5	7 %	7 %	7 %	11 — 12	11 — 12	11 7/16	11¼
62,400	*Metropolitan Electric Supply, Ltd., 101 to 62,500 ...	10	4 %	5 %	6 %	18½ — 19½	18 — 19	19⅜	18¼
220,000*l*	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½ %	117 — 121	117 —121	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	2 %	4 %	6 %	19 — 20	19½ — 20½	20¼	...
31,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord.	5	7½%	10½%	14½ %	17½ — 18½	17½ — 18½	18⅜	17½
20,000	Do. do. 7 % Pref., 20,881 to 40,880	5	7 %	7 %	7 %	10 — 11	10 — 11	...	...
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	4 %	107 —110	107 —110	...	...
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2¼ — 2¾	2¼ — 2¾	...	...
79,900	Westminster Electric Supply Corp., Ord., 101 to 80,000 ..	5	7 %	9 %	12 %	17 — 18	16 — 17	16½	16¼

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, May 4th.	Closing Quotation May 11th.	Business done during week ended May 11th, 1898. Highest	Lowest
30,000	British Electric Traction	10	...	...	...	15½ — 16½	15½ — 16½	16¼	...
10,000	Do. do. 6 % Cum. Pref. 30,001—40,000 £4 pd. (issued at £2 10s. prem. all paid)	10	...	...	...	7½ — 8½	7 — 8	...	...
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	2	2½%	*nil*	*nil*	1⅝ — 1⅞	1½ — 1¾	1¾	1⅝
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	*nil*	4 %	2¼ — 2½	2¼ — 2½	...	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock... ...	Stock	...	...	...	110 — 114	110 — 114	113½	113
50,000	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	102 — 105	101 — 104	...	...
19,894	Central London Railway, Ord. Shares	10	...	...	...	10 — 10½	10 — 10½	10½	10 5/16
129,179	Do. do. do. £6 paid	10	...	...	...	6 — 6½	6 — 6½	6¼	...
59,254	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1¼ — 1¾	1¼ — 1¾	...	...
67,680	Do. do. Def. do. £5 pd. ...	...	...	...	...	4¼ — 4¾	4¼ — 4¾	4 9/16	4½
630,000*l*	City and South London Railway	Stock	1 3/16 %	1 9/16 %	1⅞ %	67 — 70	67 — 70	70	69½
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	...	...	2 — 2½	2 — 2½	2	...
99,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 99,261	5	5 %	5½%	...	2¼ — 2¾	2¼ — 2¾	2 9/16	2½
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5½%	...	4 — 5	4 — 5	...	...
194,023	Do. do. do. 4% Deb. stock Red. ...	100	...	...	...	103 — 105	103 — 105	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	5 %	6 %	...	2⅝ — 2⅞	2⅝ — 2⅞	2¾	...
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 ..	2	7 %	7 %	...	3⅛ — 3⅜	3⅛ — 3⅜	...	...
111,100	Do. do. 4% Perpetual 1st Mort. Deb. Stock	Stock	...	...	...	106 — 108	106 — 108	...	...
91,196	Elmore's Patent Cop. Deposg., Ltd., 1 to 79,999	2	...	...	...	½ — ¾	½ — ¾	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	...	...	...	⅜ — ⅝	⅜ — ⅝	...	...
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	10½%	7 %	7 %	9 — 11	9 — 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	8 %	10 %	12 %	21½ — 22½	21½ — 22½	21¾	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½ — 19½	18½ — 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½%	110 — 115	110 — 115	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	21 — 22	21 — 22	21½	21 1/16
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	102 — 106	102 — 106	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	2⅞%	2⅞%	3½%	10⅝ — 10¾	10⅝ — 10¾	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15¾ — 16¼	15¾ — 16¼	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	15 %	15 %	35 — 38	35 — 38	37	35½
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 — 105	102 — 105	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	...	...	133 — 136	133 — 136	136	134

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

* Birmingham Electric Supply Company, Ordinary £5 (fully paid) 10⅝.

House-to-House Company, 4½% Debentures of £100, 107—109.

Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 15½—16½; 1st Preference Cumulative 6 %, £5 (fully paid), 8—8½. Debentures, 107—110. Dividend, 1897, on Ordinary Shares 10 %.

London Electric Supply Corporation, £5 Ordinary, 3¼—3¾.

* T. Parker, Ltd., £10 (fully paid), 15½.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8—8½. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount 4 per cent. (April 7th, 1898).

REVIEWS.

Alternate Currents in Practice. By FRANCIS J. MOFFETT, B.A. London: Whittaker & Co., 1898.

This work is a translation of a treatise of MM. Loppé and Bouquet, and has been undertaken by the translator with the idea of supplying English readers with a practical treatise covering the whole range of alternating currents of electricity.

It is rather a difficult matter to cover the whole range of a subject like alternating currents in a book containing only 372 pages, and we cannot expect to find in so small a space anything like complete treatment.

The book is divided into seven chapters, dealing with (I.) Alternators; (II.) Motors; (III.) Transformers and Condensers; (IV.) Transformation of Current; (V.) Distribution mains; (VI.) Current Distribution, and (VII.) Industrial Measurement of Alternating Currents.

The first three chapters, which comprise 247 pages, or about two-thirds of the whole book, are a mixture of description and theory such as is already within the reach of English readers, so that the useful addition to our literature is limited to the remaining one-third, which deals with the transformation and distribution of alternating currents. This portion should materially help electrical engineers, and form a useful reference for reasons and data concerning the various distributing systems, and it is really this part which is most suggestive of the practical engineer. It contains a good account of the methods employed in transforming from one alternating current system to another, and deals generally with the problems of transmission and distribution of electrical energy. The descriptive portions of these chapters is decidedly good, and the theoretical treatment is of a simple nature. The descriptive parts of the first three chapters are all that can be desired, the language being clear and the illustrations good, but the theoretical parts are often long and tiresome.

It seems to be a mistake to attempt to make a treatise on such a subject cover both practice and theory. There is plenty of room for two distinct treatises, one entirely practical in which difficult theoretical results may be stated but not proved, and the other devoted to establishing results whether they are known to have application to practice or not. If we were so supplied we should often be saved the tedium of hunting for practical data in book after book in the hope of finding what we want, perhaps hidden in a mass of—at the time—uninteresting figures and symbols.

The work before us is avowedly a translation, and it is, perhaps, a little out of place to review it as an entirely new production. As a translation, the book can only meet with a favourable criticism. The language is throughout precise and clear, and the diagrams and illustrations well defined and clearly explained. It would have been better if the publishers could have seen their way to produce the work at a lower cost. The price, 15s., does not compare well with other equally good publications of theirs.

An Eight Hours' Day. By W. J. SHAXBY. London: The Liberty Review Publishing Company, Limited.

This little book deals with the eight hours' question, and is generally inimical to it, and prophesies ruin if it is adopted. Our own opinion on the matter is that eight hours honestly and heartily worked, are sufficient for a day's work, and we see no advantage in meeting foreign competition by long hours of labour. Foreign competition will not gain the day on the question of hours. It rests with the workers of the country to maintain our trade by something very different from what trades unionism has fostered of late years. We fear both the van and the rear of English trade is badly officered. Improvement must come at both ends.

The intermediates who often find the brains, and have not the authority, are usually the best men. We agree with the author in condemning legislative interference, but we are by no means entirely with him on the hours question. Any length of day is useless where the spirit to utilise it is not there. We never looked on the recent strike as turning upon the hours question. It rather turned on other considerations, which were concealed behind the so-called popular eight hours. As a fact, there is yet no real public feeling for an eight hours' day, and to force it forward is an error by whomsoever done.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Earth Returns for Electric Tramways. By H. F. Parshall, member. Paper read April 28th, 1898.

(*Concluded from page 635.*)

1. *For Conductivity* the Chicago bonds in the different tests have shown practically 100 per cent. of the conductivity of pure copper. A flexible Crown bond showed only 93 per cent. conductivity. The Columbia bonds in the cases tried showed about 90 per cent. conductivity.

2. *Resistance due to Contacts.*—Measured from the potential difference between two points very close together, one on the bond terminal, the other on the steel. Experiment showed the following results:—

Bond.	Test.	Resistance per bond (2 terminals).	Resist'nce of 176 joints, or per mile with 30-ft. rails.	Remarks.
		Ohms.	Ohms.	
Chicago Bonds ... ⅝-in. terminals in ½-in. web. 1·37 sq. in. contact area.	1	0·00000197	0·000347	Bond and hole very clean.
" " "	2	0·00000215	0·000379	" "
" " "	3	0·0000025	0·000440	Bond not cleaned; hole freshly reamed, but oily.
" " "	4	0·0000080	0·00141	Bonding not supervised.
Crown Bonds ... ⅝-in. terminals in $\frac{7}{16}$-in. web. 1·2 sq. in. contact area.	5	0·0000080 0·0000028		" "
Total ...		0·0000108	0·00190	
Crown Flexible Bond ⅝-in. terminals in $\frac{7}{16}$-in. web. 1·2 sq. in. contact area.	6	0·0000422 0·0000518		Bonding not supervised; bonds afterwards found to have been put in rusty hole.
Total ...		0·0000940	0·0165	
Columbia Bond ... In ⅝-in. hole in ½-in. web. 1·37 sq. in. contact area.	10	0·0000072	0·00127	Hole clean; bond untouched.
" " "	12	0·0000095	0·00167	" "
" " "	13	0·0000077	0·00136	Hole 4 days old; bond untouched.

Tests 4, 5, and 6 show that want of care in bonding may lead to serious increase in contact resistance.

From the tests made it may be said generally that bonds properly applied—that is, clean bonds in bright reamed holes, put in with a proper fit with a drift driven square—have practically negligible contact resistance. Experiments showed that at at least 100 amperes per square inch the drop in the contact surface was inappreciable compared with that in the bond and in the rail. The same was found true with bonds—samples of which are exhibited—that have been in use for over two years, when the current-density has been limited as stated. Experiments on this point have been carried out to a considerable extent, since it has been frequently stated that the contact resistance is a very appreciable factor, and that it can be greatly lessened by amalgamating the surfaces. This will not be the case except when there is carelessness in putting the bonds in place.

3. *Gathering.*—The current may be supposed to flow uniformly through the rail at all parts, a foot or so from the ends or from bonds. At a bond, however, it has to gather, and it is scarcely to be expected that, say, 16 inches of rail terminating at a bond should show the same resistance as 16 inches in the middle of the rail.

Tests on a bar of steel 3 inches × ½ inch showed "gathering" at the two bond terminals added resistance equivalent to a total of about 1 inch of the bars.

Tests on an 83-lb. rail showed "gathering" resistance equivalent to 3·4 inches of rail at each contact, or a total of 6·8 inches per joint.

Joints.

The conductance of the joints depends, as stated, on both bonds and fish-plates.

The first have been discussed already.

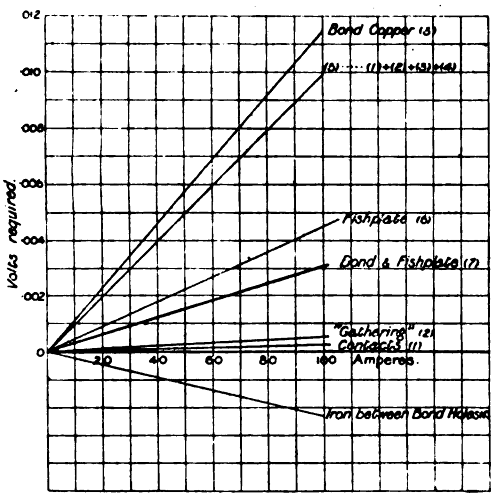
The second have a very appreciable effect, even with rails that have been in use for some time.

The following table shows the results of a number of tests made partly in the laboratory and partly on track in use:—

Laboratory tests.	Additional resistance due to joint. Ohms.	Inches of rail.	Resistance of 176 joints per mile, or with 30-ft. rails.
83-lb. rail; six tests; no bonds, fish-plates uncleaned, and not fully tight.	0·0000095 to 0·000081	10 to 87	0·0017 to 0·0143
Average	0·000039	34	0·0068
Single 0000; 30-in. bond only (calculated) ...	0·000101	109	0·0178
83-lb. rail, with one 30-in. Crown 0000 bond, plates well tightened...	0·0000024	3	0·00041
Same with fish-plate removed	0·000106	114	0·0187
This bond had too great contact resistance. See Contact Test No. 5.			
Tests on Rails in Use.			
76-lb. rail; one 30-in. 0000 Chicago bond and fish-plates.	0·0000307 to 0·0000622	32 to 65	0·0054 to 0·001
Four tests made without disturbing track *average*	0·000043	45	0·0076
76-lb. rail as above (track 2½ years old); four tests	0·0000275 to 0·0000843	28 to 80	0·0048 to 0·0148
Average	0·000046	48	0·0081
Single 30-in. 0000 Chicago bond only (calculated)	0·000103	114	0·0181
Old 65-lb. rail; one 30-in. 0000 Chicago bond, fish-plates not tight ...	0·000069	57	0·0121
Above with fish-plates removed	0·000090	74	0·0158
Above with fish-plates replaced and well tightened	0·0000473	39	0·0083
New 90-lb.; two 32-in. 000 Chicago bonds and plastic to one fish-plate	0·0000081 0·0000040	10 5	0·0143 0·0071
Average	0·0000060	7½	0·0105
Fish-plate added to conductivity.			

The above values show that the contacts had not deteriorated in any way in the two and a half years of use. Some of the rails were very old, but the fish-plates, which were not fully tight, showed bright patches of metal at places of contact with rail. On replacing plate and re-bonding, the joint was equivalent to 39 inches of rail.

A second rail tested without fish-plate showed also *no* deterioration of the bonding.



Volts required by various elements of joint in 80-lb. rail bonded with 1½-inch plastic bond to one fish-plate only.

Fig. 2.

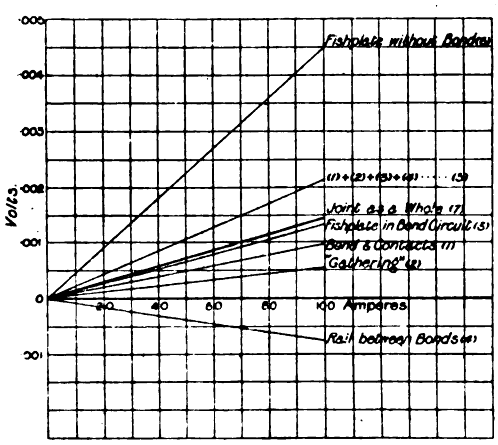
Some 66½-lb. rail laid on another line recently bonded showed joint resistances equivalent to 9½ inches to 28 inches in four different cases.

Plastic Bonds.

1½-inch hole in the cork receptacle between fish-plate and rail filled with plastic material.

Description.	Increased resistance due to joint.	Inches of rail.	Increased resistance of 176 joints, or per mile with 30-feet rails.
	Ohms.		
83-lb. rail bonded to one plate only; both plates separated by paper from rail	0·0000213	21	0·00375
Do., but bonded to both fish-plates; plates not very tight	0·0000126	14	0·00222
Do.; plates a little tighter ...	0·0000123	14	0·00217
Do.; plates very tight; brown paper still between plates and rails ...	0·0000117	13	0·00206
Do.; brown paper removed; plates tightened very hard up	0·0000083	9	0·00146

From the above, it seems safe to take the resistance through fish-plates as equivalent to some extra 50 inches of rail, and to take this resistance as in parallel with the copper or plastic bonds used in addition. Curves can then be constructed for any particular system of bonding similar to those of fig. 3, which gives P.D. for the various elements of a joint of 80-lb. rail bonded with a single 0000 B. & S. copper bond 30 inches long with 7/8-inch terminals.



Volts required by various elements of joint in 80-lb. rail bonded with a single 30-inch 0000 copper bond, with ⅞-inch terminal in $\frac{7}{16}$-inch web.

Fig. 3.

The contact and gathering resistances are added to the bond copper resistance, and the resistance of the iron between the bond holes deducted. This gives Curve No. 5. The resistance so found is taken as in parallel with the fish-plates' resistance and curve (7) calculated for the whole joint. The volts so found must be multiplied by the number of joints per mile, and added to the volts required to drive the current through a mile of jointless rail.

Apparatus Employed in Testing.

All resistances were found by measuring the potential difference between two points on the rails when a constant current of 30—150 amperes was passed through the latter. A standard resistance of 0·0000398 was placed in the same circuit, and the fall of the potential across this compared with that across the two points on the rail. The places at which current was led in and out of the rail were always at some distance from the points between which the potential difference was taken. Where measurements were made upon the actual track, current was supplied from an accumulator placed upon a car brought up to the spot. Current was led from this to a point in the middle of the rail to be tested, and was led out some 5 or 6 feet on the other side of a rail joint. The fall of potentiel was then measured between two points inside those by which the current was led into the rail, and also between two points on the same rail outside the places at which current was led into it. The standard resistance was included in the circuit, and comparisons taken with this at each stage. From these two measurements the resistance of the rail could be calculated as long as no cross bonds occurred upon the part of the track actually under test. To measure the resistance of the joints, a joint was included between the two points of which the potential difference was taken, and this compared with the potential difference between two points at a similar distance apart on the continuous rail. It was found extremely important in some cases to reverse the current both in the rail and the potentiometer, since with the small potential difference measured thermo-electric effects were very liable to disturb the results.

In certain experiments a current was passed into the rails at one end of the track, and taken out at the other. The current in the rails at intermediate points could be measured by taking the difference of potential between two points on the same metals which had been tested for resistance as above. This had, of course, to be done for all four lines of the double track. The volts used to drive current through the whole length of track were measured by making use of the test wires. The potentiometer was employed for this purpose also, and the results may be taken as correct, within the limits of correctness of calibration of the instrument itself, which was supplied by Elliott Brothers.

Notes on Electric Tramways. By Major P. Cardew, R.E., and A. P. Trotter, Members. Read April 28th, 1898.

The accompanying note on return feeders for electric tramways has been forwarded to me by Mr. A. P. Trotter, and as it contains a neat, graphical method for determining the fall of potential in the return with uniform distribution of current, and the proper points of application of return feeders, I think it may prove interesting in connection with Mr. Parshall's paper.

As Mr. Trotter alludes to previous suggestions of my own on this subject, I also forward a note which was prepared by me in May, 1894, and sent to the South Staffordshire Tramways Company, advocating the automatic regulation of this fall of potential.

P. Cardew.

Note on Return Feeders for Electric Tramways. By A. P. Trotter, Member.

While great ingenuity has been expended in designing bonds for electric tramway rails, and while these bonds, assisted in some cases by bare copper conductors laid between or near the rails, form a considerable item in the cost of building a line, little attention has been paid to the use of return feeders. The use of return conductors, provided with a small dynamo, was suggested by Major P. Cardew several years ago, and it has been independently proposed by Mr. G. Kapp. The system has been in use for some time in Geneva, and has recently been applied with success to the extension of the Bristol tramways.

The best mode of arranging such return conductors does not appear to have been described, and the present communiction is intended to afford an opportunity for discussing it.

Assume a tramway line with passing places, five miles long, and 10 cars running. The most even distribution will, of course, be when they are equidistant, and a less even distribution is not likely to occur than when all the cars are in pairs at passing places. Let each car take 20 amperes, and let the resistance of the bonded rails be $\frac{1}{20}$ ohm per mile. When the cars are evenly distributed, half a mile apart, the rail resistance between each pair is $\frac{1}{40}$ ohm, and with 20 amperes the drop on half a mile of rails is ½ volt.

The series is as follows:—

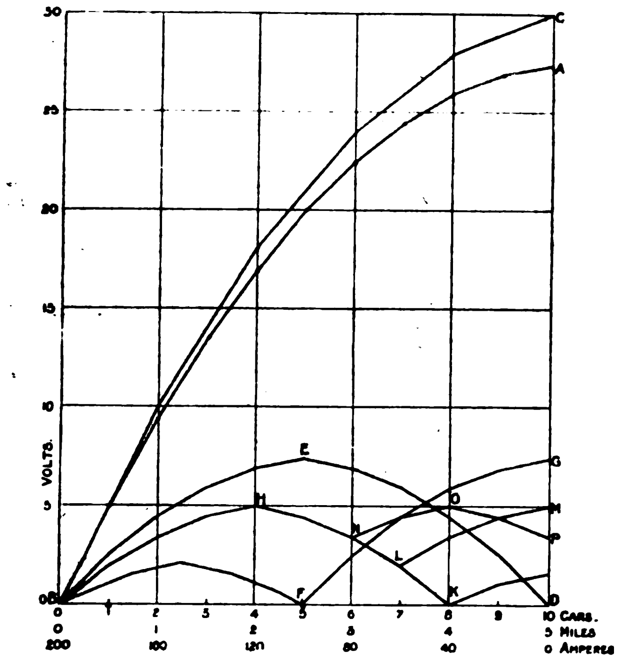
Cars ...	1	2	3	4	5	6	7	8	9	10	works.
Volts ...	0	½	1½	3	5	7½	10½	14	18	22½	27½

The first car is supposed to be at the extreme end of the line. The case is an extreme, but not an imaginary one. The large total fall of 27½ volts over five miles should, of course, be reduced in the first instance by more ample bonding, but the example serves the better to illustrate the problem.

When the cars are all passing in pairs, at a mile apart, the drop due to 40 amperes over one mile is 2 volts. The diagram shows the distribution for these two cases; the line, A B, showing the fall of volts for 10 cars evenly spaced half a mile apart, and the curve, C B, the fall for cars in pairs a mile apart. Mathematically, the point, A, is the origin of the curve, to which the line, A B, is an approximation; but as it is not intended to treat the problem mathematically, the point, A, is, for convenience, placed at the top right-hand corner.

The volts in the two cases differ so little, compared with the fluctuations of energy on an electric tramway, that this question of distribution of the cars will not be referred to again, but the line, A B, will be considered as typical.

The return feeder method by which this fall of volts may be reduced, consists in connecting a feeder to some point on the rails, and tapping off some of the return current. The conductivity of the feeder is not relied upon for this, but a dynamo, acting as a negative



"booster," may be said to suck the current back. By this means the point at which the feeder taps the rails may be brought down to zero-potential, or might be made negative to the generating dynamo.

The problem to be considered is—(*a*) To reduce the volts below a fixed maximum; (*b*) to use as little copper as possible; and (*c*) to use as little energy as possible.

Disregarding the two latter conditions, a simple plan would be to run a feeder the whole length of the line, and to reduce the volts to zero at the far end of the line, D. The distribution is then symmetrical; half of the current goes to the generating dynamo, and half to the return feeder. To draw the curve of distribution, cut out a piece of card to the shape of the curve of volts A B, and, fitting the vertical axis to the ordinate 5, place it so that it passes through the point D. Turn the card over, and complete the curve through A in the same way. The maximum volts, at the point E, are 7½.

But there is no occasion to reduce the volts at the end of the line to zero, and there is evidently a maximum expenditure of copper and of energy in the feeder. The middle point of the line is evidently not the best point to tap, for the volts would be distributed as shown by the line B F G, which may be easily drawn by means of the template. Here the maximum is, as before, 7½, and the volts near the works are unnecessarily low, viz., 2 volts at 1¼ miles out. It is clear from the line B F G, that the feeder would draw off three-fourths of the total current. It would be still worse to tap the rails at the point at which the volts rise to one-half the maximum, viz., at about 1¼ miles from the works.

Starting now in a different manner, let it be given that the maximum volts are not, under ordinary circumstances, to exceed 5, allowing a margin of two below the Board of Trade limit. Draw the line B H by means of the template, and fitting the template so that its axis is vertical, that the top touches the line of 5 volts at the point H, and that it passes through the point B. Turn it over and draw the line H K. But as it is not necessary, from the "undertakers'" point of view, to reduce the volts to zero at the point K, set the template again, allowing 5 volts at the end of the rails at the point M, and, drawing the line backwards, it is found to intersect the line H K at L. The volts at this point are 2, and this is the best that can be done with a single return feeder. This feeder will be 3½ miles long, and will draw off 0·65 of the current.

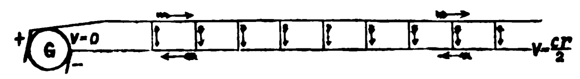
Note on Electric Tramways. By Major P. Cardew, R.E., Member.

It is, I believe, generally admitted that where the rails are used for the collection and partial transmission of the return current, the best means of preventing injurious action on pipes is to minimise the difference produced by the current between the potential of the uninsulated return at different points, and between any part of such return and the earth. On account of the resistance offered by all conductors to the current, the transmission of a current by means of a conductor causes a fall of potential throughout the length of the conductor, the difference of potential being greatest between the ends of the conductor.

This is the case whether the whole current is transmitted throughout the length of the conductor, or is fed in (as in the case of a tramway line) at different points along the length, provided that the direction of the current throughout the length of the conductor is the same, which must be the case when this conductor forms the only path for the current back to the generating machine.

But if additional conductors are used to take current from the main conductor, which receives the current distributed along its length back to the generator, the greatest difference of potential in

Fig. 1.



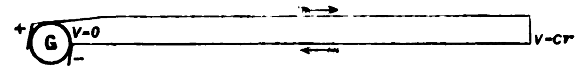


Fig. 2.

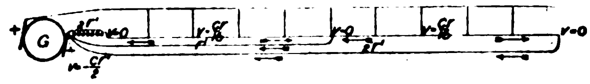


Fig. 3.

Note.—In the above figures *v* indicates potential with regard to earth.

this main conductor may no longer exist between the ends of the conductor, and the amount of this difference may be greatly reduced. The extent of the reduction will depend upon the position of the junctions effected and the resistance in the auxiliary conductors.

If we assume, for example, *n* auxiliary conductors, all of equal resistance, connected to the main conductor at equal distances throughout its length, and one from the extreme end of the main conductor of twice the resistance of the others, a resistance equal to this last being interposed between the generator and the near end of the main conductor, then with a uniform distribution of current all the points of junction will be at the same potential, and the extreme difference of potential between any points of the main conductor will be reduced to $\frac{1}{4(n+1)}$ of what it would be without these auxiliary conductors or feeders.

Thus with one feeder to the distant end alone the fall of potential in the main conductor can be reduced to one-fourth, and with a feeder to the centre as well, to $\frac{1}{12}$th, of that due to the same distributed current without feeders; and it will be seen that under such conditions the variation of potential in the main conductor can be reduced to any required limit.

But, unless these feeders are of very large cross section and conductivity compared with that of the main conductor, there will still be a considerable fall of potential in them, and in consequence a considerable difference of potential between the main conductor and the terminal of the generator to which it is connected by means of the feeders.

In place of adjusting the resistances of all feeders to equality, varying E.M.Fs. may be introduced into each feeder, proportionate to its resistance, and thus the potential of all feeding points may be kept the same as that of the terminal of the generator, if desired.

In considering the application of the feeding arrangements described above to the special case of minimising the leakage to earth from the rails of a tramway used as a return circuit, it must be borne in mind that, although the load under normal conditions may be fairly uniformly distributed, yet the exigencies of traffic may require far more current to be supplied to one section of the line than its proper share, other sections at the same time being lightly loaded.

The position and slope of the various gradients on the line also considerably affect the distribution of current in the rails. The number of cars at work, and, therefore, the total load, also generally varies during each day's running, and from day to day.

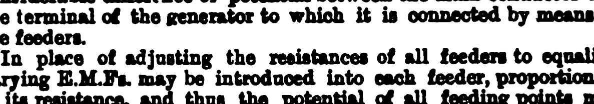


Fig. 4.

Note.—*v* indicates potential with regard to earth; *e'* and *e''*, auxiliary E.M.Fs

The disposition shown in fig. 4 can be adapted to meet the special requirements; but unless the auxiliary E.M.Fs. are continually adjusted to the variations of load, both as regards amount and distribution, the arrangement must be defective at times.

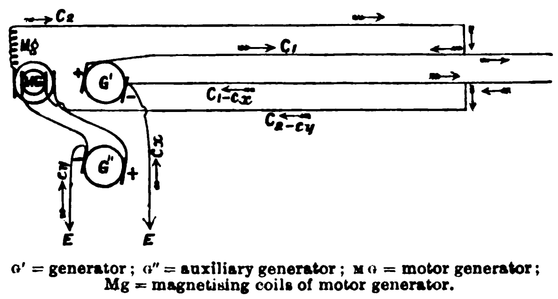
In order to provide auxiliary E.M.Fs. for the efficient working of the feeders to the return, automatically adjusted to the requirements, I would suggest the following arrangement:—

Let the tramway be divided into several sections according to its length and the amount of traffic gradients, &c.

Let there be two insulated feeders for each such section—one for the line, and one for the return; the latter being connected to an uninsulated conductor as provided in Regulation 4.

Let the current in these feeders pass through a "motor generator" at the generating station, the "field magnets" of which are excited by the current to line alone, while the armature is wound with two circuits—one for each current, so as to oppose each other—the circuit through which the current to line passes being made slightly the more powerful. The motor generator will then revolve as urged by the line current, and will generate an auxiliary E.M.F. for the return current.

The generator for each feeding circuit should be of rather higher E.M.Fs. than that supplying the near end of the line and return; but, as the extra volts will be taken by the motor generator in the station, there will be no need to exceed the limit allowed by the Board of Trade on the line outside.



G' = generator; G'' = auxiliary generator; M G = motor generator; Mg = magnetising coils of motor generator.

Fig. 5.

The expense involved may probably prevent the adoption of any such system in its entirety at present, but it possesses the advantage that it can be adapted to existing tramways, and a pair of feeders run to any part where the difference of potential from earth of the rails is found to be excessive.

Such an arrangement with one pair of feeders is sketched in fig. 5.

ELECTRIC LIGHTING PROVISIONAL ORDERS.

Rules made by the Board of Trade with Respect to Applications for Licenses and Provisional Orders, &c.

Consent of Local Authorities.

Rule I.—No application for a license or for the renewal of a license will be entertained unless proof of the consent to such application of every local authority having jurisdiction within the proposed area of supply is given to the Board of Trade.

Rule II.—No application for a provisional order (other than an application from the local authority of the district) will be entertained by the Board of Trade unless proof of the consent of every local authority having jurisdiction within the proposed area of supply to the grant of the order, or a request from the applicants asking the Board of Trade to dispense with the consent of such local authorities as have not consented and giving the reasons for such request, is deposited with the Board of Trade within the time limited for proving compliance with the provisions of the Electric Lighting Acts and these rules.

Rule III.—At the time of proving the consent of the local authority to an application for a license or renewal of a license or to the grant of a provisional order, the applicants must deposit with the Board of Trade copies of any agreement entered into with the local authority relating to such consent.

Rule IV.—Where the consent of any local authority is required to any application for a license or the renewal of a license or to the grant of a provisional order, such consent must be given by a resolution passed at a meeting of the local authority held after previous notice of the same and of the purpose thereof has been given in the manner in which notices of meetings of such local authority are usually given; and the fact that such a resolution was duly passed must be proved by a certificate signed by the secretary or clerk to such local authority reciting copies of the notice and of the resolution, and declaring that the notice was duly given and the resolution duly passed.

Notices.

Rule V.—Any local authority, company, or person intending to apply for a license or provisional order must at the time of lodging their memorial with the Board of Trade in the case of a license, and on or before November 1st in the case of a provisional order, give notice in writing of their intended application to every local authority, company, or person authorised to supply electricity under statutory powers within the district to which the proposed application refers.

Rule VI.—Except in the case of an application by the local authority for the district a provisional order will not be granted by the Board of Trade except to the body or person by whom the notice required by Section 4, Sub-section 1, of the Electric Lighting Act, 1882, was given.

Rule VII.—In any case where a local authority, company, or person is required by the Acts to give notice to the local authority of the district, "in such manner as the Board of Trade may direct or approve," such notice must be given in writing, and must be served, either by leaving the same at the offices of the said local authority, on or before the appointed day or by forwarding the same by post in a registered letter so that the same would in ordinary course of post be delivered on or before the appointed day.

Application and Deposits.

Rule VIII.—Every application for a license or provisional order must be made by memorial signed or sealed by, or on behalf of, the the applicants, headed with a short title descriptive of the proposed undertaking (corresponding with that at the head of the advertisement hereinafter mentioned, *see* Rule XIII.), addressed to the Board of Trade. With the memorial must be deposited six copies of the draft license or order, as applied for, with the schedule or schedules (if any) referred to therein.

Rule IX.—The deposited copies of the draft license or order must be in print. They must be printed on one side only and each schedule annexed must begin a new page.

The names and addresses of the Parliamentary agents or solicitors for the license or order must be printed on the outside of the draft.

There must be a notice at the end of the draft stating that objections are to be made by letter addressed to the Board of Trade, marked on the outside of the cover enclosing it "Electric Lighting Acts," and that such letter is to be sent to the Board of Trade in the case of a provisional order on or before January 15th next ensuing, and in the case of a license within two months from the date of the newspaper containing the first advertisement of the application, and that a copy of such objections is to be forwarded to the Parliamentary agents or solicitors for the license or order.

The draft must contain amongst other things:—

1. The address and description of the applicants.
2. A description of the proposed area of supply.
3. A statement of the purposes for which a supply is to be given, viz., any or all of the public or private purposes specified in Section 3 of the Electric Lighting Act, 1882.
4. Provisions concerning the breaking up of streets, railways, and tramways, where powers are sought to be obtained by the license or order for those purposes.
5. Conditions of supply.
6. Provisions for securing the safety of the consumer and of the public from injury by shock, fire, or otherwise.
7. Provisions for enforcing the performance by the undertakers of their duties in relation to the supply of electricity and for the revocation of the license or order where the undertakers fail to perform such duties.

The applicants must also deposit a sufficient number of printed copies of the draft license or order at offices in London and within the proposed area of supply to be specified in the advertisement hereinafter mentioned, *see* Rule XIII., such copies to be there furnished to all persons applying for them, at a price of not more than 1s. each.

Rule X.—The applicants must also deposit at the Board of Trade a published map of the district on a scale of not less than 6 inches to a mile, or if there is no published map, then the best map procurable, showing the boundaries of the proposed area of supply, and the streets in which it is proposed that electric lines should be laid down within a specified time.

They must also deposit a copy of the said map for public inspection—

> In England or Ireland, in the office of the clerk of the peace for every county, riding, or division, and of the local authority of every district.
>
> In Scotland, in the office of the principal sheriff clerk, for every county, district, or division, and of the local authority of every district

in which the proposed area of supply or any part thereof is situate.

Such deposits must be made in the case of a license when the memorial is lodged, and in the case of a provisional order on or before November 30th.

Rule XI.—There must also be deposited with the memorial:—

1. A list of the local authorities in whose districts the area of supply is situate.
2. A list of the local authorities, companies, or persons (if any) authorised to supply electricity under statutory powers within the area of supply.
3. A list of the streets not repairable by a local authority and of the railways and tramways (if any) which the applicants propose to take powers to break up.
4. A list of the canals and navigable rivers (if any) within the proposed area of supply.
5. A statement of the capital proposed to be expended and employed in connection with the undertaking, and the mode in which such capital is to be provided, or in the case of an application by a local authority a statement of the sums proposed to be expended.
6. If the applicants are a company incorporated under the provisions of the Companies' Acts, a copy of the memorandum and articles of association.
7. A fee of £50 by cheque payable to an "assistant secretary of the Board of Trade" to cover ordinary expenses. If in consequence of inquiries or otherwise additional expense is incurred, the amount will be charged to the applicants and must be paid by them in addition to the ordinary fee.

Applications under Section 13 of Electric Lighting Act, 1882.

Rule XII.—Where the undertakers under any license, order, or Special Act desire the written consent of the Board of Trade under

Section 13 of the Electric Lighting Act, 1882, to enable them to break up any street not repairable by a local authority or any railway or tramway which they are not empowered to break up under such license, order, or Special Act, application for such consent must be made by memorial, and the memorial must specially request such consent and must describe accurately the street, railway, or tramway which they propose to acquire power to break up.

PROCEDURE.

Rule XIII.—Applicants for a license or provisional order must proceed as follows, subject in the case of a license to the application having been previously entertained by the Board of Trade, *vide* Rule I.:—

They must publish notice by advertisement of their application, or in the case or a provisional order, of their intended application, and every such advertisement must contain the following particulars:—

1. The objects of the application.
2. The address and description of the applicants.
3. A description of the proposed area of supply.
4. The names of the streets in which it is proposed that electric lines should be laid down within a specified time.
5. A list of the streets not repairable by a local authority and of the railways and tramways (if any) which the applicants propose to take powers by the license or order to break up.
6. The address of an office in London, and another office within the proposed area of supply, at which printed copies of the draft license or order when applied for, and of the license or order when made, can be obtained at a price of not more 1s. each.

The advertisement must be headed with a short title, descriptive of the undertaking (corresponding with that at the head of the memorial), and it must state that every local or other public authority, company, or person desirous of bringing before the Board of Trade any objection respecting the application must do so by letter addressed to the Board of Trade, marked on the outside of the cover enclosing it "Electric Lighting Acts," in the case of a provisional order on or before January 15th next ensuing, and in the case of a license within two months from the date of the newspaper containing the first advertisement, and that a copy of such objection must also be forwarded to the Parliamentary agents or solicitors for the license or order.

The advertisement must be inserted once at least in each of two successive weeks in one and the same newspaper, published and circulating in the proposed area of supply, or in such other newspaper as the Board of Trade may direct; and once at least in the London, Edinburgh, or Dublin Gazette, accordingly as the proposed area of supply is situate in England, Scotland, or Ireland.

Rule XIV.—If any local or other public authority, company, or person desires to bring before the Board of Trade any objection respecting an application for a license or a provisional order they must do so by letter addressed to the Board of Trade, marked on the outside of the cover enclosing it "Electric Lighting Acts," in the case of a provisional order on or before January 15th next ensuing, and in the case of a license within two months from the date of the newspaper containing the first advertisement of the application. A copy of the objection must also be served upon the Parliamentary agents or solicitors for the license or order. If any local or other public authority, company, or person desires to have any clauses or other amendments inserted in the license or order, they must deliver the same to the Board of Trade, and also to the Parliamentary agents or solicitors for the license or order, on or before the time limited for bringing objections.

Rule XV.—When a license or provisional order has been granted by the Board of Trade and delivered to the applicants, they must forthwith deposit printed copies for public inspection in the offices specified in Rule X., and must supply copies to all persons applying for the same, at a price of not more than 1s. each, and must further publish the same as the Board of Trade may direct.

Rule XVI.—Where in a license or provisional order granted by the Board of a deposited map is referred to, the promoters must within one month from the grant of the license or order deposit at the Board of Trade a published map on a scale of not less than 6 inches to a mile, or if there is no published map then the best map procurable showing the area of supply coloured to correspond with the description in the license or order. The map must be mounted on linen and must be certified as correct as regards their respective districts by the clerk or surveyor to every local authority having jurisdiction within the area of supply.

SPECIAL PROVISIONS AS TO PROVISIONAL ORDERS.

Rule XVII.—In the case of provisional orders the following additional regulations must be observed:—

1. The advertisements must be inserted in October or November.
2. A copy of the advertisement must be deposited on or before November 30th at the Board of Trade and at the offices specified in Rule X.
3. The memorial must be lodged on or before Decembr 21st.
4. The Parliamentary agents or solicitors for the order must be prepared to prove compliance with the provisions of the Acts and these rules by January 15th, and all such proofs must be completed on or before February 22nd. Six days' notice will be given of the day and hour at which such agents or solicitors are to attend for the purpose of the Board of Trade, and printed forms of proof will accompany the notice. These forms must be filled up and brought with the requisite documents to the Board of Trade at the time fixed for receiving proof.

HENRY G. CALCRAFT,
Secretary.

The Board of Trade,
August, 1890.

NOTE.—When applications for provisional orders authorising the supply of electricity within the district of any local authority are received by the Board of Trade from such local authority, and also from any other authority, company, or person, the Board of Trade will give a preference to the application of the local authority of the district in every case where, in the opinion of the Board of Trade, no special circumstances exist which render such a preference inexpedient.

In cases of applications for a license, renewal of license, or provisional order, to which objection is made by any person locally interested, the Board of Trade will, if they consider it expedient, hold a local inquiry, of which due notice will be given.

THE GAS ENGINE IN AMERICAN PRACTICE.

MR. GEORGE RICHMOND, who writes in the *Engineering Magazine*, is, perhaps, as well versed in gas engine practice as anyone in America. Up to the expiry of the Otto patent the progress of gas engines was slow in America, partly because gas was dear, and largely because gas engines were costly.

The lapse of the patent flooded the country with cheap engines, low in strength and overrated in capacity, from which a reaction has now set in, and substantial, well-drawn engines appear reasonably certain to be soon sold in large numbers. And it is in producing electricity that Mr. Richmond foresees a brilliant future, especially with its congener, the oil engine, for the electric lighting of country houses and villages, for the average conception of America as a country of huge and hideous cities is by no means the whole truth. We have in mind as we write a little community—half village, half a mere locality—which is by no means far removed in character from that peaceful quiet which characterises some of the off-track villages of our own Sussex.

While our author refers to the Diesel motor as a brilliant success as compared with the Brayton engine, which it resembles in its operation except for its intended isothermal combustion, he states its cycle to be theoretically inferior to that of Brayton, though rendered a success by the fact of compressing to ignition temperature. Evidently Mr. Richmond is not to be caught with chaff, and has a very poor opinion of the "ripening and cooling spark" twaddle on which the Kane Pennington motor was sold to British investors. He seems honestly ashamed of this motor being of American origin, and therefore publishes cuts of really sound American engines.

On the other hand the Gardie engine, taken over to America about the same time from Europe, was really sound, but was wrecked by stock jobbing. It was Americanised as the Bates triple thermic motor, and in its operation both gas and air were separately compressed and heated thereby to about 390° F., and being then passed through regenerators to 750° F., the gas and air being still separate. They are then discharged to the motor cylinder in thin jets or layers alternated—we are not told if this stratification was really secured. On ignition by contact with an igniter (? a tube), the temperature rises to 2,730° F., the products of combustion expand, and the spent gases, still hot, pass out *viâ* the regenerators. However, good or bad, a $5,000,000 company was too much for this motor, and forthwith close on its heels, comes the Diesel motor, with an advance syndicate of a modest million dollars only. This motor he looks on as a triumph of mechanical work, with its 35 atmospheres compression and its 75 per cent. efficiency.

In the Otto engine, pressures of compression up to 38, 66 6 and 87·5 lbs. above the atmosphere gave 17, 21 and 25 per cent. efficiency, and 95 lbs. was recorded by Mr. Clark to have given 30 per cent. efficiency. The Diesel has shown 34 per cent. at 450 lbs. compression, a result disappointing, and only satisfactory as a mechanical performance; the net efficiency, after paying for the various complications, being poor for such a high pressure.

In the case of the Otto engine with 95 lbs. compression above quoted, the initial pressure was 310 lbs., so that, as regards mechanical difficulties, the Diesel may be assumed the more difficult with its 450 lbs. The Diesel engine only modifies Beau de Roche's cycle in the ignition period; it does not closely follow the Carnot cycle, at which it aims.

Our author considers that the belief in the advantage of the isothermal combustion arises from a misconception of the doctrine of Carnot, or rather a misapplication of it, and he does not think the isothermal expansion of the Diesel cycle is even its most valuable feature, while the difficulty in securing it will be very great.

The German type of gas engine was the first to be taken up in America, but the British type now seems to be gaining ground. In the gas engine, if anywhere, our national characteristic of solidity and weight ought to tell favourably. While various ingenious arrangements for direct connection have been tried, Mr. Richmond considers the link belt, run slack with a fly-wheel on the dynamo, as there ought always to be, will hold its own until a more simple system of direct connection is found.

The enormous amount of money spent in getting up new gas engines is attributed to the fact that the new designer starts out with a great contempt for all previous work. About £2,000 is spent in teaching the new man elementary ideas, a second £2,000 in trying revolutionary modifications, and the third in getting the engine to run as economically as others in the market. Our own personal observation tells us that many light-built engines run exceedingly well—when new—but we can recall no old-established gas engine that is not very heavy to-day about the cylinder. Mr. Richmond appears surprised at scientific Germany being not exempt from the above cycle of £2,000 ideas. He instances the first Diesel engine as being built without the water jacket, as compounding being now in course of being experimented upon at great expense, while to these ancient and exploded fallacies is being added the isothermal combustion "elaborated with a quasi-scientific and solemn minuteness intended to be admired rather than understood." But perhaps Mr. Richmond does not know his Shakespeare. If he does, when he gets a full-blown Diesel, minus jacket and with the many atmospheres of compression, he may think it "like a German clock still a preparing; ever out of frame; and never going aright, being a watch. But being watch'd that it may still go right."

NEW PATENTS.—1898.

Compiled expressly for this journal by W. P. THOMPSON & Co., *Electrical Patent Agents,* 322, *High Holborn, London, W.C., to whom all inquiries should be addressed.*

9,466. "The compact electric switch." P. H. BRANT. Dated April 25th.

9,475. "Improvements in and connected with arc lamps." F. R. BOARDMAN. Dated April 25th.

9,482. "Improvements in apparatus for freeing, lighting, and extinguishing gas burners at a distance by means of electricity." P. L. GUYENOT. Dated April 25th.

9,493. "Improvements in or relating to 'starting boxes' or combined rheostats and automatic cut-outs for electric motors." A. J. BOULT. (F. E. Herdman, United States.) Dated April 25th.

9,504. "Improvements in operating mechanism for the switches of electric railways." J. W. MACKENZIE. (C. W. Squires, United States.) Dated April 25th.

9,511. "Improvements in rheostats for the graduated control of electrical resistance, particularly applicable to the production of theatrical luminous effects." C. E. CLEMANCON. Dated April 25th.

9,534. "Improvements in incandescent electrical devices." W. L. WISE. (C. Hubert, United States.) Dated April 26th.

9,548. "Improvements in electric arc lamps respecting arc striking arrangement." P. SPIES. Dated April 26th. (*Complete.*)

9,581. "Improvements in coin-freed or prepayment apparatus for supplying electricity." A. G. IONIDES. Dated April 26th.

9,607. "Improved electric arc lamp." J. T. TSCHIERET. Dated April 26th.

9,637. "Improvements in process for the production of chemical compounds by electrolysis." J. W. RICHARDS and C. W. ROEPPER. Dated April 26th. (*Complete.*)

9,638. "Process for manufacturing metallic sulphides electrolytically." J. W. RICHARDS and C. W. ROEPPER. Dated April 26th. (*Complete.*)

9,677. "Improvements in swing joints or ceiling connections for carrying suspended electric light fittings." VERITYS, LTD., and P. G. EBBUTT. Dated April 27th.

9,692. "Improvements in resistance apparatus for regulating electromotors." SIEMENS BROS. & Co., LTD. (Siemens & Halske, Aktien-Gesellschaft, Germany.) Dated April 27th. (*Complete*)

9,712. "Improvements relating to telephones and to circuit arrangements and relays therefor." O. J. LODGE. Dated April 27th.

9,714. "Improvements in portable electric batteries and electric lamps." G. F. EMERY. Dated April 27th.

9,723. "Improvements in electric current switch gear." L. ANDREWS. Dated April 27th.

9,739. "Improved means and apparatus for electrolytically decomposing salts of the alkaline and earthy metals or other substances containing them for the manufacture of caustic bleaching powder chlorine, or other products contained in them." F. H. BOWMAN and F. E. BOWMAN. Dated April 28th.

9,778. "Improvements in plates for electric accumulators." M. BERNSTEIN. Dated April 28th. (*Complete.*)

9,779. "Relating to improvements in testing and projecting apparatus used in conjunction with telephone, telegraph, or other electrical circuits." D. SINCLAIR and W. AITKEN. Dated April 28th. (*Complete.*)

9,789. "Improvements in, and connected with, electroliers and incandescence electric lamp pendants." H. HIRST and J. H. COLLINGS. Dated April 28th.

9,802. "An improved system and means for driving newspaper printing, or like machines, at variable speeds by electric motors." W. A. CLATWORTHY, W. H. HOLMES, A. HOLMES, J. H. HOLMES, L. W. HOLMES, and E. HOLMES. Dated April 28th.

9,811. "Improvements in, and relating to, dynamometrical apparatus." H. BOURON. Dated April 28th. (*Complete.*)

9,844. "Improvements in adjustable shade supports for electric and the like fittings." W. H. STURGE. Dated April 29th.

9,877. "Improvements in electric switches." J. G. DIXON. Dated April 29th.

9,881. "Improvements in means and devices for electrically lighting coin-freed apparatus for displaying pictures." A. W. WITT and M. W. STIEBMAN. Dated April 29th. (*Complete.*)

9,912. "A new and improved chimney for incandescent gas, electric, and oil lights." M. ALTMAN. Dated April 30th.

9,921. "An electric brake." F. WISE. Dated April 30th.

9,960. "Improvements in or relating to electric meters." A. J. BOULT. (E. L. G. Cauro, Italy.) Dated April 30th. (*Complete.*)

9,983. "Improvements in or relating to telephonic apparatus." R. GUNTHER, E. VON KRONMYSTH, jun. Dated April 30th.

ELECTRICAL PATENTS OF 1884, EXPIRING IN MAY, 1898.

We are informed by Messrs. W. P. Thompson & Co. that about 96 applications for electrical patents were filed in the month of May, 1884. Out of these only three have been allowed to run their full length of term, viz., 14 years, and being of considerable interest we give short abstracts of them below:—

7,668. "Electric meter." J. S. RAWORTH. Dated May 13th, 1884. Relates to current meters. In one form of the instrument, for use as an electro-dynamometer, a pivoted iron spindle provided with two iron arms projecting from its ends in opposite directions, is surrounded by a low resistance coil, portions of which are parallel to the arms. When a current passes through the coil the spindle becomes magnetised together with its prolongations, which are then deflected by the portions of the coil which are parallel to them in opposition to a volute spring, one end of which is connected by an arm to an index and the other end to a spindle. The deflecting force is measured by the angle through which the spindle must be turned in order to bring back the index to its original position. In a modification for use as a voltmeter, the low resistance coil and its prolongations are replaced by coils of high resistance. 1 claim.

7,773. "Improvements in electric signal apparatus for fire alarms, telephone calls, and for like uses." H. A. SAUNDERS and A. C. BROWN. Dated May 15th, 1884. Relates to that kind of electric signalling apparatus in which the pendulum of a transmitting instrument sets in motion the isochronous pendulum of a receiving instrument in the same circuit, and consists of improvements in the transmitting and receiving instruments. The transmitter consists of a conducting rod suspended by a flat spring and carrying a flat spring, to which is attached a pendulum with an adjustable bob. The conducting rod swings between adjustable contact stops and breaks the circuit once in each vibration of the pendulum. Another form of transmitter has an ordinary adjustable pendulum, to which is attached a spring contact arm, bearing on contact pieces so arranged that the circuit is made and broken several times in each swing. The receiver has a pendulum suspended by a spring or pivot, and with the lower part of the pendulum connected with the upper by a flat spring. An electro-magnet excited by currents from the transmitter acts on the upper part, and sets the pendulum in motion. The motion of the upper part of the pendulum is limited by the electro-magnet and the stop. Methods of using these instruments for fire alarms, telegraph, telephone, messenger and police calls, and railway trains, are described in the specification. 5 claims.

8,448. "An electric switch." E. F. H. H. LAUCKERT. Dated May 30th, 1884. Relates to electric switches and consists in adapting carbon rods so that the sparks which may occur on making and breaking contact may pass between the carbon rods instead of the metallic surfaces. The carbons are fixed to the other parts by springs, and are so arranged as to be the first to make and the last to break. 1 claim.

THE

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THE ECONOMICAL EFFECT OF LIVE STEAM FEED HEATING.

IT seems to be accepted as an experimentally proved fact that the heating of feed water by live steam is productive of great economy. Several reasons are assigned for this. One is that the thermo-dynamic availability of the furnace heat transmitted to the water at a point nearer to the furnace temperature raises the efficiency of such heat. We look doubtfully on this explanation. Another reason is that the general circulation in the boiler is improved. If all the water in a boiler is at the full temperature of the steam space, as it would be if the feed were put in at that temperature, the application of further heat at any point would instantaneously cause steam to rise from that spot, and the water would nowhere be dull and sluggish, but would sweep freely over the plates and keep them cool. It is also offered as an explanation that when the boiler plates are hot there is less refraction of the heat passing through from the fire to the water side, and that it is possible we are all in error in thinking that heat transmission is the more rapid according as it traverses a medium interposed between bodies having the greatest difference of temperature. Light, we know, travels best in a homogeneous body. Is it not possible that heat also will travel better through a plate which has least difference of temperature in its own substance. In a paper by M. Normand, read at the 36th meeting of the Institute of Naval Architects, the author attributed an economy of 20 per cent. to his system of feed heating. He took the steam from the low-pressure cylinder of compound engines by a special valve, and his explanation of the economy was as follows:—

(*a*) An economy which results from the saving of so many thermal units due to using steam which has already done work in the cylinders. This saving may amount to 10 or even 14 per cent. (*b*) The circulation in the boiler is improved, and the plates kept better swept by the rapid passage of the water. He claims a trebled heat transmission from the same temperature difference. This latter economy would be that found where steam direct from the boiler is used to bring up the feed to a maximum, and it may be at the bottom of the better appreciation of the Lancashire boiler in the North, where economisers are used, than in the South, where they are comparatively rare, for it is very common practice to feed at maximum steam temperature from an economiser, leaving latent heat only to be supplied from the furnace.

In the absence of more data it is not possible to determine how the whole economy of feed heating is brought about. What is wanted are tests of a boiler with and without live steam heated feed water in order to determine two facts.

First, when using the steam are the waste gases reduced in temperature? This would show that the efficiency of heat transmission had been improved, and would prove that either the plates were more efficient, or had been more copiously watered by the more rapidly circulating water.

Secondly, does the use of steam cause any difference in the chemical composition of the waste furnace gases? It is possible that their temperature might be higher even with increased economy, for the higher temperature might be due to better combustion. If, therefore, with the colder feed an undue proportion of combustibles appeared in the waste gases, it might well be argued that this was due to contact with chilled plates. It has been shown experimentally that in contact with cold plates there is a stratum of unconsumed gas which cannot ignite, because of being cooled below ignition point. This implies waste. Mr. Thos. Fletcher, the manufacturer of gas apparatus, has shown that better results can be obtained with boiling vessels over gas flames when the bottom of the pot is studded with short projections, not so much that these afford a greater area, as that they get a little hotter than the water-cooled bottom, and do not extinguish flame. The combustible gases are thus enabled to complete their combustion. Until it is known by experimental determination how the use of live steam for feed heating affects the above conditions, the reasons for the economy which results must remain speculative.

The method of M. Normand of abstracting steam at mid-stroke from the low pressure cylinder, or in triple and quadruple expansion engines from the low pressure casing, seems well calculated to produce economy. Such removal will only slightly affect the mean pressure in the final cylinder, for it will doubtless reduce the back pressure, and if suitably arranged to abstract any collected water, may prevent some re-evaporation during the exhaust stroke, and serve to reduce the range of cylinder temperature, or the amount of its internal surface cooled by such re-evaporative effects. With every pound of steam so abstracted will be taken 966 heat units that would otherwise go to the condenser. In the compound engine, its abstraction at mid-stroke will be of very little moment on the score of power, while the less favourable point of abstraction in triple engines will matter little, because of the smaller relative value of the final cylinder.

In large boilers which are apt to contain a good deal of dead water in their lower parts—a fault that the water-tube and under-fired shell boilers do not possess—an injector or water propeller might be arranged to draw water from the bottom of the boiler and deliver it at the water surface, so as to draw down hot water to the boiler bottom. It was with this object that internally fired boilers were fitted with cross pipes in the tubes. These, however, defeat their object, and some positive means for circulation should be adopted in these boilers.

Professional Amenities.

THERE once was a time, within the memory of living man, when the announcement of any great scientific discovery was hailed with satisfaction throughout the civilised world, and the congratulations due to the man who had added to our knowledge was freely and cordially given by his co-workers in the domain of science, without any of the heart-burnings and petty jealousies which are so prevalent in these degenerate days. We have only to instance the recent achievement of Prof. Dewar as an example of the strained relations which now so frequently exist amongst scientific men. Prof. Dewar has been striving for years to liquefy hydrogen, and only a week or so ago he brought his labours to a completely successful issue. This wonder of modern chemistry is barely announced when a rival chemist, on the strength of a private letter from Cracow, combats Prof. Dewar's claims to priority and awards to Prof. Olszewski the distinction of being the first to liquefy hydrogen. This letter, said to have been written in 1895, Prof. Ramsay was challenged to produce, but apparently it was not forthcoming. This is all the more to be regretted, as it is apparently quite at variance with one of the latest publications of Olszewski, wherein he confesses his failure to accomplish what Prof. Dewar has succeeded in performing. Whatever doubt may exist as to the rival claims of the two great chemists should be set at rest by a letter in the *Pall Mall Gazette* of last Tuesday under the *nom de plume* of "One Who Knows," and the report on page 6 of Wednesday's *Times* of a paper read before the Paris Academy of Sciences on the 16th inst. This is not the first time we have felt it incumbent upon us to draw attention to the disparagement of Prof. Dewar's brilliant achievements which has been assiduously carried on in certain quarters for a considerable period, and it is now to be hoped that a better feeling may prevail in the divided ranks of the chemists, for it cannot be said that the controversy has been carried on in a manner which reflects much credit on one side at least. The peace on earth and goodwill towards men kind of spirit which seemed to prevail in Faraday's time appears to have lain dormant ever since, if it has not been wholly swept away in these days of high pressure and self-interest.

Lightning Arresters for High Tension Circuits.—The *Engineer* (New York) of April 1st prints a long illustrated article from Mr. Alexander J. Wurts on experiments with lightning arresters for high tension circuits. These arresters are intended to provide, at intervals along the distribution mains, spark gaps between the conductors of the system of low resistance in comparison with the rest of the circuit, and means for breaking the arc formed on the passage of a pilot spark from a lightning flash. They are, of course, quite different from telegraphic lightning arresters. The experiments were directed to testing the resistance of the gaps to sparking, and the rapidity with which the arc was broken after formation by a pilot spark. The discharge from a Leyden battery, excited by an electrical machine, was employed to produce the pilot spark. The resistance to sparking was measured by adjusting another gap in parallel with the arrester until the spark passed indifferently between them, and the spark was produced by shortening another gap in series with the two. The rapidity with which the arc was broken was indicated by the flicker on a bank of incandescent lamps arranged in parallel with the arrester. The occasion of the experiments and the article was to defend the author's (Wurts's) pattern of lightning arrester from the competition of another brought out under the name of Wirt's, and a third design was tested at the same time. The interest to us lies not in the commercial reputations of these arresters, but in the clear way in which the non-arcing quality of zinc alloys is brought out in the experiments, so that no arc can be maintained under an alternating pressure between such substances. The dimensions of the two parts between which, by a pilot spark, the discharge is started, seem to matter little, so long as they are made of a non-arcing alloy, and it appears that in no case where these materials are used does the discharge last beyond the time when, in the cycle of alternation, the current falls to zero. It is generally understood that alternating currents are more readily interrupted than direct currents, and the experiments, we gather, do not bear on the latter, arcs from which are generally dealt with by a magnetic blow out.

ELECTRIC LIGHTING AT WIMBLEDON.

It is now about 14 years since a series of experiments in street lighting by electricity was carried out at Wimbledon under the supervision of Mr. W. H. Preece; but, notwithstanding this early start, and the fact that a license was obtained as long ago as 1890, and a scheme prepared by Mr. Preece and Mr. Kapp, Wimbledon cannot yet be numbered amongst the towns which enjoy the benefit of an electric light supply. The local authorities do not, however, intend that this state of affairs should continue, and they have now obtained a provisional order, and have entered into contracts for the carrying out of a scheme prepared by Mr. A. H. Preece, and hope that, in the course of next year, they will be ready to supply current for public and private lighting. As the undertaking will be started under conditions which differ considerably from those which generally obtain, owing to the fact that 80 per cent. of the estimated output will be utilised for public lighting, we propose to give a few particulars of the scheme, for which we are indebted to the paper which was recently read by Mr. A. H. Preece before the Association of Municipal and County Engineers.

The streets of Wimbledon have for some years been lighted by oil lamps of about 20 candle-power each, of which there are at present about 800 in use. It is now proposed to use incandescent lamps of 32 candle-power, each oil lamp being replaced by one, or, in some of the more important thoroughfares, by two or more incandescent lamps; and for this street lighting about 900 lamps will be required. In addition to the public lighting, the scheme provides plant for the equivalent of 6,000 8-C.P. lamps for private lighting, and it is estimated that there will probably be 5,000 lamps connected in the course of the first 12 months' working. Owing to the large area to be covered, a high pressure alternating current system has been adopted, current being generated at 2,200 volts, and transmitted to transformers placed in underground chambers, whence it will be distributed by a three-wire system of mains with 400 volts across the outer conductors.

The generating plant will consist of three Crompton 120 kilowatt alternators and exciters direct coupled to Willans engines, for which a combined efficiency of 80 per cent. and a steam consumption of 28½ lbs. per kilowatt-hour have been guaranteed. Steam will be supplied by three Babcock and Wilcock boilers, each capable of evaporating 5,000 lbs. of water per hour; and to these is to be added a dust destructor plant, from which it is hoped to obtained sufficient steam to supply the requirements during the daytime, and perhaps after midnight, not only of the electricity works, but also of the adjacent pumping station. The high pressure mains will be concentric lead-covered cables, drawn into earthenware pipes, the outer of the concentric being earthed at the station. There will be three high pressure feeders terminating at distributing centres, which will also be interconnected by heavy mains, so as to allow of any feeder being thrown out of service without interrupting the supply. From these centres will branch out other and smaller high pressure mains or sub-feeders, which will transmit the current to the transformer stations, provision being made for separate sub-feeders and transformers for the public lighting, so that the street lamps can be switched on or off from the distributing centres without interfering with the private lighting. Although this arrangement will entail an extra expenditure on mains and transformers, great benefit should be derived from the concentration of all switching gear at the three distributing points, and from the greater efficiency of distribution, due to the fact that the transformers for public lighting will not be in circuit except when they are working at their normal full load output.

Provision will also be made for separate low pressure distributing mains for public and private lighting, the public lamps being arranged in circuits of from five to ten lamps each. Two different systems of laying these mains will be employed, according to the nature of the probable demand for private lighting, and to the class of pavement under which the mains are to be laid. When the demand for private lighting is uncertain, and the pavement is of such kind as to make it expensive to open up and make good, pipes will be laid down into which cables can be drawn as required; but when the demand for private lighting is certain, armoured cables will be laid direct in the ground; and the same plan will be followed under gravel pathways even when the demand for private lighting is so doubtful, then only public mains will be laid in the first instance.

As it will be necessary to lay mains in practically every street for the public lighting, the cost of mains, transformers, and public lamp connections forms an unusually large proportion of the total expenditure; this item being estimated to cost over £18,000 out of a total, including buildings and contingencies, of £32,000; whilst the estimated cost of the station plant is only £8,500, or less than half that of the distributing plant. The cost of this latter undoubtedly forms a very heavy charge, but it is stated that provision has to be made for about 40 miles of street, requiring 15 miles of high pressure and 50 miles of low pressure mains, besides some 20 miles of pipes. With regard to output and cost of production, Mr. Preece estimates that there will be an annual output of 300,000 units, of which about 80 per cent. will be required for the street lamps; and that owing to the regularity of the output due to the relative importance of the street lighting, the total cost of production will not exceed 2d. per unit, making £2,500, or a total expenditure, including interest and sinking fund, of £4,200 per annum. Owing to the profit to be derived from private lighting at 6d. per unit, it is estimated that the actual cost to the local authority of the 900 32-candle-power lamps will be only £2,450 per annum as against the present cost of £2,000 for the 800 oil lamps, or an increase of less than 25 per cent. for nearly double the amount of light; and that probably by the end of the second year the revenue from private lighting will have increased sufficiently to make the charge for the street lamps no more than it is at present.

THE ROYAL SOCIETY CONVERSAZIONE.

The usual exhibition of scientific novelties took place at Burlington House on Wednesday, 11th inst., when the first of the Royal Society's two annual conversaziones came off.

Among the scientific questions in the air at the present time, wireless telegraphy takes a first place. This was represented by a working installation of Lodge's system exhibited by Dr. Alex. Muirhead and Prof. Lodge. Telegraphic messages were being sent by this apparatus over the longest clear range obtainable in the Royal Society's rooms, for the electric waves, though they can penetrate through a moderate thickness of more solid substances, prefer, like the waves of light, to pass through air. Lodge's apparatus, of which a short description has already been given in the Electrical Review, Vol. 42, p. 103, consists of two fan-shaped sheets of copper connected at their apices by a coil consisting of a few turns of thick wire. The electric impulses are imparted to this system by sparks passing across air-gaps of about ¾ inch near the centres of the copper sheets. The sparks are obtained from an induction coil, the current of which is controlled by the punched ribbon of an automatic transmitting telegraph instrument. The receiver is exactly similar to the transmitter, but in this latter a coherer and syphon recorder are connected (in the same circuit) in shunt with the coil connecting the sheets of copper. The coherer used was of the very simple form first devised by Prof. Lodge, in which the end of a flat steel spring is pressed against an adjustable steel point—a kind of microphone sensitive to electric instead of sound waves. The telephone may be used as a receiver instead of the siphon recorder, in which case no tapper is required for the coherer, and a much higher speed of telegraphy is possible. The greatest distance over which Prof. Lodge has telegraphed with his apparatus is about 1 mile, and at that distance no falling off in its action was observable.

For wireless telegraphy at very long distances, however, Lodge prefers his system of "magnetic space telegraphy." The apparatus for this system was shown in the secretario room downstairs. The system depends on the mutual magnetic induction of two coils placed at distant points on the earth's surface. The discharge of a condenser or Leyden round a large wire coil sets up an alternating magnetic field, which excites induced currents in another distant condenser circuit tuned to the same frequency, causing the second

Leyden either to overflow into a coherer, or to disturb a Rutherford detector or a telephone, so as to give a signal. The detector shown was a special series of small free coils and granular microphones, each coil in a permanent magnetic field, and so connected to the microphone of the next, that a very feeble alternating current in the first of the series is able to make a telephone in the last emit a loud sound, or through a Langdon-Davies relay, to ring an electric bell and work a Morse sounder. A tone-telephone was also shown, which acted as a highly syntonised call. This highly sensitive receiver for magnetic oscillations had an extraordinary peculiarity, which Dr. Lodge described as "talking to itself." When two of its coils were placed relatively to each other, so that their mutual induction was large, the one starts automatically to act on the other, and the telephone begins to sound.

Mr. Mackenzie Davidson exhibited his apparatus for finding the true position of foreign bodies in objects photographed by the Röntgen rays. This has already been described in the ELECTRICAL REVIEW. He also exhibited a Wheatstone reflecting stereoscope for looking at Röntgen photographs.

Mr. A. A. Campbell Swinton had a very interesting exhibit illustrating his recent discoveries in the discharge in vacuum tubes. Radiometer mill wheels were employed to detect the direction and velocity of the gaseous streams, and the experiments indicated that in very highly-exhausted tubes of the focus type, in addition to the well known negative stream from the cathode, discovered by Crookes, there existed also a positively electrified stream from the anode, which travelled in the opposite direction to the cathode stream and exterior to the latter. A pinhole Röntgen ray camera was also exhibited by Mr. Swinton, with which he had taken photographs of the active area on the anti-cathode, which corresponded with the results he had already obtained on cathode discs. Lastly, though not least interesting, were Mr. Swinton's cathode ray lamps. Two concave cathode discs focus on a cube of refractory material, and give out sufficient light to illuminate a small room. The efficiency of this method of producing light is considered to be quite equal if not greater than that of the arc light.

Mr. Killingworth Hedges exhibited specimens of copper deposited by a process invented by Mr. J. C. Graham. Mr. Graham by mechanical means causes a circulation of the electrolyte over the surface of the cathode. By this device he claims that he can use 10 times the density of current hitherto employed, and yet obtain a more homogeneous deposit.

Prof. Ewing exhibited his new magnetic balance for permeability tests of iron. This apparatus has been designed to afford an easy means of judging of the magnetic quality of iron or steel with special reference to its suitability for use in dynamo magnets. The specimen to be tested is in the form of a turned rod, which lies across the poles of an electro-magnet excited by a constant current. One side of the rod touches both poles, and the force required to pull it away from one pole is measured, the contact with the other pole serving as a hinge. The force is measured by means of a weight which slides along a graduated scale-beam, and the beam is graduated to give, by direct reading, the value of the magnetic induction, B, which would be produced in the tested samples by a constant magnetising force, H. The constant magnetising force selected for the purpose of the test is 20 C.G.S. units, that being a sufficiently strong force to exhibit the quality of different specimens in respect of permeability under strong magnetisation.

Prof. Callendar exhibited electrical recording apparatus. This apparatus is capable of recording almost any kind of electrical quantity directly, and can be made to record other quantities indirectly, as, for instance, temperature by means of the variation of electrical resistance. It has been in use for more than a year at McGill College, Montreal. A brief mention of the apparatus, with illustrations of some of the results obtained, was communicated to the Royal Society of Canada at their last year's meeting in June, 1897, and has been published in their *Transactions*. The principle upon which the apparatus works is extremely simple. A pen or planimeter is attached to the contact point on a "slide-wire," and is kept automatically at the balance point by means of a delicate relay, controlling a pair of clock motors. The co-ordinates of the record are consequently rectangular, and the scale is one of equal parts in the majority of cases. The following are some of the special cases to which the apparatus has been applied:—Electrical records; resistance, voltage, current, and power; temperature records by thermo-couple, or by platinum thermometer; records of sunshine and humidity; cycle records; steam temperature cycles in the cylinder of a working steam engine; forms of alternating current and potential waves.

Mr. C. Orme Bastian exhibited an electric current meter acting by electrolysis, the ampere-hours being measured by the decrease of a column of the electrolyte (dilute H_2SO_4).

Mr. Wimshurst exhibited a Röntgen tube-holder, designed to prevent leakage in the leads, and showed experiments, in which the direction of the electrical discharge was indicated by small fans.

AN AUTOMATIC TELEPHONE EXCHANGE.

MANY and varied attempts have been made to evolve a system of reliably effecting inter-communication between the circuits of a number of telephone subscribers concentrated at one central point or exchange without the aid of an operator at that place. The problem presents difficulties which have not hitherto been successfully overcome, but a system recently developed, and now being exhibited by the

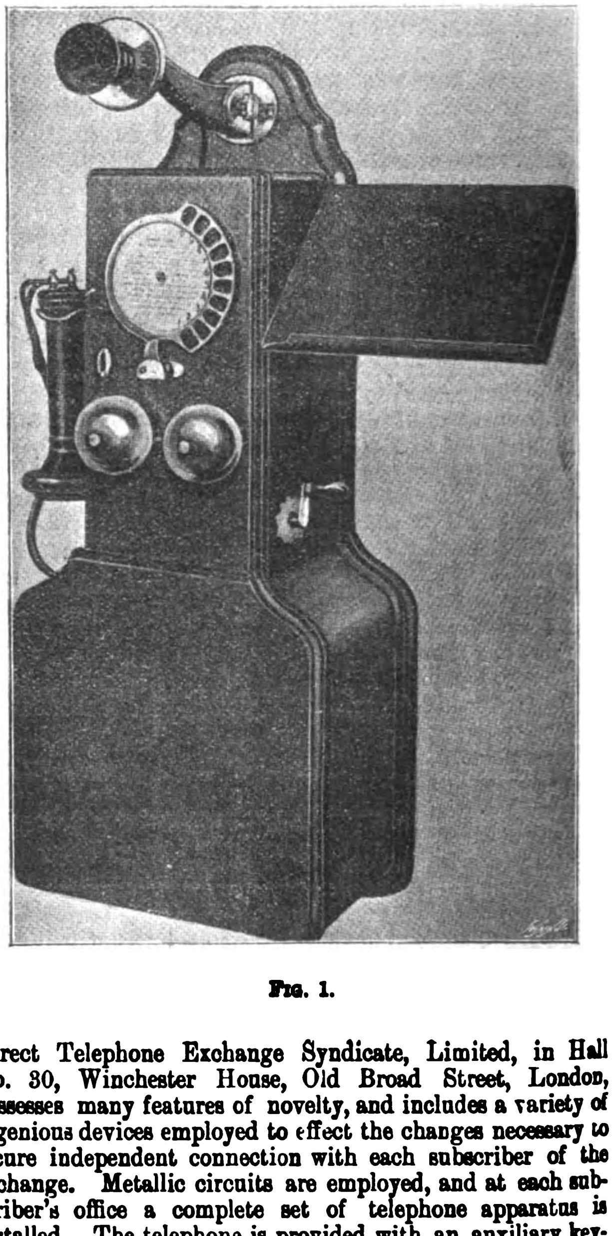


FIG. 1.

Direct Telephone Exchange Syndicate, Limited, in Hall No. 30, Winchester House, Old Broad Street, London, possesses many features of novelty, and includes a variety of ingenious devices employed to effect the changes necessary to secure independent connection with each subscriber of the exchange. Metallic circuits are employed, and at each subscriber's office a complete set of telephone apparatus is installed. The telephone is provided with an auxiliary keyboard or commutator, by the use of which the sequence of the currents necessary to actuate the automatic switching apparatus at the exchange is determined. The subscriber's instrument is illustrated by fig. 1.

The keyboard, shown on the upper part of the apparatus, is disc-shaped, and revolves around its centre, whence it is connected by means of an axle to the commutator internal to the instrument. The commutator is constructed on the well-known principle usually employed in municipal and other messenger and police call systems, where the operating of the call key winds up a clockwork system, which, during the act of running down, rotates a star or toothed wheel, which determines the number of current impulses generated for each movement of the keyboard. As a preliminary to ringing a correspondent in the usual way, the subscriber originating the call must effect the connection at the exchange between his circuit and that of his correspondent by operating the keyboard of his apparatus. This is effected by inserting the tip of the finger into a hole in the keyboard (seen in the figure) corresponding to the number required, and pulling the keyboard round to the stop, where, on being released, it returns to zero automatically. This operation is repeated for each figure contained in a concrete number representing the subscriber wanted, who is subsequently rung by the magneto-generator in the usual way.

At the exchange each subscriber's circuit terminates on an electro-magnetic switch, illustrated by figs. 2 and 3, which

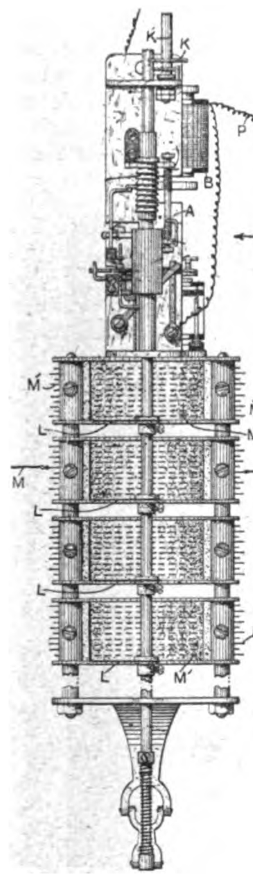


Fig. 2.

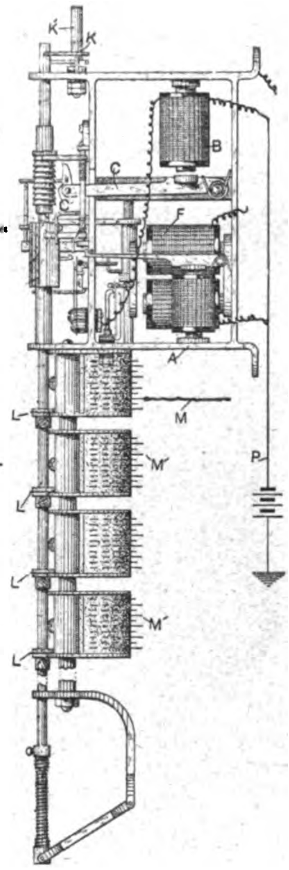


Fig. 3.

are a front and side elevation respectively, and where D is a rod movable vertically and circularly. The rod D carries a series of flexible contact arms L which effect connection with the metallic segments of the semi-circular distributors, M′; B is an electro-magnet, the lever C of which raises the rod D to the proper height for bringing the contact arms L into line with the row of segments with which connection is required on the distributors M′. These segments correspond with the multiple jacks of subscribers' circuits connected to ordinary manual boards. F is the motor magnet by whose armature lever the rod D and consequently the contact arms L, are rotated into connection with their proper segments upon the distributors, each segment of which is connected by a cross connecting wire, shown at M, with the corresponding segment of each switch throughout the exchange.

One wire of the metallic circuit may be considered as terminating upon the rod D, whence connection is continued to the segments of the distributors of the other switches, as described above, by means of the stud K′, with which a projecting pin, K, on the upper end of D makes contact when the apparatus is at rest in the normal position. The other wire of the circuit is terminated upon an insulated flexible steel spring normally disconnected. When therefore, the rod D is rotated, the pin K is moved away laterally from the stud K′, and the segments on the other switches to which this stud is multipled are thus isolated from the subscriber's circuit for the time being. The electro-magnetic switch connected with the circuit of the subscriber who is called is not, however, actuated, and provision has therefore to be made to prevent other subscribers obtaining access to his circuit whilst it is in possession of the correspondent who first called. This is effected by the auxiliary electro-magnet A, brought into use through the medium of a local circuit, and whose armature lever when depressed disconnects the circuit of the contact arms L on the switch of the third subscriber, by which means privacy is secured to the two subscribers who are already in communication. The bottom group of segments on each switch is reserved for connecting up these "non-interfering" local circuits.

A subscriber requiring to communicate with another whose circuit is already engaged, ascertains that he has failed to secure connection by his bell remaining silent when he operates his magneto-generator to call his correspondent. A separate segment is set apart in each subscriber's automatic

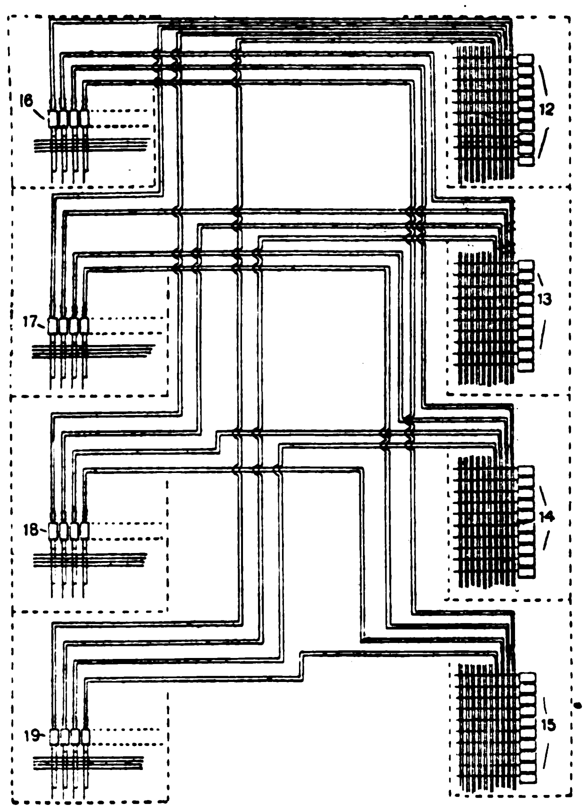


Fig. 4.

switch, to which he may connect his circuit by calling a prearranged number, and speak to the office of the manager of the system if he has reason to suspect that his apparatus is out of order and desires to verify it.

The battery P, which energises the electro-magnets of the switches is located at the exchange, one battery being common to the entire exchange.

To safeguard the apparatus from damage by stray currents from adjacent power circuits with which the telephone wire may get into contact, a "time fuse" is inserted in the wire of each subscriber's circuit connected to the motor magnet. This fuse is shown by fig. 5, where W is a solenoid of wire enclosing an ebonite core, and S S′ are flexible springs. The heating effect upon the wire W, of a continuous current, exceeding the current of half an ampere, with which the apparatus is actuated, causes the ebonite core C to expand and raise the spring S, when S′ being thus released, flies forward and breaks the circuit of the subscriber, simultaneously closing the circuit of a local alarm bell in the exchange, which gives warning of the fault. A similar result follows if the subscriber's wire finds accidental earth outside the exchange, when the motor battery P would be discharging continuously. A ready means is provided of locating an open time fuse upon the switchboard.

The act of hanging up the receiver at the subscriber's office after a conversation has terminated, causes a momentary

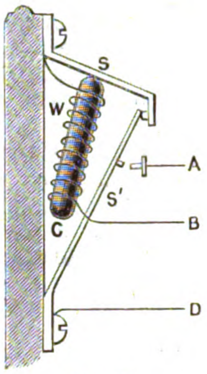


FIG. 5.

current to be sent through the intermediary of the switch arm of the telephone, and this current automatically restores the electro-magnetic switch at the exchange to its normal position.

The switch described is capable of providing for exchanges having a capacity up to 400 subscribers, above which number method of effecting combinations of numbers enables 1,000 subscribers to be reached; and by an extension of the principle it is claimed that 10,000 may be accommodated in one exchange.

In the apparatus described the electro-magnets actuating the switches are included in the circuit when conversation is going on, and are consequently given a low ohmic resistance, but in the latest development of the apparatus the "bridging" method of connection is introduced. The system has been in operation about four years, and is employed at some 20 exchanges in various States in America, some of which exchanges are built to a capacity of 1,000 subscribers. It is also in process of installation in a like number of cases at other places, at some of which a capacity up to 5,000 is being provided for.

A view of an exchange equipped to a capacity of 200 subscribers now in operation at Trinidad, Colorado, is shown by fig. 6. Each electro-magnetic switch occupies a lineal space of 12 inches × 4 inches, and projects 6 inches from the supporting base.

It will be gathered from the description that the automatic switch depends primarily upon its mechanical qualities for performing its functions. An exchange equipped with the apparatus must therefore be under the charge of a competent mechanician possessing electrical knowledge, and the accuracy with which the apparatus operates will depend upon the degree of skill with which its necessarily complex mechanism is maintained.

Apart from the central office system, there is a large undeveloped telephonic field within the residential suburban areas of our cities and towns, to the opening up of which the attention of inventors of automatic exchange apparatus has been directed, and where the provision of a reliable and con-

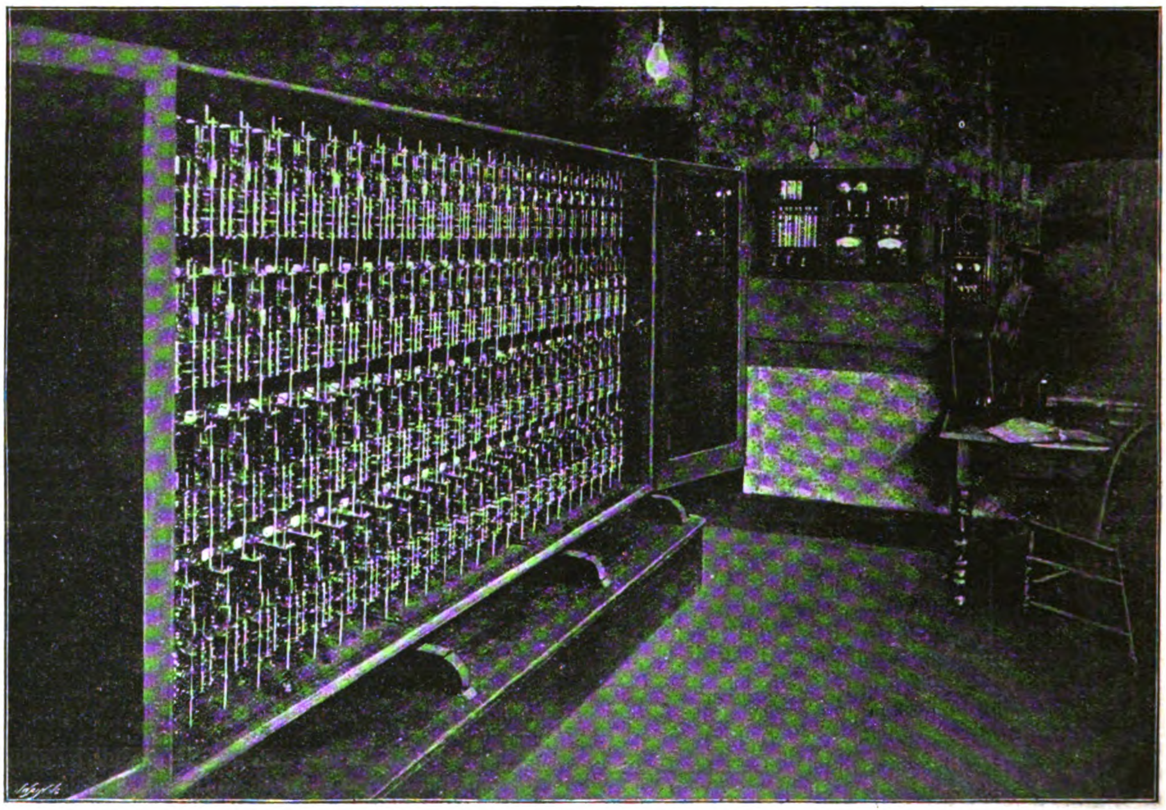


FIG. 6.

the combinations of numbers are obtained by allotting two switches to each subscriber's circuit, the first of which selects the groups of hundreds, whilst the second picks out the tens and units in each particular hundred. The principle upon which this sub-division is effected may be understood from fig. 4, where the switches diagramatically represented at 16, 17, 18, and 19 correspond with the first of a pair allotted to select the hundreds, whence the connections continue to the second switch of the pair where the sub-division to the tens and units of the different groups of hundreds is effected. The points of sub-division to the tens and units of the different hundreds are indicated at 12, 13, 14, and 15. This

tinuous automatic local service with tradesmen and others, giving optional access to the main system would appear to obtain an opening for employment.

The time occupied in operating the automatic exchange is virtually constant for any given combination of figures, and the subscribers are thus relieved by such a system from anxiety regarding preferential treatment by the operators, about which so much has lately been heard, but it is an open question whether, even in its improved state as now exhibited, the automatic switch will prove an efficient substitute for the manual operator, notwithstanding the ingenuity which has been exercised in working out its details.

LITTLE'S CONTINUOUS INTEGRATING STEAM INDICATOR.

There has been, we believe, up to the present time no instrument in existence capable of attachment to steam engines, which will automatically produce a record of the power developed during any desired length of run, and which will act in sympathy with any changes either of speed or steam pressure in the cylinder which the load on the crank shaft may demand. With the consent of the proprietors of our contemporary, *Engineering*, we reproduce an engraving of a new type of steam indicator, a full description of the theory and practice of which appeared in the issue of that journal of December 10th last, and this being so we do not propose to give more than a general outline of the aim and construction of this ingenious and handy instrument.

It will be seen from the woodcut that the general appearance of this indicator is similar to that of an indicator constructed to take diagrams as regards the steam cylinder and the drum, but that the pencil arm and parallel motion will be noted from the woodcut that the wheel stands normally at a certain deflection from the vertical, viz., about 85°, the object of which is to secure an accurate action between the contact surfaces and which is quite effectual, as will be seen from the subjoined trials of the instrument at the works of Messrs. Willans & Robinson, Rugby, on an engine of their usual type running at 350 revolutions per minute. It should be explained that although this permanent amount of deflection increases the amount of the record on the dial on the forward stroke by an amount proportional to the permanent initial inclination, the same amount of record due to the same cause is deducted by the return stroke, the difference being the actual amount of rotation of the wheel, which, owing to the mathematical conditions governing the instrument, is precisely proportional to the amount of steam pressure on the piston of the indicator during one revolution of the engine. There is, of course, no slip between the contact surfaces other than that due to the amount of inclination from the horizontal. The action of this indicator is, therefore, briefly that of a planimeter recording the areas of diagrams at every revolution of the engine, which a card

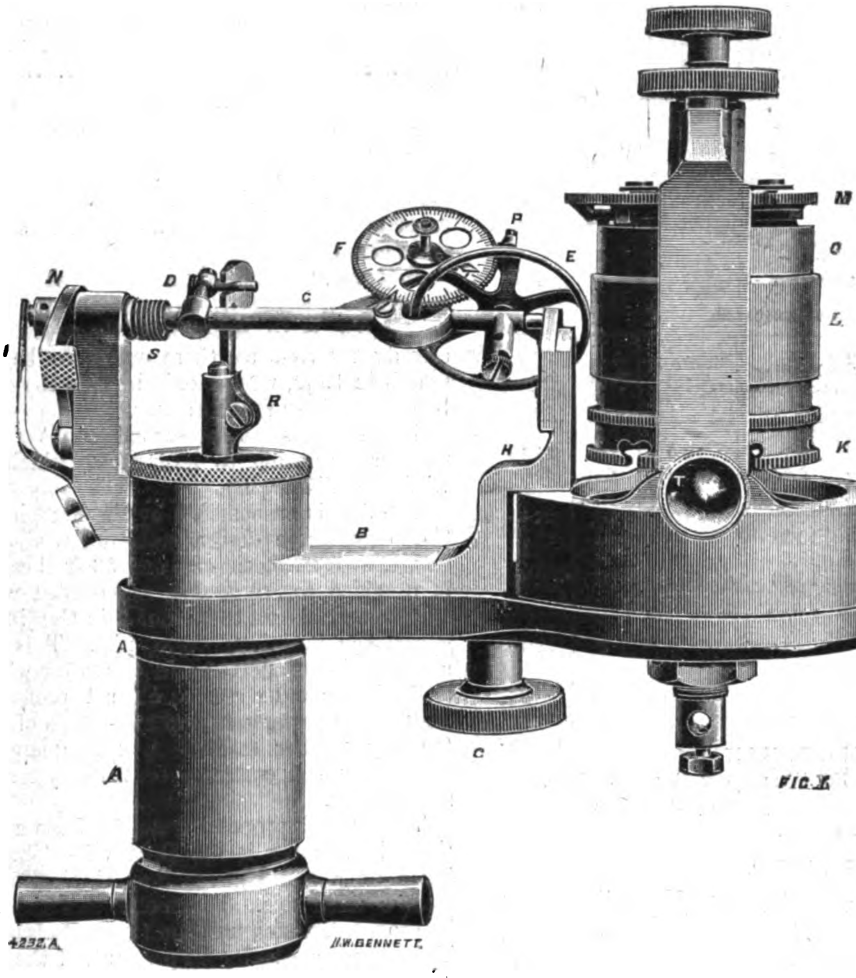


Fig. I.

are replaced by a device similar to the integrating mechanism of a planimeter, the wheel of which can be placed at will in contact with the drum in order to produce the desired rotary effect upon the wheel resulting from the combined action of steam pressure and piston speed, the requisite inclinations of the wheel being imparted to it by a simple sine motion of pin and slot as shown at D.

Since, therefore, the varying pressure of steam in the cylinder is made to produce the same amount of inclination of the wheel, as would be produced by tracing the actual diagram with the tracing point of a planimeter, it only remains to rotate the wheel by reciprocating the drum in contact with it, in order to produce the same result as if the drum (*i.e.*, indicator card), were held fixed and the diagram traced round with the point of the planimeter in the ordinary way. The amount of reciprocation of the drum (*i.e.*, length of diagram), is accurately measured to the second place of decimals by means of a simple device, M, actuated by the drum itself and which is quite easy of manipulation. It indicator would produce having the same piston area, the same piston spring, and a ratio of pencil movement to that of piston of six to one, the amount of reciprocation of drum being, of course, arranged to be the same for each.

For the calculation of H.P. by means of this instrument, the average area record per minute reduced to unit length by dividing by the amount of drum stroke if more or less than one inch was employed, is multiplied by a single figure composed of engine constants, &c., the result being the average H.P. per minute developed during the time the instrument was running. And for M.E.P. the unit area record per minute is divided by the revolutions per minute, which, in this case only, require to be known.

In cases, therefore, where a study of the steam distribution in the cylinder is not the object in view, but the actual efficiency of the engine, a knowledge of the latter can be much more accurately ascertained with the continuous indicator than by taking diagrams, and much labour in measuring them up is obviated, as also the necessity for counting revolutions. Moreover, where rapid changes of load are the rule, an accurate indication of H.P. is an impossibility with the ordinary indicator.

In electric light and traction installations it would seem that this form of power-meter should obtain for itself a wide sphere of application, as indications may be taken with it during a whole day or night, or at regular fixed intervals of working; no attention to it being required, unless it may be desired to take readings during the run, which is readily done even at high speeds, as shown in the table below:—

HIGH SPEED.

Test of Little's continuous indicator, made at the works of Messrs. Willans and Robinson, Ltd., Rugby, December 22nd, 1897, on a steady load, indications being taken simultaneously by a Crosby indicator. The two instruments were attached to the low-pressure cylinder of a large engine, running at 350 revolutions. The load was an electric one, and was kept constant by maintaining constant watts by means of an amperemeter and voltmeter in circuit.

CROSBY INDICATOR.

—	Diagram.	Planimeter.		Area.	Length	Scale	M.E.P.	Revs.
	O'clock.	Start.	Stop.					
1	4-12	0	·91	·91	2·1	50	21·67	350
2	4-0	·91	1·83	·92	2·1	50	21·91	
3	3-47	1·83	2·77	·94	2·1	50	22·38	
						3	65·96	
							21·986	

Crosby M.E.P., 21·986.

CONTINUOUS INDICATOR.

Time. Minutes.	Cumulative reading.	Reading per five minutes.	Reading per minute.	Stroke of drum. Inches.	Scale.	M.
5	50·5	50·5	10·1	1·09	80	21·18
10	102·2	51·7	10·34	1·09	80	21·68
15	154·5	52·3	10·46	1·09	80	21·93
20	208·5	54·0	10·8	1·09	80	21·65
25	260·2	51·7	10·34	1·09	80	21·68
30	313·2	53·0	10·6	1·09	80	22·23
35	366·0	52·8	10·56	1·09	80	22·14
					7	153·49
						21·927

Little M.E.P., 21·927.

For WILLANS & ROBINSON, LTD.

(Signed) P. A. LOW.

LOW SPEED.

Test of Little's continuous indicator, made at Messrs. Vicars, Sons and Maxim's Works, Erith, February 25th, 1898, on a large simple condensing engine, driving the machinery in their shops. Indications taken from one end of one cylinder simultaneously with a Crosby indicator.

CROSBY INDICATOR.

No.	Diagrams.	Areas.	Length.	Scale.	M.E.P.
	O'clock.				
1	3-55	1·74	3·02	50	Average, 28·1215
2	4-0	1·87	3·00	50	
3	4-5	1·87	3·02	50	
4	4-10	1·70	3·02	50	
5	4-15	1·68	3·02	50	
6	4-20	1·56	3·01	50	
7	4-25	1·61	3·02	50	
8	4-30	1·81	3·02	50	
9	4-35	1·52	3·02	50	
10	4-40	1·62	3·04	50	
	10	16·98	10 30·19		
		1·698	3·019		

Crosby M.E.P., 28·1215.

CONTINUOUS INDICATOR.

45 minutes' run:—Total reading, 195·6; stroke of drum, 2·95 inches; 100 spring; reading per minute, 4·3466; revolutions, 52·1.

$$\frac{4{\cdot}3466 \times 100 \times 10}{2{\cdot}95'' \times 52{\cdot}1} = 28{\cdot}27.$$

Little M.E.P., 28·27.

ELECTRIC TRACTION PROJECTS FOR THE 1900 PARIS EXHIBITION.

AT the last Paris Exhibition it will be remembered that the little Decauville light railway in the Exhibition grounds, proved not only a great convenience to visitors, but what is of quite as much consequence, it was entirely a success from a financial standpoint.

No less than 6,000,000 passengers were carried on this little pleasure line, whilst the receipts amounted to a sum of £70,000. This success might naturally have been expected when we consider that the line was inexpensively built for a summer's traffic under very favourable circumstances—the expenses stopping as soon as the receipts grew less, and the line not continuing for the winter, when sparse traffic (or none at all) prevents profits being earned.

The people of Paris are evidently much inclined to favour light lines of this kind, as anyone will believe on seeing the little horse cars running through the top of the Bois de Boulogne into the Jardin d'Acclimatation; and we are rather surprised that no serious efforts have yet been made to run these cars by electricity.

However, there is no hesitation being shown with regard to electric traction schemes for the approaching exhibition, and if one is to judge from the successful Decauville line already referred to, there ought to be a most profitable season in 1900, were it only because the extent of ground to be covered is so much greater.

The schemes at present brought forward are five in number (according to information which we abstract from *L'Energie Electrique*).

The first is propounded by the French Thomson-Houston Company, whose design embodies a single track of metre gauge, with 22 motor cars and 33 trail cars. One class only is provided for, somewhat in contrast with the usual first and second classes to be found in Continental tramcars, &c.—and the fare is uniform, 2½d. This company asks for a subvention of £60,000, in return for which the Exhibition authorities are to receive all net profits on carrying up to 15,000,000 passengers, and two-thirds of subsequent profits for any further traffic. A cash guarantee of £4,000 is offered by the company that its system shall be worked successfully.

The second proposal emanates from a syndicate of which the chief member is the Decauville Company. This also is based on a metre gauge line, single track, taking current from a third rail. Ten motor cars and 40 trail cars would be provided, with a uniform fare and class as in the last case. The company asks for 55 per cent. of the gross receipts after £72,000 has been taken.

The third scheme is put forward by Mons. Leon Francq, acting in conjunction with the Fives-Lille Company. This proposal embraces a double track of normal gauge, with three-car trains having each a seating capacity of from 180 to 200 passengers. Twenty motor cars and 40 trail cars would be provided—all one class and one fare, 3d.—but special reserved seats at 5d. might be arranged for. Mons. Francq estimates the capital outlay upon his plans, if carried out, at about £140,000, and any receipts over and above such a sum would fall to the exhibition authorities. No payment, however, would be made except on the carrying of more than 15,000,000 passengers. From this number to 20,000,000 the concessionaire would pay one centime on each ticket, and similarly two centimes should the numbers range between 20,000,000 and 25,000,000; three centimes from 25,000,000 to 30,000,000; and five centimes or one half-penny per ticket for all over that number. Evidently Mons. Francq is ambitious and thinks that increased capacity for traffic will ensure the traffic coming into existence.

The fourth system is due to one of the Paris electric lighting companies, which proposes a single track of metre gauge built generally on the Decauville principle, and employing 10 motor cars with 40 trailers. Two classes would be provided with corresponding fares of 5d. and 2½d. This concessionaire offers 20 per cent. of the gross receipts, and 25 per cent. of the net receipts after allowing for depreciation and 5 per cent. upon the expenses of erection and exploitation.

The last proposal—brought forward by Mons. de Mocomble—is supported by Mons. Henri Maréchal (the well-known Paris engineer) and the Compagnie Générale de Traction. It comprises practically two separate schemes, one an electric railway and the other a two-speed moving sidewalk somewhat after the fashion of those already suggested, or actually built, for Exhibition purposes, as at Chicago, &c. The railway is designed on the metre gauge, is single track, and provided with eight trains in service (three in reserve). Each train would have a seating capacity for 250 passengers, and would be operated by motors having an output of 140 H.P. A central rail would serve as current distributor.

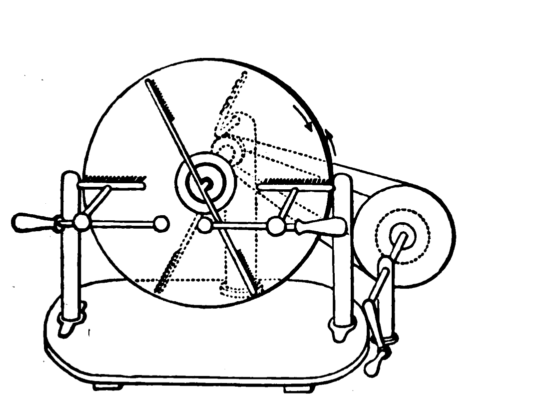
The "moving sidewalk" would run the opposite way round to the railway (it should, of course, be understood that all these proposals are for circular lines embracing practically the entire area of the Exhibition), and is built throughout on a viaduct after the fashion of the American elevated railways. It comprises a fixed platform approximately 3 feet wide, and two separate moving platforms, of which the first is about 2 feet 8 inches wide, running on a track of 18-inch gauge and maintaining a speed of about 3 miles per hour, whilst the second one has a width of about 5 feet 6 inches, with a track gauge of 3 feet, and runs at a speed of from 5½ to 6 miles an hour.

Our contemporary gives a very complete and interesting description of the working details of this moving sidewalk, and if the plans are adopted we shall hope to deal fully with the matter. At present it is sufficient to note that the power required to operate the combined arrangement is estimated to be about 472 H.P., and that nearly 40,000 passengers *per hour* can be dealt with.

HONOUR TO WHOM HONOUR IS DUE.

We read in a daily paper that Mr. James Wimshurst, inventor of the famous electrical influence machine, is one of the 15 men of science nominated by the Council of the Royal Society for election this year.

"The famous electrical influence machine" with which Mr. Wimshurst's name is associated was first described in *Engineering*, January 5th, 1883. On February 2nd in the same year a letter appeared in *Engineering* from Prof. Holtz, stating that the machine invented by Mr. Wimshurst had been invented by him (Holtz) in 1869. In one of the places cited by Holtz (*Pog. Ann.*, 136, p. 172), an influence machine is described, with an illustration, of which we subjoin a copy.



It will be seen from this figure that the machine consists of two glass discs driven by pulleys and belting in opposite directions. A neutralising rod with points for drawing off the electricity from the surface of the plate is set at a suitable angle opposite each disc. Collecting combs are placed in a horizontal diameter opposite the front disc.

Those who are acquainted with the Wimshurst machine will perceive that the only difference between it and the Holtz machine is in a few insignificant matters of detail. In the Wimshurst machine a number of radial strips of tinfoil are pasted on the surface of the discs. This makes the machine self-exciting. But Holtz pointed out in 1881 (Uppenborn's "Jour. of Prac. Elect." p. 199), that his machine could be made self-exciting by pasting tinfoil sectors on the face of the discs. He, however, considered that as the self-excitement could be obtained only at the price of loss of output, the tinfoil sectors were not to be recommended. Since Mr. Wimshurst's machine came before the public, more than one inventor has flattered himself that he has improved it by removing the tinfoil sectors. These ingenious inventors, unknowingly, no doubt, merely reverted to the original form of the machine as brought out by Holtz in 1869.

The second point of difference between the Wimshurst and the Holtz machine is in the collecting combs. In the Wimshurst machine the collecting combs are double, that is to say, there is one opposite the face of each disc. Now, Holtz states that he has tried the double collecting comb, and has found that it is not so good as the single comb.

Holtz may be wrong in both these matters of detail, but nobody could consider that it affects the principle of the invention one way or the other.

Mr. Wimshurst may have other claims to be elected a fellow of our leading scientific society, but it cannot be said that he has been elected because he is the first "inventor of the famous electrical influence machine." The scientific man often gets nothing for his discoveries except the honour of being the first discoverer, so there is all the more reason why the scientific public should see that honour is given where honour is due.

A NEW INTEGRATING MACHINE.

In another column will be found a description of Mr. W. G. Little's integrating steam engine indicator. This beautiful instrument is the latest addition to an interesting class of apparatus which has received much attention from mathematicians and mechanics in recent years. We suppose there are no problems of such entrancing interest as the construction of integrating machines to both the geometrician and the mechanic, while they exceed almost all other geometrical problems in immediate application to practical problems of surveying and engineering. The term integrator, in its widest sense, includes all the clocks which integrate time, the automatic coal weighing machines which integrate mass, the gas and water meters which integrate volume, the electrical motor meters which integrate the product of force and time, the chemical meters which integrate mass or volume according as they act by the weight of metal deposited or the volume of gas generated, as well as this indicator of Mr. Little's, which integrates the product of force and distance, *i.e.*, work. Integrators were in use when Alfred put candles in lanterns, and when Galileo and Huyghens applied the pendulum to clocks. Calculating machines, such as Babbage's and the Brunsviga, curve tracers, and tide predictors are not integrators, though they perform mathematical operations of an allied kind. The integrating machines which have occupied so much of the attention of mathematicians during the last 30 years, and perform such curiously complex operations, are all machines for calculating the properties of plane or developable curves, closed or periodic. The initial impulse was given to these designs by the invention of Prof. Amsler's well-known planimeter, largely used now for measuring areas on maps and engineer's drawings, and more commonly still on indicator cards. The use of a similar instrument for obtaining the volumes and moments of inertia of solid figures swept out by the rotation of closed curves about an axis is less generally known, but it suggests as possible an almost indefinite extension of the principle to other problems; the principle, *i.e.*, of counting the revolutions of a wheel rolled over a surface, the speed at which the wheel revolves depending on its movement over the surface, and the angle between its plane, and the direction of its motion. All the integrating machines that we know of, produced since that time, depend either on this principle of Amsler's, or on moving the wheel along a revolving cone. The latter plan is less elegant, geometrically speaking, and less elastic in its applications, but it has been useful in some cases. We may recall its employment in Siemens's steel wire slack percentage indicator, and within the last few months has been described a singularly complicated and inelegant application of it to a recording and integrating electrical instrument by Richard Fréres, in which the cone has its extreme form of a disc. But of integrating machines working on the same principle of Amsler's in some form a great variety have been proposed. In South Kensington Museum there are several models of rolling wheel and cylinder integrators designed by Mr. Vernon Boys. A very ingenious planimeter using a Peaucellier cell is due to Prof. Hele Shaw. The ergometer, or integrating transmission dynamometer of the Rev. F. Jarvis-Smith is probably the most perfect instrument of its kind yet designed, and Prof. Henrici's harmonic analyser made by Conradi, of Zurich, is a real triumph of mechanical design and construction. The list could be increased almost indefinitely. All these instruments, depending on the perfect rolling together of two bodies, suffer more or less from slip, and the error is apt to increase with the speed of the operation, and with the angle between the directions of motion of the two bodies at the contact point. Prof. Unwin's first letter to Mr. Little mentions his apprehension that the error due to this cause in the readings of the indicator might prove serious, but it seems clear that good workmanship and design have reduced the error to a very small amount, and it is probable that the indications of Mr. Little's instrument are at least as trustworthy as the figures obtained from a series of cards. The design would not have appeared to us to promise great accuracy; we should have looked rather to an instrument on the lines of the ergometer; but Mr. Little's figures are unexceptionable, and he has, without doubt, produced an extremely valuable instrument. It is unnecessary to point out the convenience of using such an indicator in prolonged steam trials, though it is probable that cards would be taken at intervals in addition as a check. We have no doubt that the instrument will be found in all laboratories and engine-testing rooms, and that its use will suggest to engineers other useful applications of integrating apparatus.

CORRESPONDENCE.

Electrolytic Refining of Lead.

I have just read the article on the electrolytic refining of lead that Mr. Sherard Cowper-Coles has published in the Electrical Review for April 22nd last.

As this article contains some criticisms relating to my process of electrolytic desilverisation of lead, I ask you to permit me to say a few words in answer thereto.

Firstly, in the numerous experiments that I have had occasion to make on different kinds of lead, I have never observed any deposit of peroxide of lead (Pb O_2), nor any other oxide on the anodes.

Secondly, the composition of the bath does not vary, for the acetic acid is not at all decomposed; and, in fact, during the passage of the current through the baths I have never detected the smallest escape of gas.

Here, then, are the well-established facts that everyone can test, and which are, however, in contradiction to the observations (which are, by the bye, very polite) that Mr. Sherard Cowper-Coles has addressed to me on the subject of my process of electrolytic desilverisation of argentiferous lead.

D. Tommasi.

Knots.

Some interesting correspondence on the subject of the *knot* has recently appeared in your journal. The term "knots per hour" has long been an abomination to many of us when used in the sense of "miles per hour." The excellently put protest against the use of "*knot*" for "nautical mile," which opened the correspondence alluded to, has been, I am confident, widely appreciated. I write to call your attention to analogies which ought to suffice to fix the meaning of *knot* to give it the meaning of "one nautical mile per hour." One analogy is the ampere, which expresses a rate of flow of electricity; another, is the watt, which expresses a rate of production or consumption of energy. Add to these the knot, expressing a rate of speed, the miner's inch, expressing a rate of flow of water, and a few others, horse-power, &c., and we have a group of practical units, whose analogy is interesting and instructive in, at least, one case, the ampere. Then just as a current of 10 amperes indicates a flow of 10 coulombs per second, so does a speed of 10 knots indicate a speed of 10 nautical miles per hour. But the ampere is not a coulomb, and the knot should never be treated as a nautical mile. A slight struggle against this misuse of the knot may be traced in our dictionaries—it is to be hoped that the misuse may vanish. But when we remember how many years were required to educate professional electricians out of the expression "one-hundred volt current," or "thousand volt current," we must not be too hopeful.

T. O'Conor Sloane.

New York, *May 7th.*

LEGAL.

Cooper v. The Electrical Installation Company and Another.

Rights of a Patentee under an Assignment.

Before the Court of Appeal, composed of Lords Justices A. L. Smith, Chitty, and Vaughan Williams, on Saturday, May 14th, the case of Cooper v. Electrical Installation Company, Limited, and another, came on for hearing. This was an appeal by the plaintiff from an order by Mr. Justice Darling in Chambers, in the Queen's Bench Division. Mr. E. W. Sinclair Cox was counsel for the appellant, and Mr. George Wallace for the respondents.

Mr. Sinclair Cox said the defendants in the action consisted of two companies, the Electrical Installation Company, Limited, and the O'Brien-Lennard Electrical Installation Company, Limited, and the order appealed from was an order striking out plaintiff's statement of claim in so far as it affected the O'Brien Company, on the ground that as against the O'Brien Company it disclosed no reasonable cause of action. The plaintiff, Mr. Henry Hayes Cooper, was the inventor of an electrical safety wall plug, and the patent was originally in the names of Cooper and the Electrical Installation Company. By agreement of July 19th, 1894, plaintiff assigned to the Electrical Installation Company his moiety of the patent.

Mr. Wallace: They were joint patentees in the first instance.

Mr. Sinclair Cox said that Cooper and the Electrical Installation Company entered into covenants under the agreement, for themselves and their respective representatives and assigns, by which the company was to pay to assignor Cooper royalties half-yearly in respect to each article manufactured under the patent by them or their licensees, to pay all stamp duties and fees for keeping up the patent, and to do all in their power to promote the manufacture and sale of articles manufactured under the patent, and the use of the invention in every possible way, and not to manufacture or apply any other invention which might supersede or tend to supersede the patent assigned. The deed also set out that the Electrical Installation Company and their assigns, should keep proper books in respect to manufacture and sale under the patent, plaintiff to have access to them. By his statement of claim the plaintiff said that the defendant O'Brien Electrical Company, Limited, became successors and assigns of the Electrical Installation Company, Limited; he said the defendants were guilty of breaches of covenant by omitting to pay certain royalties and stamp duties, and to keep proper books and accounts, and he claimed to be entitled to proceed against the O'Brien Electrical Company on the ground that they were the successors and assigns of the Electrical Installation Company.

Lord Justice Smith pointed out that there was no contract for the O'Brien Company to pay stamp duty.

Lord Justice Chitty: Though I covenant that myself, and assigns will do something, my assigns are not bound by my covenant—unless it is something connected with land.

Mr. Sinclair Cox said first there was this agreement with the Electrical Installation Company, then there was a license granted by the Electrical Installation Company to Messrs. Hodgson & Todd, then there was an assignment of the interest of the Electrical Installation Company to the O'Brien Electrical Company, who were not only their assigns but also their successors.

Lord Justice Chitty: What do you mean by successors, as distinct from assigns?

Mr. Sinclair Cox: In this way. They took over the whole of the undertaking of the Electrical Installation Company.

Lord Justice Chitty: That is to say, they were assigns.

Lord Justice Smith: All you can do is to produce a contract by the Electrical Installation Company that the other people will do certain things. That is not a contract with the other people.

Mr. Sinclair Cox: I produce a contract between the plaintiff and the defendant Electrical Installation Company "and their respective assigns."

Lord Justice Smith: How can that be?

Mr. Sinclair Cox pointed out that this was not a document by plaintiff or his assigns to pay a certain sum of money. It was an agreement by which plaintiff handed over his whole interest in a patent, so as to prevent himself from in any way being concerned with the manufacture of anything under the patent, and he not only did that in respect to the Electrical Installation Company, but in respect to their assigns.

Lord Justice Smith: Where is the contract between the O'Brien Company and you?

Mr. Sinclair Cox argued that the O'Brien Company became the successors of the whole undertaking of the Electrical Installation Company, which had disappeared into them, and he submitted that he was entitled to go against them.

Lord Justice Chitty: I was looking to see if there were any negative covenants, but there are none.

Mr. Sinclair Cox submitted that there were both affirmative and negative covenants. If he might cite a case——

Lord Justice Smith was curious to see a case in which, under these circumstances, the assignee was bound by the assignor's contract.

Mr. Sinclair Cox cited the case of Werderman v. Société Générale, but that case and the one before the Court their Lordships declared to be as different as two poles.

Lord Justice Smith: Have you any allegation in this statement of claim that the O'Brien Company took what they did take with notice of the contract?

Mr. Sinclair Cox: I say there is no direct statement of notice——

Lord Justice Smith: Then no direct notice is no notice at all.

Mr. Sinclair Cox argued that all he had to do was to show reasonable cause of action, and he alleged in the statement of claim facts from which it could reasonably be inferred that the O'Brien Company had notice of these conditions. They were successors of the original company.

Lord Justice Chitty: A phrase which I cannot for the life of me understand.

Lord Justice Vaughan Williams: Do you mean by successors that they were posterity?

Mr. Sinclair Cox said they described themselves as successors of the Electrical Installation Company, and that, he submitted, showed that they had notice of the conditions under which the Electrical Installation Company did their business, the whole of the liabilities of which they took over.

Lord Justice Smith: How can you come to a court of common law for breach of a contract between A and B which does not exist, and ask B to pay you damages?

Mr. Sinclair Cox: Because B holds the patent.

Lord Justice Chitty: If you are suing on the equitable ground of notice you ought to have stated it. Your explanation of them as successors, which I can hardly accept—it is very ingenious—you say involves notice?

Mr. Sinclair Cox said if they were successors, they succeeded to all the rights and liabilities of the company which they effaced, and amongst those liabilities was that in respect to the assignment of this patent. This case was not limited to damages for breach of contract.

Lord Justice Smith: The main part is for damages.

Mr. Sinclair Cox said the plaintiff asked for royalties due, for an account, and for a declaration that he was entitled to access to the books. If the O'Brien Company was struck out of the case, it would defeat the whole power of the plaintiff to protect himself, because the Electrical Installation Company was gone, and his rights in respect to the patent, which was now in possession of the O'Brien Company, had disappeared.

Lord Justice Smith delivered judgment, observing that the appeal must be dismissed. With any question of equity he had nothing to do; he took this statement of claim, and reading it according to its plain English, this was an action claiming damages against the two defendant companies for breach of contract. The O'Brien Company said to plaintiff, "Produce your contract that I have made with you." No such contract could be produced, because the O'Brien Company never did make a contract with the plaintiff, and the point taken was, that inasmuch as plaintiff was suing for damages he failed, because there was no contract between the O'Brien Company and himself. Plaintiff's contract was, that the Electrical Installation Company and its assigns would do certain things; and when a person entered into a contract of this nature "for himself and his assigns," his contract was that he or his assigns would do what he had contracted to do, and if his assigns did not do what he had contracted that they should do, then the cause of action was against the person contracting for himself or his assigns; it did not give cause of action against the assigns. It had been argued that plaintiff had title in equity on counsel's interpretation of "successors," as implying that the O'Brien Company had notice, and if plaintiff by amendment or alteration could make out another cause of action against the O'Brien Company, well and good; but at present he had not done so. In his judgment, the order that the O'Brien Company should be struck out of the claim should stand, plaintiff having leave to amend, this appeal being dismissed with costs.

Lord Justice Chitty was of the same opinion. Neither in law nor equity could a man covenant for his assigns so as to bring them by his covenant into his contract; there must be an independent contract between them. It might be that plaintiff might make out a case in equity by proving that the O'Brien Company had notice, but there was no allegation of notice in this claim; and if he intended to set up equity against the O'Brien Company, it ought to have been done in a manner which was not done in this case.

Lord Justice Vaughan Williams concurred, holding it to be a fatal defect in this claim that there was no allegation that the O'Brien Company took the assignment with notice of the antecedent agreement.

Lord Justice Smith observed that while this judgment held Mr. Justice Darling's order to be right and dismissed the appeal, if Mr. Justice Darling thought fit to grant plaintiff indulgence to amend he might do so.

Mr. Wallace said no question of amendment was raised in Chambers.

Mr. Sinclair Cox: I understand your Lordship to say I shall have leave to amend?

Lord Justice Smith: Yes; apply within seven days.

Colman v. Kempe.

On Saturday in the Queen's Bench Division, before Mr. Justice Day, sitting without a jury, the case was heard of Colman v. Kempe. This was an action brought by Mr. Alexander Colman against Mr. Harry Robert Kempe, to recover £98 4s. 2d., commission earned as advertisement agent in connection with the "Engineers' Year Book," of which publication the defendant was proprietor. The question turned upon the construction of a contract in writing made between the plaintiff and defendant in January, 1894, by which the plaintiff had been appointed sole advertisement agent of the defendant, the plaintiff contending that having been appointed sole agent he was entitled to receive commission on all advertisements sent to the "Engineers' Year Book," and the defendant contending that he was not entitled to receive commission on advertisements obtained by his employer without the plaintiff's intervention. It appeared in the course of the evidence that the plaintiff had issued a number of circulars for the purpose of obtaining advertisements, and it was upon the advertisements obtained through the medium of these circulars, amongst others, that he based his claim.

His Lordship gave judgment for the defendant. He said that the plaintiff, having been appointed sole agent, would have been entitled to resist the appointment of another agent, but that although sole agent he was not entitled to commission upon orders for advertisements received by the defendant without the intervention of the plaintiff. Judgment accordingly.

Mr. Cagney and Mr. Ritter were counsel for the plaintiff, while Mr. Bray, Q.C., and Mr. Hume Williams represented the defendant.

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending May 17th, 1897.

	£	s.
Alexandria	70	0
" Teleph. mat.	23	0
Amsterdam	30	0
Bilbao	25	0
" Teleg. mat. ...	21	0
Buenos Ayres	30	0
" Teleg. wire	407	0
Calcutta...	133	0
Cape Town	583	0
Cologne	480	0
Colombo	18	0
Copenhagen. Teleg. wire	12	0
Delagoa Bay	86	0
Durban	246	0
East London	121	0
Gothenburg	386	0
Hamburg	54	0
Malta	96	0
Marseilles	73	0
Melbourne. Teleg. mat.	85	0
Montreal	25	0
Rio Janeiro. Teleg. mat.	133	0
Rosario	212	0
Sandakan. Teleg. mat.	19	0
Sarawak. Teleg. mat.	15	0
St. Petersburg. Teleg. cable	214	0
Singapore. Teleg. mat.	69	0
Stockholm	58	0
Sydney	719	0
Vera Cruz	21	0
Total ...	£4,461	0

Week Ending May 17th, 1898.

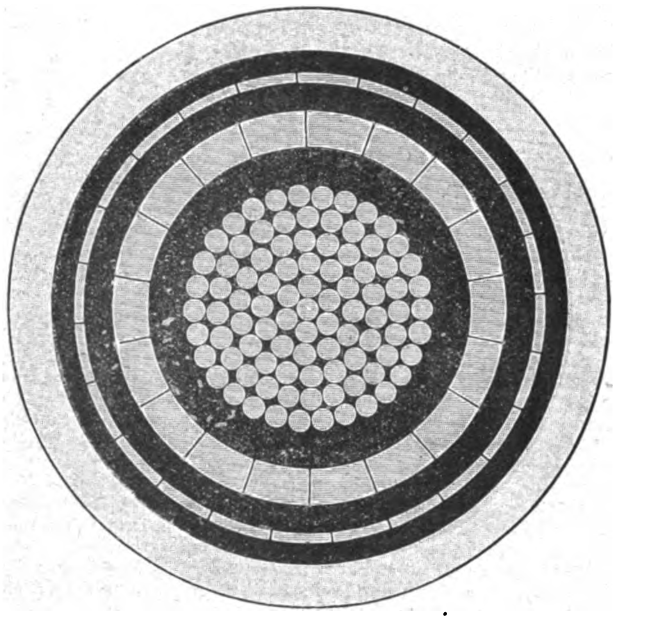
	£	s.
Berbice	11	0
Beira. Teleg. mat. ...	373	0
Bilbao. Teleg. mat. ...	400	0
Bombay	78	0
Boulogne	110	0
Brisbane	40	0
Buenos Ayres	380	0
" Teleg. mat.	65	0
Calcutta...	74	0
Cape Town	846	0
Copenhagen	15	0
Demerara	42	0
Durban	428	0
Flushing	36	0
Fremantle	39	0
Lisbon	2,310	0
Madras	9	0
Melbourne. Teleg. mat.	170	0
New York. Teleg. mat.	532	0
North Atlantic. Teleg. cable	11,520	0
Novorossisk	23	0
Penang. Teleg. mat. ...	356	0
Port Elizabeth... ...	250	0
Shanghai	393	0
Singapore	466	0
St. Petersburg	200	0
Sydney	44	0
Teneriffe	19	0
Townsville	14	0
Wellington	122	0
Yokohama	43	0
" Teleg. mat.	99	0
Total ...	£19,516	0

Foreign Goods Transhipped.

	£	s.		£	s.
Syracuse	27	0	Syracuse	105	0

Auction Sale.—Messrs. Percy Huddleston & Co. are to sell by auction seven tramway cars and a quantity of electrical plant, including dynamos, motors, arc, and incandescent lamps, carbons, switches, numerous fittings, cables, &c. See our "Official Notices" for particulars.

B. I. Cables for Glasgow.—The illustration shows the full size section of the triple cable recently supplied for Glasgow by the British Insulated Wire Company. This cable has a sectional area on each of the inner conductors of 1 square inch, the neutral or outer conductor having an area of ·3 square inch. The net weight of



the cable, exclusive of drums, is 45 tons per mile, and it is believed that this is the largest cable that has yet been built. The whole of it was tested at a pressure of 2,500 volts for 15 minutes before leaving the factory, and we understand that a sample of the cable was, in Mr. Chamen's presence, bent six times in opposite directions round a 3 feet barrel, and the insulation afterwards withstood successfully a pressure of 30,000 volts alternating for 10 minutes.

Books Received.—"Elementary Chemistry: Practical and Theoretical." (First year.) By T. A. Cheetham, F.C.S. Published by Blackie & Son, 50, Old Bailey. Science Hand-books Series. 1s. 6d.

"The Electric Wiring and Fittings Details Book." By W. Perren Maycock, M.I.E.E. Published by Whittaker & Co., London. 2s. 6d. net.

"Electro-Dynamics. The Direct Current Motor." By C. A. Carus Wilson. Longmans, Green & Co., Paternoster Row. 7s. 6d.

Catalogues and Lists.—Messrs. Dobsons & Curtis Bros., Limited, of Dublin, have issued a second edition of their illustrated catalogue of electric lighting supplies. The list includes a variety of electric lighting switches, wall plugs, cut-outs, and other fittings of that character, also lamps, brackets, pendants, &c. The firm has recently opened an electrical fittings showroom in Stephen's Green, Dublin, where a large varied stock of electric lighting fittings and supplies is kept. The firm makes a speciality of switch and distributing board work.

A splendid volume of several hundred pages has been issued by Messrs. Ernest Scott & Mountain, Limited, in which are bound together sections 1, 2, 3, 4, 5 and 10 of their catalogue. The electrical trade is well acquainted with the class of work made at the Close Works, Newcastle-on-Tyne, which is mainly in heavy electrical engineering plant and machinery. The compilers have aimed at making the book a useful work of reference for civil, consulting, and electrical engineers, shipbuilding firms, and buyers of machinery generally, and we think they have achieved their object. Section 1 is a useful collection of general information on several important points. It gives a comparison of the relative costs of gas and electricity, and some instructions by Mr. Mountain for fixing and working dynamo-electric machines; the notes for dynamo attendants as to current required for various sized lamps, loss in cables, &c., are sure to be of use. Section 2 is mainly devoted to the "Tyne" dynamo machines and combined engines and dynamos. Sections 3 and 4 are the more interesting, dealing with the electric transmission of power, and steam, gas, oil, and other motive power plants. In the former section are some general remarks regarding the application of electric motors to various industrial purposes, general instructions are given for ordering dynamos for these classes of work, and rules given for finding the power required to drive a dynamo, the power obtained from motors, the loss in volts in a cable, and the loss in watts in a cable. Electric pumping machinery, winding and haulage plant, cranes, hoists, portable drilling machines, coal cutting, ventilating and other machinery and apparatus driven by means of electric power are among the many items of interest in this excellent catalogue. There are numerous illustrations, and among these we particularly notice a full page group of eight 60-H.P. electric motors of special vertical type, which have been constructed by Messrs. Scott and Mountain for Messrs. Smith's Dock Company, Limited, of North Shields. Estimates appear for electric welding plants of several sizes. Section 4 describes steam engines and boilers, gas engines, oil engines, turbines, &c. Section 5 is devoted to arc lamps and accessories, projectors, accumulators, wires, and cables. Engineering specialities and machinery in general come in for treatment in Section 10, various types of steam engines, electrical and steam fans, pumps, condensers, combined engines and dynamos, being described and illustrated, and detailed accounts are also given of various colliery electric plants which have been installed by the firm during the past few years. These brief notes will suffice to give an idea of the vast amount of interesting matter which the book contains, and its service to electrical engineers and the others for whom it has been prepared is a foregone conclusion.

Messrs. Miller & Woods, of Gray's Inn Road, have issued a circular on electric signalling through space, describing their transmitter, receiver, and Tesla transformer for this purpose.

Church Lighting.—The contract for the electric lighting of the Trinity Church House, Great Portland Street, W., was placed in the hands of Mr. Leo Sunderland, of the Brush Electrical Engineering Company. The building contains a large public hall, with extensive gymnasium, class rooms, reading rooms, and residences for the clergy, and is wired for about 280 lamps. Mr. Sunderland has lately completed the lighting of St. Paul's Church, Clerkenwell; St. Paul's Church, Camden Square; the Church of the Smithfield Martyrs; St. Stephen's Church Room, East Putney.

The Edison and Swan United Electric Light Company have brought out a screw leaflet (No. 101) in which they show various screws, terminals, &c., manufactured at their Ponder's End works, where there has been put down special automatic stamping, piercing, and screwing plant. The list illustrates and gives prices per gross of binding screws and clamps and cable connections.

Electricity in Cork.—The contract for fitting the Cork Cold Storage Company's premises with electric motors, mentioned by us last week, has been given to the Cork branch of Messrs. Handley and Shanks, of Dublin. This factory, we understand, will be the first requiring over 100 effective horse-power to be driven entirely electrically in Ireland.

Fritsche's Motors.—Messrs. Wilhelm & Co., 11 and 12, Westmoreland Buildings, Aldersgate Street, E.C., have been appointed agents for the sale of Fritsche's electric motors for continuous current. They have issued a list of various types, starting at $\frac{1}{16}$ B.H.P., giving all necessary particulars and prices.

The Heilmann Company.—The Heilmann Company is about to be reconstituted and additional capital introduced.

Liquidation Notices.—A general meeting of the Thetford Electric Light and Power Company is to be held at the offices at Thetford on June 17th, at 12.30, to hear an account of the winding up from Mr. Lovewell Blake, liquidator.

A meeting of the Manchester Edison-Swan Company is to be held at the offices of Messrs. Needham, Parkinson, Slack & Needham, solicitors, 10, York Street, Manchester, on June 15th, at 12 o'clock, to hear an account of the winding up from the joint liquidators, Messrs. Gover & Sharples.

Creditors of the British Electrozone Corporation must send particulars of debts and claims to Mr. A. E. Edwards, liquidator, 8, Trafalgar Buildings, Northumberland Avenue, Charing Cross, W.C., by June 25th.

Machinery Users' Association.—We have received the report of this Association for the year ending March 31st, 1898, which was presented to the annual general meeting held at Westminster Palace Hotel on Wednesday. The report shows the work done during the year in the way of negotiation, legislation, and litigation for the furtherance of the objects of the Association.

Mavor & Coulson.—This firm have brought out a somewhat elaborate book of 60 pages, in which they describe at length, with the aid of some good illustrations, the various departments at their new works at Glasgow, which we have already illustrated in the Electrical Review. The arrangement of the matter and blocks is neatly done, and a thick glazed paper is a great advantage to the production.

Three-Phase Plant.—The Bristol Waggon and Carriage Works Company, Limited, of Bristol, have placed in the hands of Messrs. Thos. Richardson & Sons, of Hartlepool, a contract for putting down a three-phase plant for electric lighting and machine driving at their works. The aggregate power of the motors will be 230 horse-power, and for lighting the works there will be used 20 arcs and about 759 glow lamps. The power is at present generated by five Lancashire boilers, with an equal number of engines. By the adoption of electricity the economy in steam will, it is claimed, be such as to enable the whole of the power, including the lighting, to be supplied by one Lancashire boiler, while the total saving effected, after allowing for all charges, will be considerably over £1,000 per annum. Notwithstanding this saving in steam power, it is anticipated that the present machinery, with the improved driving arrangements, will produce from 10 to 20 per cent. more work. The generators and motors will be supplied by Messrs. Richardson, of Hartlepool. The boiler will be fitted with a Bennis automatic stoker and Green's economiser, while a Bennis automatic damper regulator will be provided in the main flue. The engine will have horizontal compound side-by-side cylinders, and in order to provide spare power for extension it will be capable of developing a maximum of 400 indicated horse-power. This contract has been placed in the hands of Messrs. Geipel & Lange, London, who are Messrs. Richardson's agents.

Wireless Telegraphy.—The first installation of Marconi's wireless telegraph system in Ireland for business purposes was made at Clara, King's County, last week, at Messrs. Goodbody's factories, the transmitter being placed at their flour factory and the receiver at their jute works, a mile away. It is reported to have worked most successfully.

ELECTRIC LIGHTING NOTES.

Alderley Edge.—An early start is to be made with the construction of the electricity works at Belmont, and it is expected that current will be available before the end of the year. The plant to be put down will supply 5,000 8-C.P. lamps, and the three-wire continuous current system, with feeders, is to be adopted. The mains will first be laid along London Road and Macclesfield Road to Underwood Road, meeting others laid in Woodbrook Road, and continuing to Rookwood, Trafford Road, Hey's Lane, Wilmslow Road, and Brook Lane.

Amblecote.—The District Council having been requested to join the Kingswinford Council in getting a provisional order for the electric lighting of the district, has resolved not to withdraw its opposition to the application of the Kingswinford Rural District Council for lighting powers so far as Amblecote is concerned.

Bangor.—The City Council has resolved upon the extension of the electric lighting scheme to Upper Bangor, and to amend the application already made to the Local Government Board for sanction to borrow an additional £3,500 for this purpose.

Barnsley.—The Council adopted the electric lighting scheme proposed by Mr. Miller, on Tuesday last week. Mr. Miller's report recommended the three-wire direct current system, with 230 volts at consumers' terminals. This system, he mentions, would also be suitable for electric traction, if adopted. The plant proposed would supply current to 6,000 8-C.P. lamps, and will comprise three Lancashire boilers 7 feet 6 inches by 28 feet, working at a pressure of 160 lbs. per square inch, and one economiser having 192 pipes; three sets of 125 I.H.P. steam engines, each coupled to a shunt-wound dynamo of 75 kw. capacity. There will be two batteries of accumulators, each consisting of 125 cells, and having a capacity of 500 ampere-hours; and there will be two transformers to raise the pressure for charging from the station 'bus bars. Two balancing transformers will regulate the pressure on the two sides of the three-wire system. The site for station is situated at the Town's Yard. The total cost is estimated at £23,322. The capacity of the plant could be doubled by an outlay of another £2,000 on plant and £500 on buildings. For public lighting it is proposed to employ 10-ampere arc lamps for lighting the main streets, and incandescents for the smaller streets. There would be 35 arc lamps, complete with cables, &c., to cost £45 each, and 30 incandescents at £4 per lamp, the total cost being £1,695. The maintenance and interest and repayment total out at £2,820 per annum. The revenue is estimated at £3,000. 7d. per unit will be charged for the first hour, and 3d. after.

Belfast.—The Electric Committee recommends the adoption of the Wright charging system, 7d. to be charged for the first hour and a half, and 2d. afterwards; power will be 4d. and 1½d. per unit on the same conditions. The matter comes before the Council in June.

Birmingham.—It is stated that the General Purposes Committee and the Birmingham Electric Supply Company have arranged terms for the purchase of the company's plant and business by the Corporation. The conditions have yet to be submitted to the Council and to the company's shareholders. The matter has been in the hands of a Committee for the past 12 months. The Birmingham *Mail* says that the terms of purchase are on the basis of £10 10s. per £5 share, which is about their actual Stock Exchange quotation, and but little, if at all, in excess of the market value of a gilt-edged and improving 5 per cent. security. On these terms, if they are accepted, there can be no question that the Corporation would secure a bargain for the ratepayers, seeing that the company's dividend is an advancing one, and that the needful money can be raised for considerably less than 3 per cent. For 1891, the first year of the company's existence, the net profit earned was only £361. For 1892 a dividend of 3½ per cent. was paid. For each of the three following years the distribution was at the rate of 4 per cent. For 1896 it was raised to 4½ per cent., and last year's dividend was at the rate of 5 per cent., with a balance of £1,042 carried forward. The capital expended on works to the end of last year was £215,050, in addition to £4,027 spent in obtaining Parliamentary provisional orders, and the total assets were valued at £244,504. At the annual meeting, in March last, the directors were authorised to raise the capital of the company to £300,000, by the creation of 20,000 additional ordinary shares of £5 each, but it was understood that nothing would be done in the matter until the issue of the negotiations with the Corporation was known.

In regard to the above statement, the Lord Mayor at Monday's meeting of the General Purposes Committee made it clear that *no* provisional agreement had been entered into with the company. It is understood that Mr. Harris (of Bramwell & Harris) has not yet officially submitted the results of his investigations as to the position of the company. It is expected, however, that the matter will be ripe by the middle of next week, and may come before the City Council at the June meeting.

Bournemouth.—The Town Council have under consideration the appointment of an electrical inspector, but are deferring it until their installation for lighting the pier and gardens is laid. Messrs. Cash & Co., who tendered for this work, having notified that their tender would be increased, and the Electric Light Company declining to do the work as the Council proposed to generate their own supply, the Town Council on Wednesday (May 18th) decided to advertise for fresh tenders.

Bradford.—It has been resolved to light the Bolton Road tramway route from Foster Square to Peel Park Gates, and the Horton route from the bottom of Morley Street to Laisteridge Lane, by electricity—a total of 40 arc lamps being placed upon the poles to be erected for carrying the electric cable for working the tramways, the total estimated actual cost of this lighting being £500 per annum.

Bridlington.—On Saturday night last there was a trial of the new electric light installation on the New Spa, and the whole length of the promenade will in future be lighted by electricity.

Bromley.—Mr. W. A. Dickinson has written to the District Council on behalf of the ratepayers and inhabitants of Bromley, to strenuously protest against the proposed erection of electricity works, with chimney shaft 120 feet high, in the centre of the town.

Camberwell.—The General Purposes Committee reported at last week's Vestry meeting that the Board of Trade had conditionally approved the alternating current system of the County of London Electric Lighting Company, and to the use of an earth connection on the system of mains on the extra high pressure system.

Cardiff.—The Corporation is giving public notice that next month it will apply to the Board of Trade for permission to alter the standard pressure at which energy is supplied. No change will be made in the supply to premises which have used current since March 4th, 1596, without the consent of the consumer.

Clonakilty.—The Town Council is of opinion that there should be some improvement in the lighting of the town—oil lamps are now used—and electric lighting is favoured. The Council has been in communication with Messrs. Handley & Shanks, electrical engineers, of Cork, who put forward a scheme estimated to cost £2,750. The Council has appointed a committee to inquire into the subject.

Cork.—The governors of the Cork District Lunatic Asylum held a special meeting the other day to consider the question of lighting the Asylum by electricity. Reports on the subject had already been received from two experts, and a detailed scheme submitted by the Cork Electric Tramway and Lighting Company. The company went very closely into the present gas lighting system and compared it with the electric lighting proposals put forward by them, showing the advantages of the latter. After a very lengthy discussion the governors resolved that it would be unwise to enter on this matter at present. The total cost per annum to replace the present lighting, including all renewals, was put at £561 odd. To run three 30-inch fans, each with a 2-H P. motor, the total yearly cost is estimated at £132.

Cromer.—At the last Council meeting the clerk submitted *précis* of Mr. Gibbon's letter of March 24th, with the draft agreements and scheme as to electric lighting. After discussion, the surveyor was directed to report as to the cost of necessary works for establishing an electric light installation in the town.

Derby.—The Derby School Board contemplate introducing the electric light in some of the public schools of the borough, and at the meeting of that body on Monday afternoon a discussion took place as to the advisability of adopting the new illuminant in place of gas, and tenders were received for wiring the Traffic Street Schools, these ranging from £474 downwards. It was pointed out that the matter was proposed as an experiment, and on the ground that there was no immediate hurry, as the summer was coming on, it was resolved that the question be postponed. The chairman expressed the opinion that the experiment should be tried upon the new Orchard Street Schools.

Douglas.—Prof. Fleming, who has been consulted by the Corporation, recently visited the island, obtaining information on which to base his electric lighting report.

Durham.—Although the City Council at its last meeting apparently shelved the question of introducing electric light into the city on account of the satisfactory reports given in respect of several trial incandescent gas burners, those interested in the matter are keeping the agitation alive. Alderman Jepson, M.D, one of the leading spirits of the Council, has ascertained from Messrs. Edmundsons, of London, that street lighting in the city, which now costs £3 per lamp per annum, can be done cheaper by electricity, and that the firm are willing to introduce into any agreement that might be drawn up between them and the Council, a purchase clause. Alderman Jepson is taking steps to arrange a public meeting for the purpose of hearing an address from an electrical expert, and he hopes, by making plain the advantages of electric light, both as regards efficiency and cost, to bring about its introduction into the city at no distant date.

Folkestone.—The Lighting Committee estimate that an additional £1,500 will be required this year to pay for the extra cost of lighting the streets by electric light.

Germany.—A new central station has just been completed and put in operation at Wiesbaden. The plant, which has a capacity of 11,000 incandescent lamps, has been established by Messrs. W. A. Lahmeyer & Co., Frankfort-on-the-Main.

Glasgow.—The collection of electricity rents to date amounts to £30,386, an increase of £5,661 over the corresponding period of last year.

Glasgow.—A Sub-committee of the Corporation Electricity Committee has been appointed to confer with the Partick authorities regarding the proposal that the city should exercise the burgh's powers under its provisional order, and supply the burghal area with electric light. Negotiations are still proceeding with reference to the Clyde Trust's request for a rate, and a large engineering company have asked for a rate for about 600 horse-power to drive a portion of their machinery.

Hammersmith.—The Vestry's installation has been supplying current for private lighting for just over nine months, and for public lighting about six months, and the chief engineer now reports that up to the present time an average price of only 4½d. per unit has been received from private consumers, being the lowest obtained by any London municipal authority whose accounts have been published. The charge to the lighting rate is only £22 10s. per lamp per annum, as against about £40 per lamp per annum obtained by other authorities.

Hanley.—The Town Council is reducing the charge for electric motive power to 2½d. per unit for four hours per day, and 1d. per hour afterwards. The engineer is to approach the authorities of Stoke and Burslem with a view to ascertaining if they are willing to take electric current from Hanley in lieu of erecting separate stations for themselves.

Hove.—The Hove Electric Lighting Company having announced their intention of laying certain new mains, a member of the Council at its last meeting endeavoured to raise the question of the purchase of the electricity works by the town. Would it not be better, he asked, to purchase now, than wait till these mains had been laid down, and the cost had consequently increased? He was ruled out of order as the matter was not on the agenda, but there is little doubt that Hove will, before long, purchase the electricity works for the town.

Hull.—At a meeting of the Electric Lighting Committee on 13th inst., the chairman (Mr. Skinner) in presenting the annual accounts said that they commenced the year with the carrying out of a large extension of the electric system to the west and the northward, estimated to cost £40,690, for which they had borrowing powers. These works were well in hand, the buildings were nearing completion, and the equipment was proceeding with due despatch, and in a very short time they hoped to be able to put to use this latest addition to the enterprise and energy of the Corporation. During the year they had had, with scarcely an exception, a continuance of the support so largely given to them before, supplemented by 134 new users, and 65 old customers who had increased their lighting, while many of the new customers required a very large supply. No accident or serious breakdown had occurred during the year. The total working costs were slightly in advance of last year, but this was more than accounted for by the increase in salaries and wages, by a heavy rateable charge, and by the necessity cast upon them of providing a supplementary plant to keep pace with the demands for current. The temporary works, erected in North Street for this purpose, had cost a sum of about £900, all of which had been charged to revenue account as repairs and maintenance. At the close of the financial year they reduced the charge for motive power. The total expenditure on capital account now amounted to £61,738, of which £14,153 had been spent during the year under consideration. The total received for the 12 months was £10,453, and the expenditure £5,450, leaving a balance of £5,003, out of which, after paying £1,496 interest on loans, and £1,457 contribution to sinking fund, the committee were left with a net profit of £2,040 for the year, to be carried to reserve. The increased demand being made for the current, even at this season, and the pledge made to the residents of East Hull, made it necessary that they should take in hand very shortly a further extension, and this was accentuated by the difficulty in obtaining electrical machinery quickly. The electrical engineer submitted an analysis of the works' costs during the 12 months ended March 31st, together with a comparison for the three previous years, as under:—

	Units sold.	Works' costs.	Rents, rates, &c.	Management expenses.	Total per unit.
		d.	d.	d.	d.
1894-5 ...	163,857	2·09	0 21	0 56	2 86
1895-6 ...	246,277	1·95	0·14	0·61	2 70
1896-7 ...	340,439	1·62	0·15	0·54	2·31
1897-8 ...	467,352	1·63	0·38	0·57	2 57

The committee regarded the reports as very satisfactory. The electrical engineer submitted a report, in which he recommended a further extension of the generating plant for the purposes of extending the electric light to East Hull. The engineer reported that on March 31st last the lamps actually connected to the mains were equivalent to 43,534 8-C.P.; applications to be connected with present mains, 17,666 lamps; and on the east side of the river Hull applications for 2,520—in all 53,720 lamps, against which the present capacity of supply is 36,666 lamps. Application to the Local Government Board had been made for sanction to borrow £10,000 for the extension to East Hull, but the sanction had been temporarily withheld till full details of the scheme should be submitted. The engineer urged that the time had now arrived to pursue the matter, and to consider the question of laying down additional mains, and he recommended a scheme modified from that of 1896. With regard to the sub-station, instead of placing it on the Holderness Road, as he formerly proposed to do, he recommended that it be placed as near as possible to the North Bridge on the west side of the river, so that the cables crossing the river should carry low tension current only, the cables to be laid side by side with the tramway feeder cables. The engineer's report also fully dealt with the details, and concluded by stating that the sum of £10,000 applied for would not be sufficient to cover the cost of the extensions now recommended, and that £26,000 would be needed. The report was received and adopted, and a resolution carried to apply to the Local Government Board for borrowing powers to the extent suggested.

Hyde.—The Council has appointed Messrs. Lacey, Clirehugh & Sillar as consulting electrical engineers.

Ipswich.—Last Friday the Board of Guardians had a long discussion regarding the scheme for electrically lighting the new workhouse. Tenders were sent in by Messrs. Laing, Wharton and Down, who quoted £3 583; Edmundson's Electricity Corporation, £3,208; and Crompton & Co., who quoted £3,035, less £220, if boilers made by Messrs. Taylor & Sons are supplied. The Committee had recommended that Messrs. Crompton's tender with Taylor's boilers be accepted. After discussion the matter was referred back, several speakers considering the outlay too heavy for them.

Keswick.—The *London Gazette* contains notice of the intention of the Urban District Council to transfer their 1896 electric lighting order to the Keswick Electric Lighting Company, Limited, for a period of 42 years. The company pays £520 for the order.

King's Norton.—The District Council's provisional order was passed by the Chairman of Committees in the Commons last week.

Lambeth.—The Vestry has approved of the plans of the generating station buildings to be erected by the South London Electric Supply Corporation.

Marylebone.—The Marylebone Vestry have agreed to let the Metropolitan Electric Supply Company lay a cast-iron conduit from their station in South Street, Manchester Square, to their station in Rathbone Place, according to a route prepared by the Vestry's surveyor, which is a diversion of that proposed by the company's engineer.

Matlock Bath.—The District Council decided last week to oppose the General Power Distributing Company's Bill.

Morecambe.—At the monthly meeting of the Morecambe District Council on May 9th, the manner in which the contract for the installation of electric light has been carried out was again referred to. Mr. Parkinson read a report of his recent visit to Colchester to test the first two sets of engines. He submitted the engines to a four hours' run and found one set satisfactory, so far as speed efficiency went. The other one he found required 440 revolutions per minute instead of 400 in order to obtain the full output. There were a number of details which he refused to pass, and gave orders for them to be remedied. He was of the opinion that the sets were smaller than those which had been ordered. He would recommend the Council to take the lesser dynamos from Mr. Parker with an abatement on each set, say, of £200. Mr. Parkinson said he would not like to promise definitely for Whit week, but if they got the two sets of engines last week they would be able to light 50 lamps for that time. In committee it was afterwards resolved that Mr. Parkinson, electrical engineer, test the steam dynamos up to the specified speed, and that he report the result to Messrs. Parker, Limited, and the Electric Light Committee. The tender of Messrs. J. Ash & Son, of Birmingham, for the construction of a tank at the electric light works was accepted. It was resolved that Mr. Parkinson write to Mr. Parker urging him to come over at once to meet the Council to discuss the question of the flue, as the matter was assuming a very serious aspect.

Newport.—At a recent meeting of the Electricity Committee, the consulting engineer, Mr. Robert Hammond, submitted a lengthy report upon the question of extending the low tension mains and the construction of sub-stations in Commercial Road. At the present time this district is served as follows:—(*a*) From Hill Street to Cardiff Road by the low tension network of small capacity, fed by three isolated underground transformers, this being the usual pioneer system. (*b*) From Cardiff Road to Constable's Lane direct from the high tension mains, the high tension being converted into low tension on the premises of the consumer. Mr. Hammond says that the policy that is generally adopted in connection with the system in use at Newport, is wherever the load shows signs of density, to replace isolated transformers with larger size transformers fixed in sub-stations and feeding on to a low tension network stretching about a quarter of a mile in each direction. Under this system the amount of electricity lost in conversion from high tension to low tension is minimised, as the larger the transformers the more efficient they are. As the demand is likely to be considerable in this part of this district, it is absolutely necessary that the distribution system should be put upon such a basis as to cope with a large number of lights, and the sooner this is done the more economically and efficiently that district will be served. The distance being one mile it would be impossible, without an immense expenditure in copper, to deal with it by low tension from one sub-station, and it is therefore necessary to feed from two sub-stations. Sites have been found for these in Cardiff Road and Albion Street. Mains capable of dealing with a load many times that now obtaining have been included, and it is also proposed at the same time to lay two new feeders from the generating station to the new sub-stations. Mr. Hammond recommended that the order for the cables be given to Messrs. W. T. Glover & Co. The recently sanctioned mains extensions include high tension service mains in Alexandra Road, which would be connected up to, and fed by, the existing high tension feeders above mentioned. These will continue to do good service in the more distant district. Mr. Hammond has considered the possibility of drawing the new feeders into the 3-inch pipes already carrying one high tension feeder and one a main each; but fears such a course would lead to the almost certain destruction of the present mains, and has therefore allowed for the new mains to be laid quite independently, and on the solid system. Estimated cost of proposed extension of sub-station system and low tension distribution in Commercial Road:—Cardiff Road sub-station:—Distributors with trenching, £1,300; brick boxes, £50; altering services, £50; feeder (with trenching beyond L.T. main), £280; sub-station equipped, £800; extra feeder panel at sub-station, £40 = £2,520. Albion Street sub-station:—Distributors with trenching, £965; brick boxes, £25; altering services, £100; feeder (without any trenching), £360; station equipped, £675; extra feeder panel at station, £40 = £2,165; plans, engineering fees, contingencies, &c., £315 = £5,000. It was resolved that the report be received and adopted, and that the work which, with contingencies, is estimated to cost £5,000, be carried out as extras to the contracts of Messrs. Glover & Co. and the Electric Construction Company. In due course the committee's report came before the monthly Council meeting this week, and it was adopted. Although the electric light was only installed in 1895, it has already been found necessary to spend £30,000 in extensions, and the £5,000 authorised above will be an addition to the £30,000.

Paddington.—The Board of Guardians has referred it to the visiting committee to consider and report as to the advisability of providing the necessary electric lighting plant, &c., for the electric lighting of the workhouse and infirmary.

Pemberton.—The District Council has appointed an Electric Lighting Committee to inquire into the subject.

Peterborough.—The Town Council last Friday had a discussion *re* the appointment of an engineer in connection with the electric light undertaking. There was a proposal that Mr. J. C. Gill, C.E., who seems to hold the positions of water-works engineer and superintendent of the fire brigade, be paid an extra £50 per annum to look after the electric lighting undertaking until a profit is earned. This, however, was not passed, a counter-proposition to the effect that £100 per annum be the salary, being carried by 10 votes to five. The Council some time ago retained Dr. Fleming as consultant, and he is to continue in that capacity.

Pietermaritzburg.—Customers are applying for current in earnest now; already there are over 1,100 lamps connected to the old plant, and over 1,700 lamps ready for connection to the new plant, which is expected to be started in June. Messrs. Mowat & Still are very busy, having over 800 lamps of 8 C.P. already erected. They are also erecting 100 temporary lights and complete steam plant for the forthcoming Agricultural Show in May Week, and they have erected two very handsome arc lamp columns outside the Legislative Assembly, one on either side of Her Majesty's Statue, with the requisite underground piping and mains, and connected the Legislative Assembly with the Corporation transformer sub-station by means of a lengthy concentric armoured cable of large size. Other contractors are equally busy, and prospects for the industry look bright. The borough electrical engineer has adopted a very good and fair set of wiring rules, which ensures good work being done, and the best of materials being used, a strong contrast to other towns in South Africa, especially Johannesburg.

Poplar.—The Electric Light Committee's action in advertising for a resident electrical engineer to devise and supervise an electric lighting scheme, was approved by the Board of Works last week.

Portsmouth.—The Electric Lighting Committee proposes to borrow £5,000 for laying mains in additional thoroughfares. A committee is considering the desirability of electrically lighting St. Jude's Church, Southsea.

Mr. H. G. Burr has been appointed clerk of works for the extension of the electricity station. A building adjoining the station has been purchased for £325.

Provisional Orders.—The Bill to confirm provisional orders made by the Board of Trade relating to the burghs of Hamilton, Airdrie, Brechin, and Rothesay passed the Committee on Unopposed Bills on Wednesday last week.

On Monday the Bill to confirm the Bermondsey and Marylebone Provisional Orders was read a first time in the Commons.

A Bill has been introduced to confirm provisional orders made by the Board of Trade under the Electric Lighting Acts relating to Chelmsford, Melton Mowbray, Norwich (Extension), Preston (Extensions), and Warrington.

Radcliffe.—Mr. F. F. Bennett, consulting engineer, of Manchester, has been instructed to advise the Radcliffe Urban District Council on electric lighting, and to attend the Local Government inquiry.

Railway Train Lighting.—The question of train lighting recently occupied the attention of the South Indian Railway Company, and the matter was referred to the company's consulting engineer in London, Sir George Bruce, who advises the equipment of mail trains running between Madras and Tuticorin as a tentative measure, the equipment of the whole service to be decided by the result of the experiment.

Reigate.—Last week the Town Council held a special meeting to consider the minutes of the Electric Lighting Committee. Prof. S. P. Thompson was, on March 28th, engaged to advise the Council on the electric lighting question, and on April 25th the report was submitted, in which the Professor referred to the report prepared by Mr. Medhurst in November, 1895, and after considering the requirements of Reigate and Redhill at considerable length, he expresses the opinion that Mr. Medhurst's scheme was a well-advised one. On May 4th it was resolved to instruct Mr. Medhurst to prepare plans and specifications for the installation on the lines of his previous report, with certain modifications recommended by Prof. Thompson, and to ask him to state his terms. It was further decided to ask Prof. Thompson whether the sites of the Reigate and Redhill gas works, which the Council is thinking of purchasing, would be of any use as sites for electricity works. At last week's Council meeting Mr. Medhurst's terms were considered and accepted.

Ryde.—In officially announcing that the Board of Trade have refused an application to form an electric light and power company in this town, the Mayor, at a meeting of the Council last week, said that on consideration of what had transpired at the public inquiry it was his intention to call a public meeting to consider the matter, and decide what steps should be taken.

Salford.—On Wednesday the Salford County Borough Council considered a resolution of the Electric Light Committee, adopting the plans of Mr. John Holt, for the erection of a new generating station on land in Strawberry Road, at an estimated cost of £28,161.

Shoreditch.—At the Vestry meeting on Tuesday it was resolved, at the suggestion of the London County Council, to amend the application for a loan of £15,700 for electric lighting purposes to £16,537, so as to bring the expenditure up to March 25th, 1898. Mr. A. J. Hazell submitted the report of the Valuation List Committee with regard to the rating of the electricity works and the refuse destructor. The committee had considered a report from Mr. Mansfield Robinson (the Vestry Clerk) on the subject, and had resolved to calculate the rateable value at a 3 per cent. basis on the cost of the land and buildings, in accordance with the decision of the House of Lords in the case of the London County Council *v.* Erith. The Vestry approved this, and resolved to apportion half of the rateable value to the electric light undertaking, and half to the refuse destructor. Mr. H. E. Kershaw, who submitted the report and accounts of the Electric Lighting Committee, stated that the Vestry was to be heartily congratulated on the magnificent success during the past nine months in the sale of electricity. With regard to the wiring department there had been a loss of £158; but that branch had answered its purpose of counteracting some of the unsatisfactory practices pursued by some contractors. The results obtained were phenomenal in the history of any electric light undertaking for a period of nine months, since the gross profits amounted to £4,264, which sum, in the case of a company, would be equivalent to a dividend of 6½ per cent. After providing for redemption of capital and payment of interest, there remained a net profit of £2,072, which left a surplus of £700, after paying off the contribution from the rate. In conclusion, Mr. Kershaw mentioned that the committee had resolved to wait for 12 months before entering into the question of the cost of refuse destruction, since it would be unfair to consider the cost on anything less than a year's basis. Mr. Winkler complained of the accounts of the dust destructor not being included in those presented to the meeting, the speaker contending that the two sections of the undertaking should not be separated from each other. Nothing had been provided in the accounts for depreciation and for other items, and in his opinion the working of the refuse destructor was being carried on at a loss. Where would the surplus be at the end of the year? It would be cheaper to use coal for steam-raising purposes and to shut down the refuse destructor. He therefore moved, and it was seconded, that the accounts should be referred back in order that Mr. Adams (the accountant) might prepare a balance-sheet of the income and expenditure of the refuse destructor and electric lighting works jointly. The chairman (Mr. Wakeling) pointed out the impossibility, from a legal standpoint, of a joint report being prepared, and at his suggestion the amendment was altered in favour of a balance-sheet for the refuse destructor only being got out. Other speakers having followed, Mr. Kershaw replied to the criticisms at some length. On the amendment being put to the meeting, no votes were recorded, and eventually the report and accounts were passed.

Southampton.—The Council has resolved, upon the recommendation of the electrical engineer, that when the total number of units consumed by one consumer in any one year for lighting exceeds 30,000, the maximum charge be 5d. per unit instead of 6d. The electrical engineer recently reported that the number of units metered at the works during April was 17,468, an increase of 6,780, or 63 per cent. over the output for April, 1897; and that on April 21st the supply to the electric cranes had to be shut off for a few minutes owing to a slight accident to one of the temporary engines. During Mr. Manville's absence abroad Mr. Aldridge will look after the laying of the mains. Alderman Bone said at last week's Council meeting that the making good of the damage done by the recent accident at the works would be much less than was at first thought. With regard to the proposed alterations in charges, the Committee thought it was their duty to encourage large consumers, and they hoped that they would get one or two very large customers in consequence of the reduction.

Stafford.—The annual report of the Gas and Electricity Committee shows that during the financial year ended March 31st there was an increased amount of business in both spheres of its operations. In the electricity department the increase in the sale of current was very marked. There were now the equivalent of 6,200 8-C.P. lamps connected, as against 5,003 last year, and the current sold was 55,542 B.T.U., an increase of no less than 27 per cent., but the low tariff of charges fixed last May seriously affected the revenue. The sale of current amounted to £1,202 13s. 6d., as against £1,162 1s. 10d. last year, being an increase of £40 11s. 8d., or only 3½ per cent. The total receipts were £1,292 12s. 9d. The total expenses amounted to £765 10s. 3d., leaving a gross profit of £527 2s. 6d. Adding to this £897 16s. 3d., brought forward, the total sum standing to the credit of the electric department was £1,424 18s. 9d. Out of that sum the Committee has paid £555 19s. 5d. for interest, £436 9s. 6d. in repayment of loan, and carried forward £432 9s. 10d. The total amount borrowed was £20,000, and the sum repaid is £1,271 13s., the debt on capital account now being £18,728 7s. The electric mains are now practically at the limit of their capacity, and if the demand for the electric light continues to increase, it will be absolutely necessary to incur considerable further expense on capital account in order to increase their capacity by doubling the pressure. The boilers, engines, and dynamos are ample for a considerably greater demand, and the whole installation is in the highest state of efficiency. The chairman of the committee, Alderman W. H. Peach, is about to retire. The Corporation at the same meeting voted Mr. J. F. Bell, the manager of the works, a bonus of £250, in consideration of the extra work he has undertaken in connection with the electricity department, and also on account of great increase in gas output.

Taunton.—Mr. E B. Thornhill, the borough electrician, reports that the Free Wiring Company is making very satisfactory progress, as during the past quarter it has installed the equivalent of over 500 8-candle-power lamps. There had been connected with the mains during the quarter the equivalent of 1,541 8-candle-power lamps.

The total new connections during the month of April have been equivalent to 512 8-C.P. lamps.

Train Lighting.—The London and South Western Railway Company are fitting up some of their new triple composite coaches with electric light.

Wakefield.—Mr. Wigham, chairman of the Electric Lighting Committee, last week reported that Messrs. Fowler & Co. had delivered the two engines for the electricity works. One was working to the entire satisfaction of the Committee, and the other was being fixed. Some connections were yet to make, but that was only a matter of two or three days' work.

West Ham.—Tenders were received for electric light fittings for public buildings in the borough, as follows:—Salmony & Co., 2½ per cent. below; General Electric Company, 5 per cent. below; National Free Wiring Company, 45 per cent. below; Electrical and General Engineering Company, schedule price; Beaver & Co., 11 per cent. below; William McGeoch, schedule price; Benham & Froud, 6 per cent. above schedule; Rogers & Co., 7½ per cent. below schedule; Verity, 5 per cent. below schedule. The tenders were referred to the Highways Committee.

The Guardians have decided to light the workhouse by electricity.

Westgate.—On Friday last a Board of Trade inquiry was held by Major Cardew in the matter of the application by the Isle of Thanet Rural District Council for a provisional electric lighting order within Westgate-on-Sea. The scheme was opposed on behalf of a number of objecting ratepayers. There was a numerous gathering of ratepayers present. Mr. Bartley Denniss, who opened the case for the promoters, urged that the price of gas, namely, 4s. 9d. per 1,000, which was the maximum charge allowed by the Westgate and Birchington Gas Company's Act, was hard on the consumers. It was agreed that the more modern method of lighting, as suggested by Mr. Hawtayne, would be not only an advertisement for the place, but a profitable source of income, which would go towards the yearly diminution of the rates, the consulting engineer's figures on this point showing an annual profit of from £120 to £130 a year. It was stated that although the town was small, the rateable value was exceedingly high. The success of the scheme was practically ensured. The estimated cost was under £10,000. The majority of the objectors are interested in the gas company. Mr. Hawtayne's figures were criticised in cross-examination by Mr. Morton Smith, and Mr. F. E. Gripper, consulting electrical engineer and expert, was called to speak as to Mr. Hawtayne's estimate, and put it at £15,000 instead of £10,000. He also pointed out that the house installations would cost on an average £1 per light. He also condemned Mr. Hawtayne's estimate of the working expenses as being too low. Mr. Monkhouse (Messrs. Burstall & Monkhouse) supported this view, and other evidence having been given in opposition to the scheme, the inquiry was adjourned without any definite date being fixed.

Weston-Super-Mare.—The Board of Trade did not intend to proceed further with the local syndicate's application for a provisional order.

Whitechapel.—Notwithstanding repeated promises, the report of the Electric Light Committee is not yet forthcoming, and at the last week's District Board there were signs of growing impatience on account of the prolonged delay in dealing with the matter.

Willesden.—The Board of Trade has sanctioned the Council's provisional order.

Windsor.—The Windsor and Eton Electric Lighting Company have extended their mains down Park Street. The company has adopted the slot meter system.

Woodstock.—The Lighting Committee is negotiating with an electrical engineer as to an electric light installation for the borough.

Ulverston.—The Board of Trade has advised the District Council that as the Windermere and District Electric Lighting Company had not carried out their order of 1895, they are considering its revocation, but would like to hear the opinion of the Council. The Council thought that unless the stipulations in the order were carried out, it should be allowed to lapse.

Yarmouth.—Mr. W. H. Preece has reported to the Council upon the recent explosion at the electricity works. He was of opinion that the cause of the accident was an undue level of water in one of the old single drum boilers, and the main question was the remedy for preventing a similar accident in future. The addition of four high-level indicators would be of advantage as a safeguard against future mistakes in gauging the water level. He did not recommend the addition of separators on the ground of the extremely heavy expenditure that would be involved—£250—and any omission on the part of the engine driver to observe the level of water in the indicators would at once lead to a probable accident, and therefore introduce further danger. Mr. Preece, however, suggested an improved system of drainage, which he could conveniently include in the new extensions. Mr. Preece's report closed with the following paragraph: "It is well to bear in mind that whatever precautions are taken in arranging safety devices, such precautions are rendered useless if carelessness is shown by the workmen. It is impossible to design work which is entirely independent of this contingency."

The Electric Light Committee received replies from the Yarmouth and Gorleston Tramways Company in regard to points raised by the town clerk on their application to the Corporation in regard to the supply of electric light and power in Gorleston and Southtown. The company intimated that they would ask for an extension of 29 years beyond the time mentioned in the order, giving the scheme a total life of 35 years. The company could not pay more than the permit if they took electric power from the Corporation for the tramways. The company would undertake the supply of public and street lighting, erecting a generating station, &c. The average charge made would be 6½d. per unit. If the Corporation provided the cables and handled the supply to private consumers, the average charge would be 4½d. per unit as metered at the company's switchboard. The company offered to supply the current, to maintain and clean street arc lamps on the tops of the trolley posts, at a charge of £22 to £28 per annum. If the Corporation supplied the standards the cost would be £2 per annum less. Incandescent lamps would be supplied, fitted into the existing gas lanterns where arc lamps were not needed, at £4 per annum, where the mains were already laid. The Corporation would be asked to take over the electrical plant when exercising power to purchase the tramway equipment, under the Tramways Act, at a premium of 10 per cent. upon the cost of plant. The company was not prepared to offer any concession, monetary or otherwise, to the Corporation for surrendering its rights. On a consideration of these replies the Electric Light Committee recommended the Council to adhere to its agreement of May 8th, 1897, when an understanding was given to supply the Tramways Company with electric energy according to a graduated scale, commencing at 3½d. per unit, when the amount of energy does not exceed 250,000 units per annum. Mr. A. Peaton said that Gorleston had equal right with Yarmouth to the enjoyment of the electric light, but if there were obstacles in the way of the Corporation carrying the light across the water, the offer of a private company to do so should not be refused. He moved that a special committee be appointed to consider this matter.—Mr. Ruddock seconded.—At the suggestion of the Mayor, Mr. Peaton substituted for his amendment a reference back to the Electric Lighting Committee.—This amendment was then adopted.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

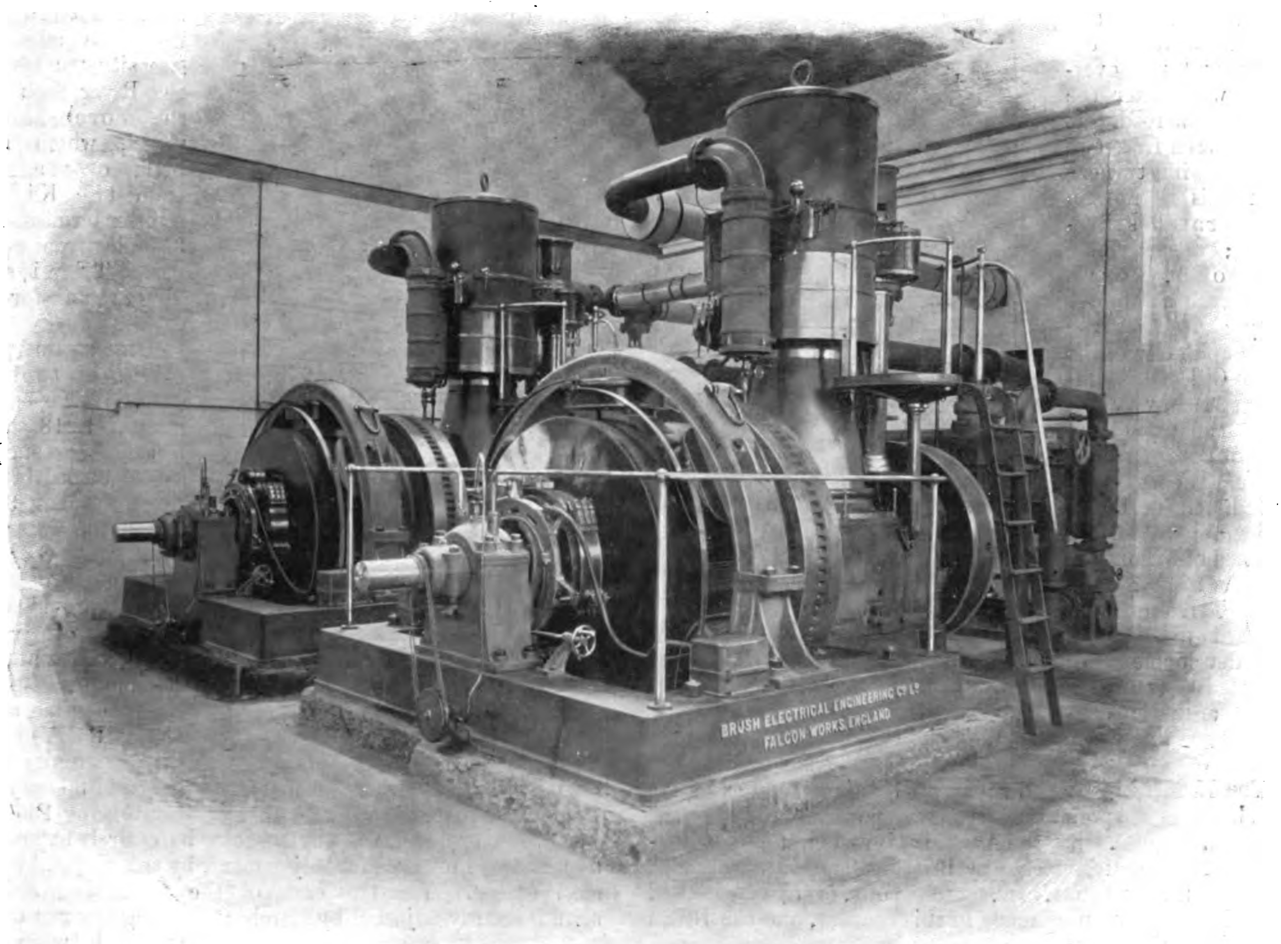
Barnsley.—Several communications respecting tramway proposals have been before the Streets, Buildings, and Improvements Committee, as follows:—(1) A letter dated the 30th ult. from the British Insulated Wire Company, Limited, asking for the consent of the Town Council to a proposed application by a company to be formed by the British Insulated Wire Company for a provisional order to enable them to construct and work tramways in the borough, and also offering certain terms in consideration of such consent; (2) a letter dated the 30th ult. from Messrs. Newman and Bond, explaining the proposals of the syndicate on whose behalf application has been made by them for the consent of the Council to an application for a provisional order; and (3) a letter dated the 3rd inst. from the clerk to the Worsbro' Urban District Council, suggesting that a conference take place between representatives of this Council and of the Worsbro' Urban District Council with respect to the provision of tramways in Barnsley and Worsbro'. These matters were to be considered by the committee at a special meeting arranged for yesterday, and each of the interested parties was invited to send a representative.

Bristol.—At the closing private meeting of the Sanitary Committee on the question of electric traction and tram extension in Bristol, all opposition on the part of the Corporation to the progress of the Tramway Company's Bills in Parliament was finally withdrawn. The opposition of private frontagers has also almost entirely disappeared. The final concessions of the company in the matter of fares are contained in a lengthy letter from the directors' solicitors to the town clerk.

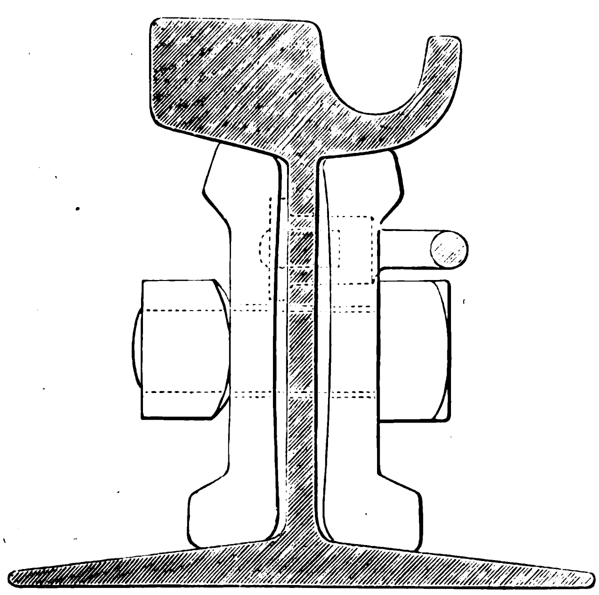
(*Continued on page* 698.)

THE KIDDERMINSTER AND STOURPORT ELECTRIC TRAMWAY.

There is not much doubt that we are in a fair way to remove the reproach that has been so often cast at this country in the matter of electric tramways. The most prejudiced patriot cannot deny that as a nation we have been slow to avail ourselves of the many great advantages offered by electric tramways. It is true that vested interests have been in a large degree responsible for the lack of progress, but after all very little has been done to bring the merits of electrically operated tramways before the public, who are the real arbiters on social innovations. With a growing disposition on the part of municipalities, however, to control and operate electrical tramlines, we are in a fair way to bring the public in much nearer relationship with the benefits of mechanical traction. At the same time, without decrying in the least the laudable efforts of town authorities, there can be little doubt that much of the future of electric traction lies in the hands of private concerns, or perhaps we had better say that much of the immediate progress that will be made in this direction we shall owe to the capitalist.

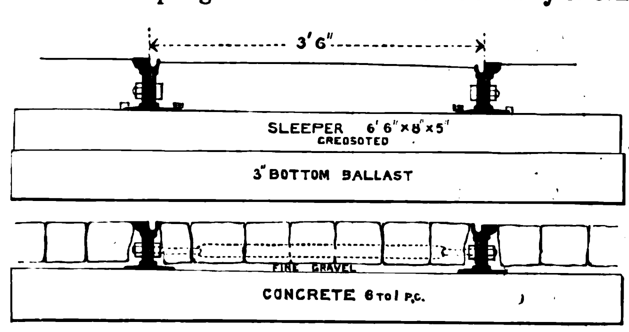


View of Generating Plant.



Section of Rail, Half Size.

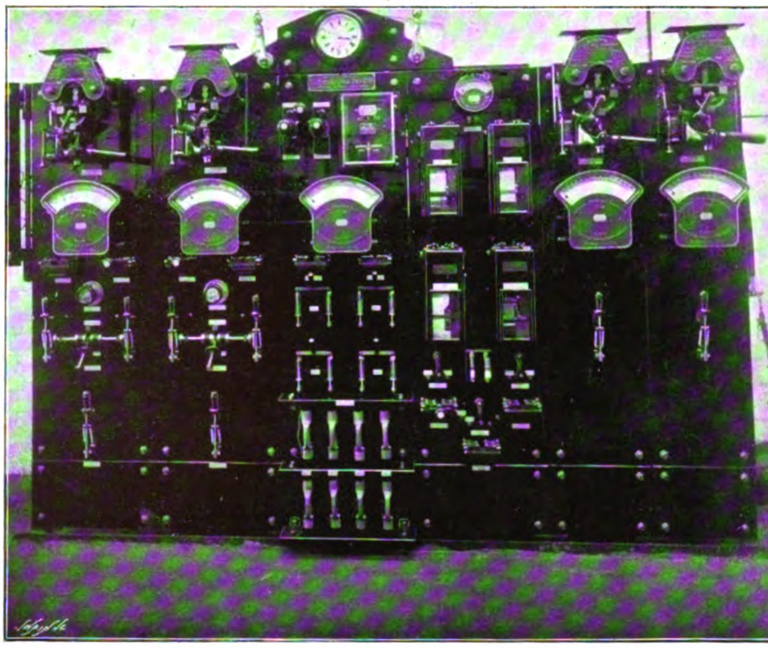
It is obvious that a municipality is bound to be more cautious in adopting schemes that call for the outlay of considerable sums of public money, consequently, municipal traction plant is of slow growth. It is quite true that the Corporations of Glasgow, Leeds, Sheffield, Dover, and Plymouth have recognised the merits of the system, but to show how much we must still rely on private enterprise, it is only necessary to say that one company alone—the British Electric Traction—probably one of the most powerful electric traction organisations in Europe, is contemplating



Details of Permanent Way.

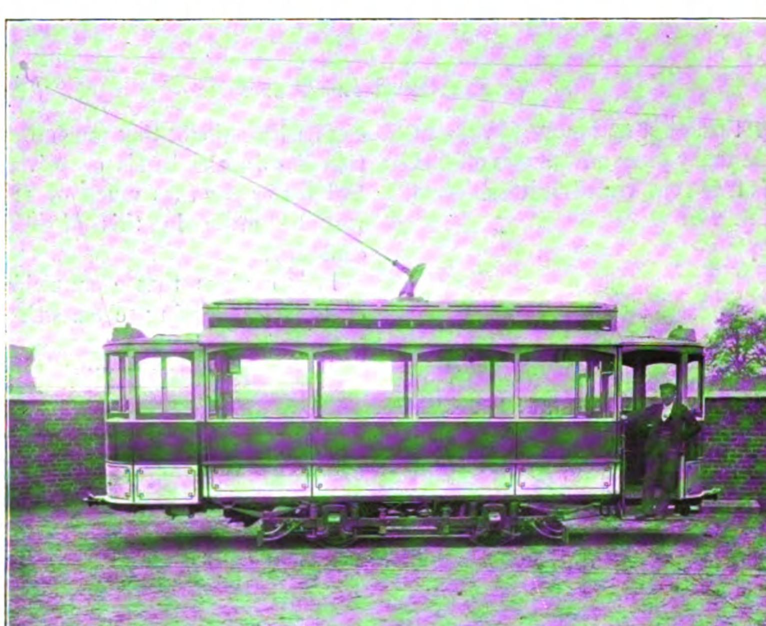
schemes which will involve an outlay of £3,000,000. The first completed system erected by this company is the one we are about to review.

The district of Kidderminster is an excellent place to demonstrate the merits of an electric tramway system. A portion of the route is a hilly one, and there is an unusual proportion of interesting scenery alongside the tramway. Hence one is able to show with what ease are gradients mounted and how little the posts and the overhead wires alter the aspect of a road. It will be seen from two of our illustrations that this is not an exaggerated statement; these views, moreover, serve another purpose—they show that the telegraph poles of the Post Office are immeasurably worse than the posts that support the trolley wire. Yet who ever heard the Postal Telegraph authorities accused of defloration of scenery? We have, however, reached a stage in the development of electric tramways when æsthetic considerations may be neglected.



SWITCHBOARD.

The Kidderminster and Stourport line is not an extensive one, but it is of special interest and importance at the present moment, because, since the American invasion, it may be considered the first line erected by British manufacturers. The steam plant, generators, cars, motors, posts, overhead wire and material all have been made in this country, and the Brush Electrical Engineering Company, the principal contractors, are to be congratulated, not only upon the successful completion of the line, but also because they have had the good sense to copy some of the best features of American practice. Prior to the introduction of the present electric system, there were no tramways in Kidderminster, the chief means of vehicular communication between different parts of the town and the outlying districts being a somewhat desultory service of omnibuses.



CAR ON LINE.

Parliamentary powers for the line were obtained by the British Electric Traction (Pioneer) Company, Limited, under whose control the system has been carried out. Commencing at Somerleyton Avenue, about half a mile in an easterly direction from the Great Western Railway station at Kidderminster, the line passes through the chief streets of the sleepy old town; past the carpet manufactories that line the outskirts of the town, along the Stourport Road, where the country opens towards the valley of the Stour, thence it traverses the crossing of the Great Western Railway, terminating in Bridge Street, Stourport, on the banks of the River Severn.

THE GENERATING PLANT.

The power house possesses features of more than usual interest, arising from the use that is made of home-made plant.

The building comprises power house and car depôt which are arranged together upon an admirable site situated between the River Stour and the Worcestershire Canal, which is a little over a mile from the Kidderminster terminus, and 3½ miles from Stourport. There is shedding room for 10 cars.

The steam plant consists of two Babcock & Wilcox boilers, each of 1,218 square feet heating surface, and capable of evaporating 3,500 gallons of water per hour. A Green's economiser of 120 pipes is provided, the scrapers of which are driven by an electric motor.

The engines are of the "Universal" single crank compound type, and have cylinders of 20 inches and 30 inches × 12 inches stroke, the working steam pressure being 135 lbs.

Though enclosed the engines can be entirely exposed in two or three minutes for adjustment, by the removal of the steel casing. The two ends of the connecting rod are simultaneously adjusted by merely tightening the nut on the strut between the crosshead and crank pins, the operation taking quite a small fraction of time.

One of the principal features claimed for the Universal engine is that fluctuation of load does not produce water hammering, the engine being automatically self-draining. Steam is admitted only to the under side of the H.P. piston, the H.P. cylinder being drained throughout the whole of the downstroke by the valve, whilst the drainage of the L.P. cylinder is effected by the piston exposing a number of holes around the cylinder when at the bottom of its stroke. This quality is a most important one, particularly in traction work, where the variations of load are severe and priming necessarily more frequent than with steady loads.

There are two direct-coupled six-pole generators provided with Mordey's new chord winding and notched armature; they work at a pressure of 550 volts, and have a normal output of 100 kw., though they are capable of working to 135 kw. without a rise of temperature exceeding 80° F.

The most noteworthy feature about the machine is that the armature is of unusually large diameter in proportion to the width of field. This allows ample room for armature winding, notwithstanding the high voltage, and renders the whole of the windings and connections extremely accessible.

Owing to the adoption of the Mordey chord winding, the field coils are extremely small, as will be seen from the illustration, and no doubt the economy of copper in this respect is very marked. Each dynamo has a single bearing of ample proportions, provided with spherical seating, and is automatically lubricated by a small rotary pump.

There are two Wheeler surface condensers of the Admiralty type, one being provided for each steam set. The exhaust pipes are arranged so that either engine can exhaust to either one of the condensers, or if the condensers fail, means are provided for automatically exhausting direct to the atmosphere. An ample supply of water for the condensers is obtained from the canal, that for the boilers being obtained from the town mains.

The Line Along Stourbridge Road.
Postal Telegraphs v. Electric Tramways.

The steam piping, which is arranged in duplicate, is of mild steel, the valves being manufactured by Messrs. Winn and Co., of Birmingham.

The arrangement of the switchboard does not differ materially from that usually adopted in American practice; it is split up into panels, which are known as the main station, generator, feeder, and Board of Trade panels. The main station panel is fitted with an ammeter, which shows the total output of the plant; and recording volt and watt-meters are placed on the same board. The generator panels are each fitted with an automatic circuit breaker of the General Electric type, an ammeter, shunt regulating switch, and plug board for station voltmeters.

View of Line.

The feeder panels are also provided with an automatic circuit breaker and lightning arrester. The inevitable Board of Trade panel contains all the instruments necessary to comply with the Board of Trade regulations.

The Track Construction.

The line is single track throughout. The gauge is 3 feet 6 inches, and constructed throughout with girder rails weighing 75 lbs. to the yard. In the borough of Kidderminster the track is laid upon a bed of concrete 6 inches in thickness, and for 18 inches on either side of the track it is paved with 3 inches × 5 inches Clee Hill granite setts. Along the Stourport Road to the level crossing of the Great Western Railway the line, with the exception of one short length, is laid along the northerly side of the road, the rails being laid on sleepers, the space between the rails and on each side being made up with macadam. The return is entirely by the rails which are bonded with Chicago bonds.

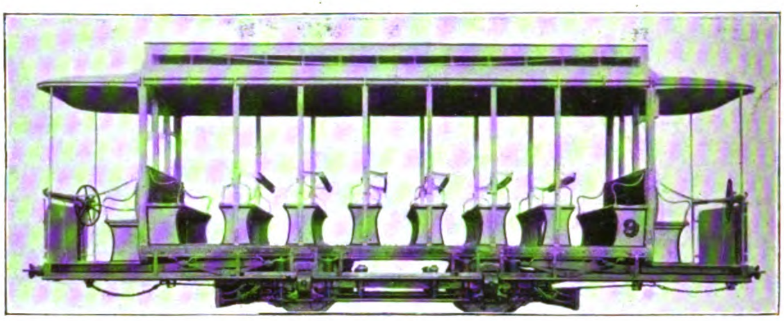
This line is probably the first instance in this country of a tramway passing over the level crossing of a railway, and it is hardly necessary to say that a satisfactory means of doing this has necessitated much care. It was imperative that the tramlines should be broken where they intersected the railway, and to keep up the continuity of the return circuit of the tramway entailed carrying heavy copper connections from one side of the crossing to the other.

It generally follows that the introduction of an electric tramway system into a district brings certain road improvements in its train, nor has the Kidderminster line proved any exception to the rule, for the system has entailed very considerable road alterations along the route. The line runs mostly at one side of the road, and as a clear carriage-way had to be left for the ordinary traffic, it necessitated widening the roadway in many places, but, what was more serious, it involved the widening of three bridges. One of them being a double bridge spanning both the River Stour and the Worcestershire Canal, presented considerable difficulty, for the sides of the original bridge did not run straight, but in a double "S" bend, and to make matters worse, the arch spanning the canal was skewed. This bridge has been widened on both sides and made straight throughout its entire length of about 180 feet. The arch spanning the river was widened on both sides by building brick arches alongside, the new work being tied in to the old by means of tie-bolts carried right through from side to side. The skew arch could not be widened in the same manner, owing to the peculiar shape of the old bridge, and necessitated steel girder construction, the longest span being 38 feet 6 inches.

The Overhead Work.

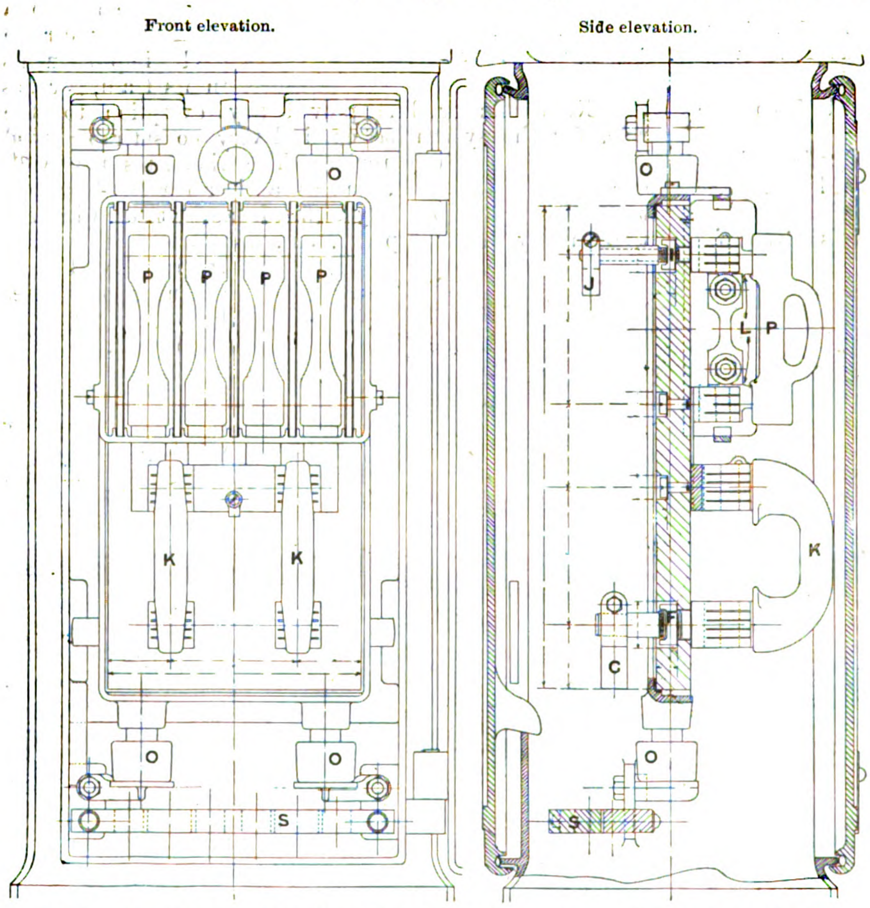
Owing to various obstacles, it has been necessary in no less than three instances to place the poles on opposite sides of the road; that is, the poles and wires for some considerable distance are on one side of the road only, and then for some distance on the other side of the road, when they again cross, so that the system provides excellent examples of the adaptability of the Dickinson side trolley with regard to the wire, for it must be remembered that the track cannot follow the variations that have been rendered necessary in the position of the overhead wire.

The overhead wire is suspended from tapered steel poles, 6 inches and 7 inches diameter, which are fixed at an average distance apart of 50 yards. They stand 22 feet above the ground, and are bedded in concrete to a depth of 6 inches below the surface of the road. Two trolley wires are provided, one for up line, and the other for down line working, the necessity for overhead switches at the passing places being thus avoided.



TRAILER.

The height from the rail to the trolley wires is 21 feet. The lengths of the bracket arms from which the trolley wire is suspended vary considerably, the longest being 8 feet 6 inches, and the shortest 2 feet 6 inches, the greater number being of the latter length. The trolley wire is suspended by riveted gun-metal ears, which are in turn suspended from bell insulators fixed to the bracket arms by wrought-iron clips.



G and J, Clamp cable sockets; K, Main switch carrying 400 amperes; O, Oil insulators; P, Section switch; S, Clamp for cables.

HALF-MILE JUNCTION PILLAR.

There are two main feeder cables from the power house, one going east towards Kidderminster, and the other west towards Stourport. As is customary on English lines, at every half mile the trolley wire is divided by section insulators, at which points the feeder boxes are located. These feeder boxes are about 4 feet 8 inches high, and are placed usually near the post supporting the sectional insulators; they contain two main knife switches feeding on to an omnibus bar, from which bar there are four cut-out fuses, which can feed both ways on to the double trolley wire. The feeder switches are shown at K in the detail drawing, and are capable of carrying 400 amperes, while the section switches are shown at P, and are designed to carry 50 amperes. Any section can thus be easily disconnected for testing, &c. The main cables are somewhat heavy on account of the considerable distance traversed. It has to be remembered that the power house is practically at one end of the system, which is, of course, dictated by convenience and economy. The east-going feeder is a 19/14 stranded cable, and extends to within half a mile of the Kidderminster end. The west-going feeder consists of a 37/11 cable as far as the third feeder box, from which point, and on as far as the next two boxes, it is reduced to 37/12, and from thence to the last feeder box it is reduced again to 19/14, finishing up within half a mile of the terminus. A 7/22 cable is connected to the rails at the extreme ends, and brought back to the switchboard for testing the drop in the return circuit.

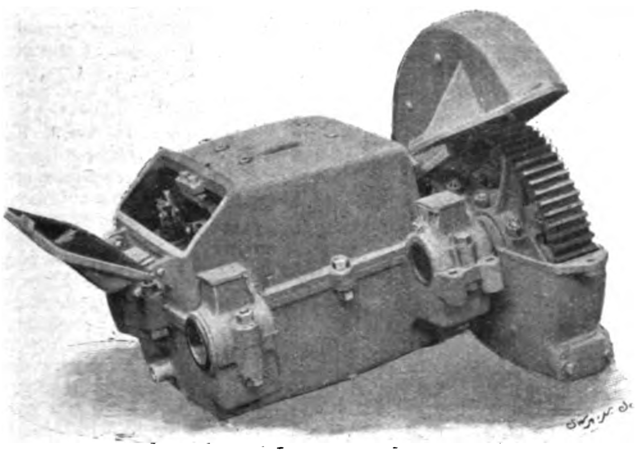
The feeder cables, which are of the Diatrine type made by Messrs. Glover & Co., are lead sheathed and armoured; they are buried in the ground at a depth of 18 inches.

It will be noticed from the illustrations that the cars differ from the usual English practice, in that they are not provided with outside seats, and they are furnished at each end with vestibules. There are 10 in all, six of the closed type with motors 27 feet 6 inches in length over all and 6 feet 4 inches in breadth. These have a carrying capacity of 24 passengers; in addition there are three open trailer cars with a carrying capacity of 40 passengers.

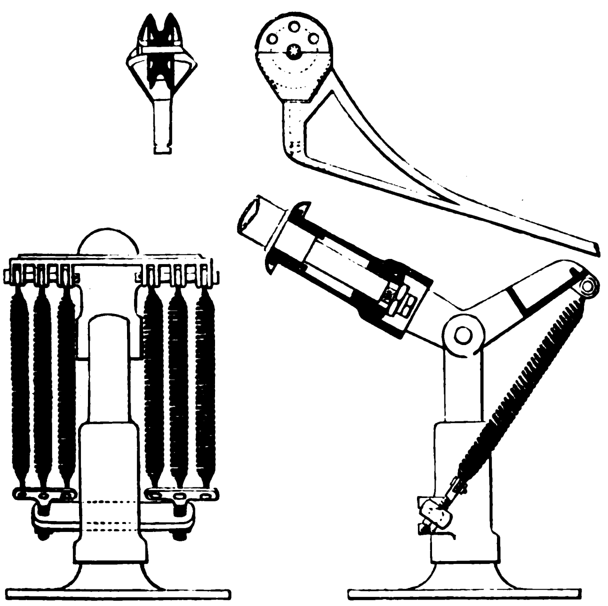
The trucks are of the Brill cantilever type, with a wheel base of 6 feet 5 inches, the wheels being 2 feet 6 inches diameter. The bottom framing of the cars is constructed of teak, the body of teak and English ash, and the panels of Honduras mahogany. Each motor car is equipped with two 15-B.H.P. four-pole motors of the ironclad type, with spring suspension and geared to the axles with spur gearing having a ratio of 4 to 1. The armatures are of the drum type, slot wound with counterpart renewable coils. The armatures are cross connected, so as to have only two points of commutation, carbon brushes being employed.

The controllers, one of which is fixed at each end of the car, are of the series parallel type, one controller handle being supplied with each pair of controllers, which are so arranged that it is impossible to detach it, excepting when the controller is in the "off" position. Each car is lighted with 10 16-C.P. incandescent lamps arranged in two circuits of five lamps in series. The interior of the car is lighted by three clusters of lamps, one containing four, and two containing two lamps, and a head light, which also lights the vestibule, arranged at each end over the platform.

The most interesting feature about the car is the trolley pole, which is of the well-known Dickinson type. It will be remembered that this device was first used on the South Staffordshire tramway, and the principle has been since pretty widely adopted on English lines. The chief difference that exists between the Kidderminster and the South Staffordshire trolleys is, that the horizontal springs used at the base of the latter have been replaced by inclined springs. The detail drawings show the arrangements very clearly.



Car Motor and Gearing.



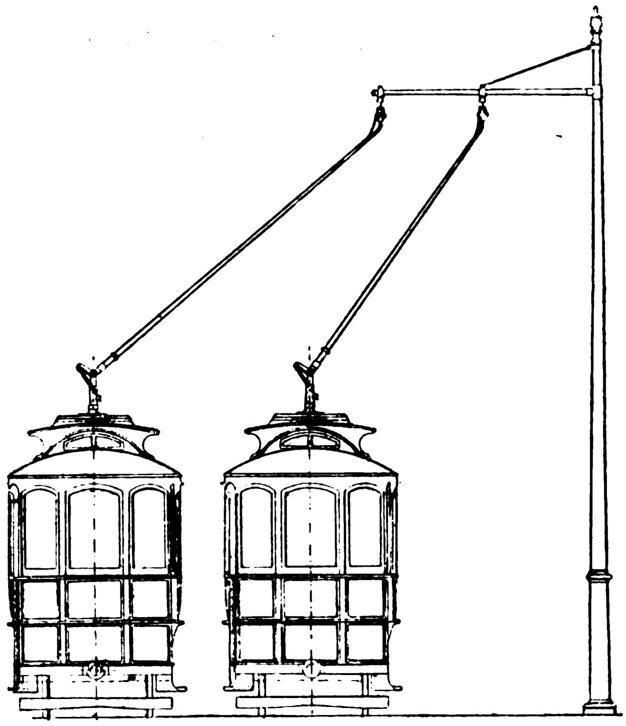
Details of Trolley Pole.

The trolley pole is a light steel tube 15 feet long, tapering from $2\frac{3}{8}$ inches to $\frac{3}{4}$ inch outside diameter, and fitted

the pole forms part of the electrical circuit. Each car is provided with a lightning arrester.

As we have already mentioned, the contractors for the complete electrical installation were the Brush Electrical Engineering Company; the contractor for the permanent, way and buildings was Mr. George Law, Kidderminster Messrs. James Russell & Sons, Limited, Crown Tube Works, Wednesbury, supplying the poles.

Messrs. Alfred Dickinson & Co., 120, Colmore Row, Birmingham, were the consulting engineers for the whole



End Elevation of Two Cars on Line.

undertaking, Mr. G. B. Parlett, A.M.I.C.E., being resident engineer and their representative throughout the work. On behalf of the Brush Company, the work has been carried out by Mr. Geo. Sillar, under the general direction of Mr. R. Dawbarn, superintendent engineer, assisted by Mr. S. Mahood, as resident engineer. We are much indebted to these gentlemen, as well as to the Brush Electrical Company for their assistance in compiling this article

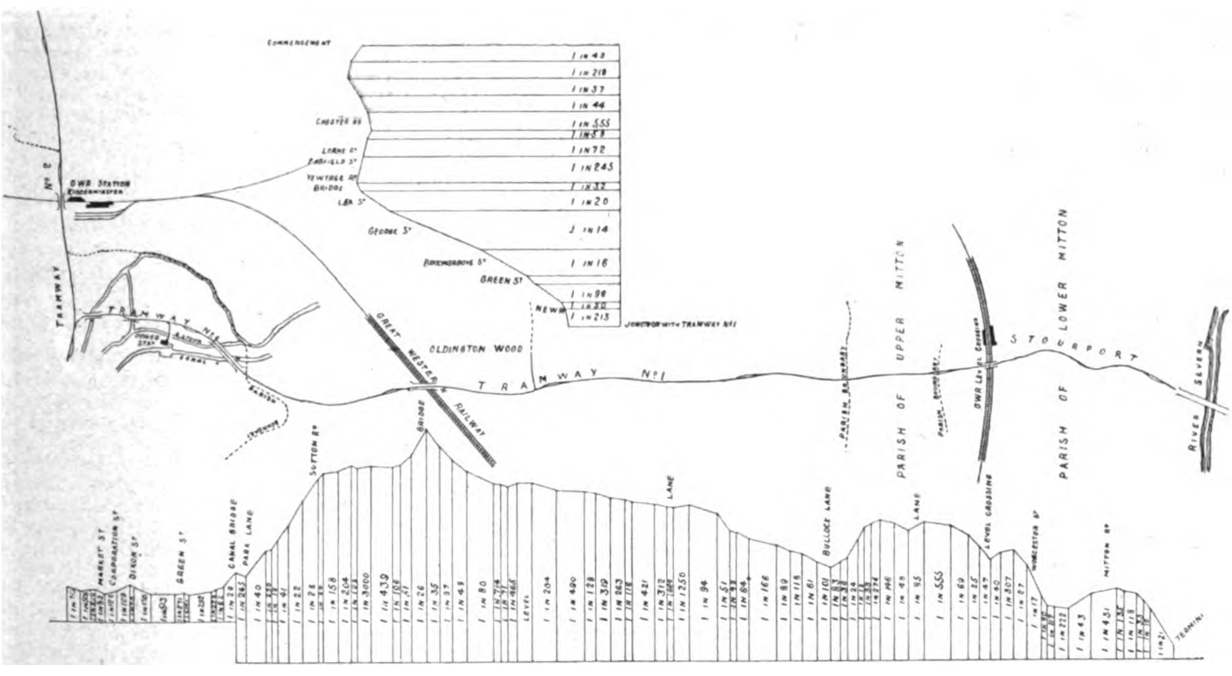


Diagram of Kidderminster and Stourbridge Tramway.

with swivel head, so as to allow the wheel to turn and adapt itself to any position of the trolley wire. The base of the trolley pole is supported on four insulators, as the whole of

National Telephone Company.—It is stated that Mr. Faithfull Begg is named as the successor to Sir James Ferguson on the board of this company.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

(*Concluded from page* 692.)

Bradford.—The Tramways Committee has now given up all hope of the possibility of the Bolton Road being ready for Whitsuntide.

Chesterfield.—The question of the adoption of electrical tramway traction is at the present time occupying the attention of the Corporation. There exists a tramline in the borough about a mile in length, but the extension of the system is under consideration, and as the hilly nature of the district renders horse traction both expensive and inadvisable the "city fathers" are considering the best substitute. The matter was ventilated at a meeting of the Council last week, when the matter of mechanical traction was mentioned. The following resolution was passed:—"That this Corporation recognise the advisability of applying mechanical traction on the present tramways, and that it be an instruction to the Tramways' Committee to have estimates prepared for the work and present to the Council at the next monthly meeting, bearing in mind any subsequent additions, and the necessity of providing workmen's tickets at nominal rates." A special meeting of the Council is to be called to consider the matter in all its bearings. Councillor Markham, in moving the resolution, referred to what is being done in electric traction in other parts of the country. He said that the Corporation had now the Brampton Tramway in their own hands, and it would be an easy matter to demonstrate on that piece of line whether electrical traction would be for the good of the town or not. He himself believed it would add very much to the prosperity of the town and add materially to the value of the land adjacent to the tramways if such a system were adopted. Alderman Wood, in seconding, said that they wanted to consider whether a small scheme to begin with, or enlarging the present tramway, would be a wise thing for the Corporation to entertain. To go into the question of supplying electricity for a tramline only a mile long would be going to enormous cost with very little benefit, and it would be much easier for the committee to report on a tramway double or treble that length.

City and Brixton Railway.—The City and Brixton Railway Bill, which has already been sanctioned by the House of Commons, has been referred to the Unopposed Bill Committee of the House of Lords, owing to the withdrawal of the threatened opposition. By this Bill, which will now in due course receive the Royal assent, a new company will be incorporated with a share and loan capital of £1,600,000 for the purpose of constructing an electric railway from Brixton Hill to a junction with the City and South London Railway at a point under the High Street, Borough. The period sought for the construction of the line is five years from the passing of the Act.

The Electric Power Schemes.—The Nottingham Chamber of Commerce on Monday resolved to support the Bill of the General Power Distributing Company now before Parliament.

Halifax.—The Tramways Committee made a trial trip on one of the electric cars on Tuesday. It is expected that the cars will commence running on June 9th.

Leeds.—The Highways Committee, on 11th inst., confirmed the recommendations of the management committee to extend the electric tramway system along Dewsbury Road and on the Headingley and Chapeltown routes. The city engineer (Mr. Hewson) reported that the city accountant's estimate respecting the cost of the electric tramways on the Kirkstall-Roundhay section had proved accurate, notwithstanding certain statements which had been made to the contrary. Mr. Derry's estimate per car mile was as follows:—For repairs, $5\frac{3}{4}$d.; renewals, $1\frac{1}{10}$d.; interest and sinking fund, $2\frac{1}{4}$d.; total, 9d. The actual expenditure had been $8\frac{7}{10}$d. per car mile.

Llandudno.—Mr. Preece has been consulted by the Electric Lighting Committee upon what system of traction they should insist upon with the Light Railway Syndicate. In his report Mr. Preece strongly advises the overhead system.

The Metropolitan District Railway and Electric Traction.—The shareholders of the Metropolitan District Railway Company had before them on Tuesday the Bills which are being promoted by their company. One of these is applying for further powers to the Metropolitan and Metropolitan District Railway for the ventilation of the railway, and in relation to the working of their undertakings by electrical power. Mr. Staats Forbes, in explaining matters, said that the Bill would give them power when the convenient time came, and the method was sufficiently developed, to apply certain funds of the company for the purpose of working by electricity the railways of the Inner Circle. The Metropolitan Company is applying for similar power, and the District Company could not dissociate itself from that company in respect to electrical communication. They were bound to work in harmony. One of the clauses in the Bill empowered the Metropolitan and District Companies to enter into agreements as to working of traffic by and supply of electrical power. Of course, the adoption of electricity was a matter they could not go into with absolute indifference as to the question of cost. A good deal, however, was now known about this form of traction. It had its advantages and its disadvantages; but the proprietors decided as far back as February last year that it was a matter they ought to be prepared to face at the right moment. Their idea was that £500,000 would be extremely well spent in adapting their railway to electrical traction over that particular part of it which he had mentioned, which was crowded with traffic, and so much of which was incapable of anything but very imperfect ventilation. They were instructed by very eminent authorities that the financial burden cast on the two companies would be extremely moderate in comparison with the great advantages to be secured not only by getting rid of many of the offensive qualities of the air in the tunnels, but also in the saving in the cost of traction, which they were advised would be considerable. The matter was one demanding some care, and they, naturally, wished to be in the hands of perfectly responsible engineers of eminence. In Sir J. Wolfe Barry, a man of considerable experience, who had advised the company almost from its inception, and Mr. Preece, the electrician of the Post Office, and one of the most distinguished members of his profession, they had thought well to vest the preliminary inquiries. Those gentlemen were now concerned in the matter, and the directors would not proceed until they were assured by the report and recommendations of those gentlemen that it was safe to do so. They were gradually gaining experience in the matter of electrical traction. The greatest enterprise of the kind yet approaching to anything like development was the Central London Railway. They knew a little about the question from what had been done on the City and South London line and the Liverpool Overhead Railway, but the Central London Railway, which would be running by the end of this year or the beginning of next year, would doubtless open their eyes to a good many things. The experience of that company would be very useful to the District and Metropolitan Companies. The Chairman then moved the approval of the Bill in so far as it affected the company.

Newcastle.—The lease of the Newcastle Tramways to a private company is rapidly running out, but the new committee of the Corporation is now moving in the direction of a complete scheme, and on Monday agreed to appoint as specialists, to prepare a full report, Dr. Hopkinson, to advise as to the electric system; and Mr. Colamb, C.E., of Edinburgh, to do the same in respect to cable tramways.

Nottingham.—It is stated that a special meeting of the whole Council in committee was held on Monday for the purpose of considering in detail the report of the Tramways Committee, which was presented to the Council on April 4th last, and was discussed a second time on May 2nd. After an exhaustive debate the report, slightly altered, was adopted. There were two dissentients; one objected to the position of the proposed tram centre in the Great Market Place, and the other was opposed to the overhead electric system; he preferred the cable system. The Council instructed the Tramways Committee to include in the Bill to be presented to Parliament several sites for the power stations in connection with the tramway system, in addition to the site originally agreed upon. At the same meeting the Council considered the Bill now being presented in Parliament by the General Power Distributing Company. The meeting authorised the Electrical Energy Committee to reduce the charges for the supply of electrical energy in the city, and also to extend the electrical undertaking all over Nottingham, both for lighting purposes and for power.

Penarth.—The Penarth Light Railway inquiry will probably take place at Cardiff on June 2nd. The opponents include the Cardiff Corporation and the Taff and Barry Railways.

Richmond.—"A Resident of Richmond" writes to the *Times* railing at the promoters of the proposed light railway over Richmond Hill, and flinging the invective at the overhead trolley system in the same old-fashioned way adopted in bygone days in the country. He says it is unfortunate that the promoters have not to apply to Parliament for powers. "All that is necessary for the London United Tramways' Company, Limited (the promoters of the scheme), being to obtain an order from the triumvirate composing the Light Railway Commission, and the approval of the Board of Trade." He adds, "It need hardly be pointed out how a lofty line of gibbet-like supports for the wire which conveys the electricity will interfere with the natural beauty of the neighbourhood, and it is sad to think of the sylvan glades of Petersham Common—perhaps unequalled in wild picturesqueness within so short a distance of London—being desecrated by the vulgar if useful tramcar and its iron way."

Southport.—The Town Council has an electric tramway scheme in view, for it has resolved to widen the esplanade from the promenade to the Birkdale boundary, and form a shrubbery as a preliminary to a future electric tramway round the Marine Drive.

Sunderland.—At the Town Council meeting last week Mr. Crown moved the rescinding of a minute recommended by the Tramways Committee, and passed at the last meeting by the Council, appointing a deputation of six members and the electrical engineer to visit a number of towns for the purpose of gaining information with respect to electrical traction as applied to tramways, for the benefit of the Corporation who are considering a scheme for the application of electric traction to, and for the aquisition of, the tramways of the borough. Mr. Crown said he had learned that the deputation had drawn up a programme to visit the Continent as well as towns in England. They were going to start at Newcastle, and go from there to Hamburg, from Hamburg to Berlin, from Berlin to Brussels, and Brussels to Paris, and from Paris to London and the English large towns. He thought there was no need for seven gentlemen to go any such distance and spend any such amount of the ratepayers' money, and he hoped that the majority of the Council would come to that conclusion. Of course, the gentlemen could go to St. Petersburg and New York, and Philadelphia if they liked, but what he did object to was to them going at the ratepayers' expense. There were ample opportunities at Hamburg to see all that was desired, and this was a cheap place to go to. There were also West

Hartlepool, Leeds, and Sheffield, towns all well supplied with electric traction, and he therefore moved that the minute be rescinded. Alderman Fairless seconded, and said he did not object to the deputation, but he thought the number was excessive. After discussion, Mr. Crown replied, and said the arguments for the deputation were fallacious. There was no amendment, and the motion was then put, and carried by 26 votes to 20.

Swansea.—The British Electric Traction Company, who have taken over the Swansea Tramway system have appointed Mr. Daniel Sugrue, late manager of the Swansea system, to be their district superintendent for South Wales, and have appointed him to a seat on the board. It is anticipated that the work of re-laying the lines will commence in a week or so.

TELEGRAPH AND TELEPHONE NOTES.

Telegraphic Interruptions and Repairs:—

CABLES.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1898	...
West Indies—		
St. Croix-Trinidad	Nov. 30th, 1896	...
Cayenne-Pinheiro	March 24th, 1898	May 14th, 1898
St. Lucia-St. Vincent	May 16th, 1898	May 18th, 1898
Amazon Company's cable—		
Parintins-Itacatiara	May 5th, 1896	...
Obidos-Parintins	Dec. 7th, 1896	...
Cable beyond Gurupa	April 4th, 1898	...
Cyprus-Latakia	Feb. 10th, 1898	...
Bolama-Bissao	April 12th, 1898	...
Maranham-Para	„ 17th, 1898	...
Kotonou-San Thomé	„ 27th, 1898	...
Hong Kong-Manila	May 3rd, 1898	...
San Thomé-Loanda	„ 4th, 1898	May 14th, 1898
Monte Video-Rio Grande	„ 5th, 1898	...
Havre-Waterville	„ 10th, 1898	May 17th, 1898
LANDLINES.		
Trans-Continental line beyond Masol	March 12th, 1896	...
Cartagena-Barranquilla	July 4th, 1896	...
Saigon-Bangkok	May 13th, 1898	May 17th, 1898

The Telephone Service.—According to the *Daily Chronicle*, it is proposed to hold a conference of representatives of local authorities on the subject of the telephone system, in view of the appointment of a Select Committee of the House of Commons to inquire whether the telephone service should be undertaken by municipal and other local bodies. The Highways Committee have invited the local authorities of London to appoint representatives to attend at the County Hall on Thursday, May 26th, to confer with them as to the needs of London as regards the telephone service, and as to what suggestions should be offered to the Select Committee with reference thereto.

Mr. Hanbury has been appointed chairman of the Parliamentary Telephone Committee, which is to meet on Tuesdays and Thursdays to take evidence, the first witnesses being officials from St. Martin's-le-Grand. A strong effort will be made to expedite matters, so that the committee may be in a position to report to the House before the end of the present Session.

The "Tutanekai."—An Auckland, N.Z., paper says that Mr. W. C. Smythe, of the Telegraph Department in Wellington, is to accompany the *Tutanekai* during her cable-laying operations, as electrician. Mr. C. May, of Dunedin, left for Wakapuaka at the end of March for the work of laying the new cable across Cook Strait, and subsequently to pick up, repair, and relay the present one. This work was estimated to occupy several months.

The War and the Cables.—The *Standard* special correspondent at Key West says that on Saturday last the cutter *Windom* landed there the six men who were wounded while engaged in the risky operation of cutting the cable off Cienfuegos on Wednesday. Four boatloads of men were sent from the ships to Colorado Point, at the entrance to the harbour, furnished with grapplers for the purpose of hauling up and severing the cable. As they approached the shore a detachment of Spanish infantry opened fire from rifle-pits, assisted from time to time by a machine-gun. The warships at once shelled the pits, and drove most of the Spaniards, it is believed, into the lighthouse. Altogether 175 shots were fired from the men-of-war. The boats' crews suffered rather heavily. The operation of cutting the cable was carried out successfully, and Havana is consequently cut off from Cienfuegos, and Cienfuegos from Santiago, while the junction with the British cable from Jamaica to Halifax, which was previously possible, is now destroyed. Marshal Blanco is also isolated from Madrid and the Western portion of Cuba.

A Washington despatch says that the United States Government proposes to sever all the southern cables from Cuba and to leave only the one from Key West to Havana, which it controls. The reason that the Cienfuegos cables were not cut before is that several Americans and other foreigners were still in that town; but now they have all safely reached Port au Prince.

It is stated that the British cable between St. Lucia and St. Vincent has been cut by the Spaniards in furtherance of their designs against the *Oregon*, the *Marietta*, and the *Buffalo*, now off the mouth of the Amazon. These vessels are thus placed beyond the reach of orders or information from the United States, except such as reach the telegraph points, *viâ* steamer, across the severed loop of the cable. That Spain shall get no further telegraphic information is being assured by a stricter censorship, especially over the French line from New York, which has been induced to give a written acceptance of the rules imposed upon it, under the penalty, if found in default, of an instant cutting of the company's cable at Coney Island.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belgium.—May 25th. The date for the receipt of tenders for the electric lighting plant at the railway station at Ghent (Gand-Sud) for the Belgian State Railway Authorities has been fixed for May 25th.

Belgium.—May 31st. The Municipal Authorities of Ixelles, a suburb of Brussels, are inviting tenders until May 31st for the exclusive concession for the supply of electrical energy for lighting and power purposes during a period of 26 years, that is, to September 1st, 1924. Tenders to be sent to the Secretariat de la Commune d'Ixelles, Brussels, from whence particulars may be obtained.

Bury St. Edmunds.—June 13th. The Corporation invites tenders for the supply and erection of Lancashire boilers, three 60-kw. steam dynamos, transformer and booster, accumulators, street mains, and various other machinery and apparatus for the electricity undertaking. Consulting engineer, Mr. F. H. Medhurst, 13, Victoria Street, S.W. See our "Official Notices" May 13th.

Coventry.—June 7th. The Electric Lighting Committee invites tenders for electric mains, switchboards, arc lamps, posts and apparatus in connection therewith. For particulars of the several sections see our "Official Notices" May 13th. Mr. Gilbert S. Ram, city electrical engineer.

Dublin.—May 23rd. The Corporation wants tenders for the supply of high tension feeders and low tension distributors laid and jointed complete on a solid system, not including road work, but including the connecting up of existing consumers to the new mains. Also for transformers (20 to 50 kw., about 700 kw. in all) with instruments and apparatus in sub-stations erected and fitted complete. Particulars at the office of the city engineer; or from Prof. Kennedy, 17, Victoria Street, S.W. See our "Official Notices" May 6th for particulars.

Glasgow.—May 21st. The Corporation is inviting tenders for the excavator and concrete works of the new generating station to be erected at Port Dundas. Architect, Mr. A. Myles, 143, West Regent Street, Glasgow.

Hammersmith.—June 8th. The Vestry is inviting tenders for the supply and erection of a Ledward evaporative condenser and tanks, air pump, circulating pumps, and pipe work. Consulting engineer, Mr. A. H. Preece. See our "Official Notices" for particulars.

London.—June 21st. The London County Council is inviting tenders for engines, dynamos, accumulators, switchboards, feeders, distributors, and service mains and all accessories, to be fixed complete in buildings at the Crossness Outfall Works, near Erith, Kent. The L.C.C. also requires tenders for providing and fixing cables, wires, conductors, casing, pendants, brackets, and other fittings, columns, lanterns, lamps, switches, and switchboards, distributing boards, fuses, cut-outs, &c., necessary for the lighting by electricity of the Crossness pumping station and works, near Erith, Kent. Particulars of both contracts from the Engineer's Department, County Hall, Spring Gardens, S.W. See also our "Official Notices" this week.

Russia.—May 27th. Tenders are being invited by the Municipal Authorities of Odessa for the concession for the construction and working of three lines of electric tramways in the town, the total length being about 39 versts. Particulars may be obtained from La Mairie d'Odessa, Russia, to whom tenders are to be sent.

Southampton.—May 23rd. The Corporation is inviting tenders for the necessary trenching and laying of conduits for electric mains in various thoroughfares. Particulars from the Town Clerk, Municipal Offices.

Spain.—May 28th. Tenders are being invited by the Municipal Authorities of Plencia (province of Vizcaya) for the concession for the electric lighting of the public streets of the town. Tenders to be sent to El Secretario del Ayuntamiento de Plencia (Vizcaya) from whom particulars can be obtained.

Sunderland.—May 27th. The Corporation invites tenders for the supply of steam and other piping, and water softener for the electricity works. Borough electrical engineer, Mr. J. F. C. Snell. See our "Official Notices" May 13th for particulars.

Victoria.—June 24th. The Council of the city of Hawthorne (Colony of Victoria, Australia) is inviting tenders for the supply and erection of buildings, boilers, engines, dynamos, transformers, mains, meters, arc lamps, poles; also running the plant for three years. See our "Official Notices" March 11th.

CLOSED.

Aberdeen.—The Gas and Electric Light Committee last week considered the tenders sent in for laying the necessary cables for the extension to the harbour and the West End. The offers sent in were as follows:—The Western Electric Company, £14,318; W. T. Glover & Co., £13,113; Callender's Cable Company, £12,642; British Insulated Wire Company, £12,405; and Messrs. Siemens Bros., £12,138. The Messrs. Siemens' offer, being the lowest, was accepted. Powers are to be applied for to borrow an additional £20,000.

Bethnal Green.—On Tuesday, at the meeting of the Bethnal Green Guardians, the following tenders were received for the installation of the electric system in their new infirmary, which will be the most complete in the metropolis:—Messrs. Speedy & Co., £6,659; Cox Walkers, £9,920; W. B. Scott & Co., £8,671 8s. 5d.; G. E. Cockburn, £8,741; Sharp & Piper, £6,460; Thames Ironworks Company, £9,321; Paterson & Cooper, £6,992; Nicholson & Tyler, £7,921 6s. 7d.; H. F. Joel & Co., £7,920 14s.; Private Wire and Telephone Installation Company, £8,919; Calvert & Co., £4,965; National Electric Free Wiring Company, £7,631; Richmond Engineering Works, £5,840 10s.; H. C. Keen & Co., £7,775; Cash, Robinson & Co., £8,100: Crompton & Co., £8,223; Laing, Wharton and Down, £7,272; Hampton & Sons, £6,837; H. J. Rogers & Co., £7,125; Troup, Curtis & Co., £7,192; Brush Electrical Engineering Company, £6,958 10s. The tender of Messrs. Calvert & Co., the lowness of which was freely commented upon, was unanimously accepted. Messrs. Giles & Gough, of Charing Cross, are the architects.

Bootle.—Last week on the recommendation of the Watch Committee, the following tender of the British Insulated Wire Company, Limited, Prescot, was accepted in accordance with the specification prepared by Mr. T. L. Miller, electrical engineer for the borough:—65 10-ampere arc lamps with lamp-posts, incandescent lamp brackets, lamps, and other accessories, at £25 5s. 3d. per lamp; and seven 10-ampere arc lamps, with suspending wires and other accessories, at £19 18s. 9d. per lamp.

Colwyn Bay.—The District Council last week accepted the tender of Mr. Bertram Thomas for £1,469 for electric lighting on the parade. The following is a list of the tenders sent in, reproduced from the *Contract Journal*:—

	Gas plant.	Steam plant.
Eckersley & Co., Manchester	£1,971	£2,101
B. Thomas, Manchester (*accepted)	1,469*	1 589
British Insulated Wire Company, Prescot	1,507	1,589
Calvert & Co., Manchester	1,306	1,415
Smith & Co., Southport	1,398	1,418
Siemens Bros. & Co., Westminster	1,723	1,838
Sharp & Piper, Westminster	1,684	1,784
H. J. Mills & Co., Salford	1,684	1,807
Lea, Son & Co., Shrewsbury	1,870	2,008
Laing, Wharton & Down, London	1,661	1,764
Brook, Hirst & Co., Chester	1,510	1,627
Crompton & Co., Limited, London	1,685	1,707
Donnison, Barber & Co., Manchester	1,530	1,611
J. Maxwell & Sons, Dundee	1,490	1,584
J. Lomax, Kendall & Co., Manchester	1,769	1,864
G. Hill & Co., Manchester	1,522	1,654
Rhodes, Webster & Co., Bradford	1,481	1,591
Wallsall Electric Company, Wallsall	1,545	1,648
Belshaw & Co., Chester	1,904	2,084
W. Lucy & Co., Oxford	1,472	1,699
Donnison, Berlyn & Co., Liverpool	1,474	1,599
Lightfoot Bros., Manchester	1,425	1,541
J. Haynes & Co., Limited, Liverpool	1,577	1,751

France.—The French Post and Telegraph Authorities have just divided a contract for 139 kilometres of electric cables between the three following firms:—Messrs. De la Malrie & Co., of Gravelles-St. Maurice (Seine); the India-Rubber and Gutta-Percha Company, of Persan Beaumont; and M. A. Grammont, of Port de Cheruy.

London.—The London County Council Asylums Committee reported on Tuesday having accepted at £16,665 the tender of Edmundson's Electricity Corporation, Limited, of Westminster, for the electric lighting of the Heath Asylum, Bexley.

London.—The Private Wire and Telephone Installation Company have received orders from the Metropolitan Asylums Board to supply and fit an installation of telephones, fire alarms, and electric bells at the Grove Hospital, Tooting; and telephones at the North Eastern Fever Hospital, Tottenham. The same company has also instructions to fit the New County Hospital at Wakefield with telephones, electric clocks, and electric bells, for the West Riding County Council of Yorkshire.

Shoreditch.—At the meeting on Tuesday evening the Vestry considered the following tenders for the supply of cables for the arc light extension:—Messrs. W. T. Glover & Co.; Messrs. Siemens Bros.; Henley's Telegraph Works, Limited; The British Insulated Wire Company, Limited; Callender's Cable Company, Limited; The Western Electric Company, Limited; and Messrs. Witting Bros., Limited. The tender of Messrs. Glover & Co., for supplying cable under a five years' guarantee, was accepted at the following rates:—

		Including laying and jointing. s. d.	Delivery only. s. d.
·023	High tension twin cable	1 6 per yard	1 8
1·0	Low " "	10 1 "	9 9
·75	" " "	7 11 "	7 7
·5	" " "	5 4 "	5 1
·33	" " "	3 9½ "	3 6½
·25	" " "	3 1 "	2 10
·16	" " "	2 2 "	1 11

The Vestry also considered the following tenders for the supply of arc lamps and fittings:—

	£	s.
Messrs. Oliver & Co.	1,968	8
The Brockie-Pell Arc Lamp Company	2,046	0
Messrs. Johnson & Phillips	2,053	18
Messrs. Crompton & Co.	2,110	0
Messrs. Lucy & Co.	2,331	0
Messrs. Bergtheil & Young	2 382	0
Blahnik Arc Lamp Company (exclusive of carriers)	1 570	0

The tender of the Brockie-Pell Arc Lamp Company was accepted. The Vestry received the following tenders for supplying and fixing an electrically driven fan in the engine room:—

	£	s.	d.
Messrs. Pickup & Co.	69		0
The Blackman Ventilating Company	80	10	0

The tender of the Blackman Company was accepted.

Walsall.—The Electric Lighting Committee has accepted the tender of Messrs. Thomas Parker, Limited, to supply and erect an additional transformer for £558.

Waterloo.—The Council has given the contract to Messrs. Waring & Gillow, Limited, of Liverpool, for an electric light installation at the Town Hall.

FORTHCOMING EVENTS.

1898.

Friday, May 20th, at 10.30 a.m.—Second day of the Federated Institution of Mining Engineers at Burlington House, Piccadilly. Paper by Mr. W. T. Goolden, on "Coal Cutting by Machinery." Mr. W. Dixon's paper on the "Latest Developments and the Practical Application of Alternating Multiphase Machinery for Electric Power Transmission" will be open for discussion.

Saturday, May 21st, at 11 a.m.—Institution of Electrical Engineers. Students' visit to the works of the Electric Welding Company. Applications to join the party should be made at once to the Students' Hon. Sec.

Monday, May 23rd, at 8 p.m.—Society of Arts. Fourth and final Cantor lecture on "Electric Traction," by Prof. Carus Wilson:—Case when the final speed is not given—Design for covering a given distance in the shortest time for a given current—Time curves—Effect of using driving-wheels of different diameters — Design for covering a given distance in a given time, with the least possible expenditure of energy—Influence of the weight of the motor on the economy—Advantage of gearing—Example—The Chicago Metropolitan Elevated Railroad.

Wednesday, May 25th, at 7.30 p.m.—Institution of Civil Engineers. Students' Annual Dinner, Sir Douglas Fox in the chair, Restaurant Frascati.

Thursday, May 26th, at 9 p.m.—Conversazione at the Institution of Civil Engineers.

At 8 p.m.—The Institution of Electrical Engineers at the Society of Arts, John Street, Adelphi, W.C. "The Design of Electric Railway Motors for Rapid Acceleration," by Prof. Charles A. Carus-Wilson, member.

Friday, May 27th, at 5 p.m.—Physical Society, Burlington House. Agenda, "A Simple Interference Method of Reducing Prismatic Spectra," by Mr. E. Edser and Mr. Butler. "Some further Experiments on the Circulation of the Residual Gaseous Matter in Crookes Tubes," by Mr. Campbell Swinton.

At 9 p.m.—Conversazione at the Institution of Civil Engineers.

NOTES.

Presentation.—The employés of the Edison and Swan U.E.L. Company, Limited, and Altrincham Electric Supply, Limited, were entertained on Thursday evening at supper by Mr. Cowan, their late manager, and Mr. Still, who has been associated with him for many years, on the occasion of their leaving the firm. The gathering was a great success, and the men, having drunk prosperity to the Edison-Swan Company, presented Mr. Cowan with a handsome silver bowl, and Mr. Still with a massive cigarette box, both suitably inscribed. The presentation was made by Mr. Fawcus, director of the company, on behalf of the men, who all very heartily wished Messrs. Cowan & Still every success in their new venture as manufacturers of electrical specialities.

Appointments.—Mr. E. Garcke, managing director of the British Electric Traction Company, Limited, informs us that the following staff appointments have been confirmed by the board of directors :—

Mr. George Stevens (late town clerk of Hyde).	has been	appointed	Secretary
Mr. C. H. Dade	"	"	Assistant secretary.
Mr. G. Walmsley (late secretary of the company)	"	"	Accountant.
Mr. Stephen Sellon, Assoc.M.Inst.C.E.	"	"	Parliamentary engineer.
Mr. C. H. Gadsby, Wh.Sc., M.I.E.E.	"	"	Contract engineer.
Mr W. Howard Smith (late engineer on the construction of Lynton and Barnstaple Railway, and formerly city engineer, Carlisle)	"	"	Permanent way engineer.
Mr. H. M. Sayers (late engineer to Madrid, Oporto, and Bournemouth Electric Light Stations)	"	"	Power engineer.
Mr. T. B. Goodyer (late traffic manager of Birmingham Tramways)	"	"	General traffic superintendent.
Mr. J. A. Lycett (late clerk to the Kingswinford Rural District Council). Address: Wollaston, Stourbridge	"	"	Superintendent for Birmingham district.
Mr. J. Vincent Kitchener, (formerly secretary of the company). Address: 19, York Place, Oxford Road, Manchester	"	"	Superintendent for Manchester district, including the Potteries.
Mr. D. F. Sugrue (late manager of the Swansea Tramways Company). Address: Tramways Depôt, St. Helens, Swansea	"	"	Superintendent for South Wales District.
Mr. Frank B. Lea ...	"	"	Superintendent for Glasgow district, and *(pro. tem.)* for Newcastle district.
Mr. W. Gumbley, Assoc.M.Inst.C.E.	"	"	Superintendent for Midlands and Eastern Counties district.

Except where otherwise stated, the headquarters of the staff are Donington House, Norfolk Street, Strand, London, W.C.

The Parliamentary Electrical Committee.—Substantial progress was made on Monday, according to the Yorkshire *Daily Post*, by the Joint Committee of the House of Lords and the House of Commons which has been considering the question of electric light generating stations. Considerably more than half the chairman's draft was passed under review, and the main principles upon which electric light companies are to be allowed to work settled. The Committee, in the portion of the report dealt with, hold that the proved public advantages of electrical energy warrant the granting to undertakers of compulsory powers for acquiring sites for generating stations, and lands or easements for mains and pipes and other works. Provision, in their opinion, should be made for the granting of these powers in the provisional orders of the Board of Trade, subject to confirmation by Parliament. Procedure by private bills should be reserved, as at present, for exceptional cases. The powers indicated, it is suggested, may be given either to local authorities or to incorporated companies, whether the incorporation be by special Act or under the Companies Acts. With respect to liability for nuisance the Committee are of opinion that where the site for a generating station is acquired under compulsory powers, and is specified in the provisional order or special Act, the undertakers should not be subjected to any further liability than that which is imposed by the common law in the case of persons exercising statutory powers and duties. On the other hand, where the site for a generating station is acquired by agreement the Committee think the undertakers ought to be subject to the liability imposed by the common law. With respect to notices, they think that the existing practice as to notices to the local authorities, and also to owners, lessees, and occupiers of land, should be followed. As to notices in gazettes and newspapers no amendment of the existing law is suggested. Subject to these observations the Committee are of opinion that compulsory powers for the acquisition of land for a generating station may be properly given where the proposed site is not within the area of supply. The local authorities along the trunk lines, it is suggested, should have the same notices and the same *locus standi* as if that district were within the area of supply. In the case of powers being given for the erection of a generating station outside the area of supply the Committee think that powers may properly be given for laying the mains in streets leading from the generating station to the boundaries of the area of supply. It is also thought that the local authorities should not have a veto against the erection of overhead wires excepting in the case of the London County Council, the City Corporation, and the larger municipalities throughout the country.

A Cable Tramway Condemned.—Colonel Yorke has recently reported to the Board of Trade on the subject of the Cliff Railway at Constitution Hill, and a copy of the report was before the Swansea Council last week. In his report Colonel Yorke described the line, and said that from tests made in his presence he did not consider that the slipper brakes, which would have to be relied upon in case of the cable breaking, could be relied upon to pull up a heavily-loaded car, especially when the rails were wet or greasy. On the other hand, the grip brake, though powerful enough, was not sufficiently rapid in its application, and the speed might increase to a dangerous extent before this brake came into play. There were other features in the tramway to which objection might be taken. The fact that it had been laid as a single line necessitated the use of automatic switches at the crossing place. These switches must necessarily be uncontrolled, and any ignorant or mischievous person or child could push the switches over into the wrong position and cause an accident. Objection is taken to the Y shaped openings running down the hill, and the report continues :—"On looking at the order of 1896, I find that the line is to be laid on an interlacing line, and that the consent of the Board of Trade and of the Corporation is required if any alteration in this method of construction were desired. Had the line been laid as an interlacing line no switches would have been required, and no opening in the conduit such as I have described would have existed. I am unable to find that the Board of Trade have ever been asked to approve of the construction of the tramway as a single line. For this reason and because of the objectionable features inseparable from the use of a single line, and also on account of the insufficient control over the cars (1) by the engine, (2) by the brakes, which form sources of danger not only to passengers by the trams, but to the public using the thoroughfare, I do not consider the line in its present state suitable for public traffic, and I am unable to recommend the Board of trade to grant a certificate to the company."

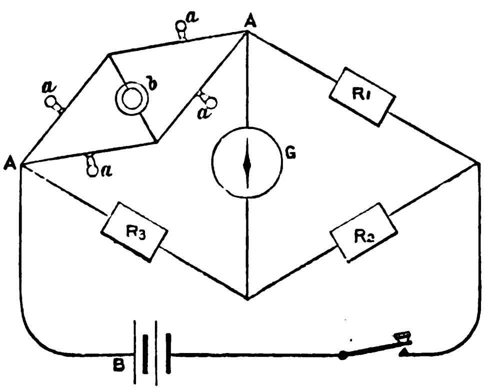
Personal.—Mr. Roland S. Portheim, of Messrs. D. Bruce, Peebles & Co., engineers, Leith, has just concluded a six weeks' tour in the States, where he has inspected many of the electrical manufactories and electrical power installations, more especially those dealing with transmission of power in mills and factories.

We understand that on Thursday last Mr. Henry Wilde, F.R.S., whose name is so well known as that of one of the pioneers in electrical work, was elected an honorary member of the Institution of Electrical Engineers.

Appointment. — We understand that Mr. A. Bentley, A.I.E.E., who went out to South Africa three years ago, has been appointed "electric wiring engineer" to the Johannesburg City Council, at £400 per annum. Mr. Bentley was formerly with Mr. Shoolbred.

Range Finder.—We understand that the Fiske range finder, of which we reproduced a description last week from the *Scientific American*, is made by the Western Electric Company, of Chicago and London.

Measuring the Resistance of Incandescent Lamps.—To those who like unnecessarily complicated ways of electrical testing the method of measuring the resistance of incandescent lamps when lit, described in the *Revue d'Electricité* of March 26th, may be interesting. The authors, MM. Abt and Hoffmann, content neither with taking the ratio of the reading of a voltmeter across the terminals to that of an amperemeter in series with the lamp, nor with a plain bridge test, arranged the test shown in the figure. Four lamps, *a*, *a*, *a*, *a*, are arranged in a quadrilateral



with the battery, *b*, for keeping them alight connected across the diagonal. If the lamps are of equal or proportional resistances, the potentials at A A will be the same. If not, additional resistances are arranged to make the two equal. Then the resistance between A A is measured by connecting R_1 R_2 R_3 to form another quadrilateral with A A and the testing battery, B, and galvanometer, G, connected to complete a Wheatstone's bridge. Then the measured resistance of A A gives the mean of the four lamps, *a*, *a*, *a*, *a*. The whole forms a pretty example of conjugate conductors in a complicated network, and suggests examination problems, but seems poor practice.

The Wright Wave Motor.—An interesting description of the Wright wave motor appears in the New York *Electrical Engineer*. This motor is one of the latest of a long list, which so far has been one of considerable failure. Tests were made in January, 1897, and were encouraging enough to warrant a new wharf and pier extending 350 feet out to sea, and carrying three floats with machinery on the wharf. The floats rise and fall with the waves, and operate vertical hydraulic compressors, which force water into a large air pressure tank, whence it issues as jets upon Pelton motors driving dynamos. The water is simply used over and over again. The tank acts as an equaliser from wave to wave. The present small plant has been running an electric generator continuously since September last, and when enlarged, a transmission line will be built to Redondo, four miles distant, and not far from Los Angeles. A table is given of the results of a public test, extending from December 1st to 11th. The number of waves per minute varied between 3 and 8 on the different days, according to the weather, averaging about 5½. The piston travel varied from 12½ to 18½ feet per minute, both the extremes being, on stormy days, averaging 15½. The average daily tank pressure varied between 150 and 195 lbs., and each float discharged an average of 3·9 cubic feet per minute, and 2·1 H.P. at the Pelton wheel. These figures represent a fall of about 24 gallons of water through a height of 370 feet. The result was nine electric lights kept going. The apparatus is self-regulating to a very large extent, any excessive air pressure tending to counteract the float movement. There is thus steady and continuous working within the limits of the plant.

New Fellows of the Royal Society.—Among the candidates selected by the Council of the Royal Society we observe the name of the Hon. C. A. Parsons, for his invention of the compound steam turbine, which he has adapted successfully to dynamo driving and other uses, and for his recent application of it to marine propulsion. Mr. James Wimshurst is also selected for his electrical influence machines and improvements therein, to which we refer at length on another page.

Corea.—The United States Consul-General at Seoul, Corea, reports as follows, according to *Trade and Industry:* "A company has been formed in the city of Seoul for lighting the streets and residences with electricity, and for operating electric street railroads through the principal thoroughfares. Only the latter will be begun at once. The company, known as the Seoul Electric Company, is composed entirely of Coreans, with the governor of the city as president. They have an exclusive franchise from the Department of Public Works."

Presentation.—Mr. Cassells, late superintendent of mains under the Glasgow Corporation, who has now entered the contracting business, was presented with a handsome testing set by the officials of the electricity department at a smoking concert held a few days ago.

Technical Education.—The Coatbridge Town Council has agreed to give £100 towards the teaching of metallurgy, electricity, &c., in the Technical School, from the local taxation grant, provided a similar sum is given by the County Council.

Correspondence.—Pressure upon our space compels us to hold over until next week a letter from Messrs. Zeitz regarding the "Limerick Electric Tramway Proposal," and one from Mr. E. K. Scott on "Testing Magnet Steel in Bulk."

Appointments Vacant.—The Corporation of Londonderry invites applications for the post of electrical engineer at £160 per annum. See our "Official Notices" this week for particulars.

The St. Pancras Vestry Electricity Committee wants an inspector of works. See our "Official Notices" this week.

The Glasgow Scheme.—We understand that the Corporation on Wednesday approved the minutes of the Electricity Committee, which embodied Mr. Chamen's large extension scheme which we gave briefly a few weeks ago.

The Telephone Committee.—We are compelled, owing to pressure upon our space, to hold over until next week our report of Tuesday's and yesterday's proceedings before the Parliamentary Telephone Committee.

NEW COMPANIES REGISTERED.

British Illuminating Company, Limited (57,260).—Registered May 7th, with capital £50,000 in £1 shares, to adopt an agreement with Smith's Acetylene Gas Lamp and Generator Syndicate, Limited, to manufacture, sell, and deal in calcium carbide acetylene gas generators, and to generate, sell, and deal in acetylene gas, coal gas, and electricity. The subscribers (with one share each) are:—G. Sandeman, Colinton, Midlothian, gas engineer; F. B. Taylor, 25, Mulgrave Terrace, Gateshead, accountant; P. Gilham, 27, Edward's Road, Whitley, Northumberland; J. A. Rowell, 10, Chester Crescent, Newcastle, agent; J. F. Kelly, 51, Doncaster Road, Newcastle, clerk; G. Robson, 64, Rothbury Terrace, Heaton, Newcastle, engineer; T. E. C. Green, 1, Poppelwell Terrace, Preston, North Shields, agent. The number of directors is not to be less than five nor more than nine. The first are H. Coates, N. Wyld, F. H. Smith, and D. J. Adler; qualification, £100; remuneration as fixed by the company. Registered by Jordan & Sons, Limited, 120, Chancery Lane, E.C.

J. Tylor & Sons, Limited (57,279).—Registered May 10th, with capital £200,000 in £10 shares (10,000 £5 per cent. cumulative preference), to acquire the business of a company of the same name (registered in 1890), to adopt an agreement with the said company and its liquidator, and to carry on the business of mechanical and consulting engineers, sanitary, hydraulic, and electrical engineers and contractors, brass founders, galvanisers, platers, tool makers, boiler makers, millwrights, &c. The subscribers (with one share each) are:—W. H. Tylor, 2, Newgate Street, E.C., engineer; J. G. M. Rumley, 43, Palace Court, W., C.E.; W. B. H. Drayson, 2, Newgate Street, E.C., engineer; P. Bright, 2, Newgate Street, E.C., engineer; J. S. Maples, 2, Newgate Street, E.C., engineer; R. Tylor, 2, Newgate Street, E.C., engineer; W. S. Salter, 2, Newgate Street, E.C., engineer. The number of directors is not to be less than three nor more than five; the first are the first four subscribers. Qualification, £1,000; remuneration, £100 each per annum. Registered by H. & G. Keith, 43, Chancery Lane, W.C.

Automatic Light Controlling Company, Limited (57,287).—Registered May 10th, with capital £10,000 in £1 shares, to adopt a certain agreement, and to manufacture, sell, and deal in apparatus and contrivances connected with electric light or gas, and for controlling and regulating the same. The subscribers are:—J. Gunning, Bournemouth, engineer, 100 shares; J. T. Gascoine, Bournemouth, gentleman, 60 shares; G. H. Rolls, Bournemouth, property agent, 60 shares; C. J. Haydon, Bournemouth, solicitor, 20 shares; Mrs. A. P. Gunning, Bournemouth, 20 shares; E. P. Wills, J.P., Haselwood, Stoke Bishop, Bristol, 100 shares; E. S. Wills, Frankfort Lodge, Clevedon, Somerset, 40 shares. The number of directors is not to be less than three nor more than seven. The first are: J. Gunning, J. T. Gascoine, G. H. Rolls, C. J. Haydon, and E. P. Wills. Qualification, £200; remuneration as fixed by the company. Registered office, Richmond Chambers, Bournemouth.

British Electric Transformer Manufacturing Company, Limited (57,293).—Registered May 10th, with capital of £50,000 in £1 shares, to adopt an agreement with A. F. Berry for the acquisition of certain British and Foreign patents for electric transformers, and to carry on the business of electrical engineers, electricians, electric transformer manufacturers, iron and brass founders, tool makers, mechanical engineers, boiler makers, &c. The subscribers (with one share each) are:—R. S. Bain, 25a, Cockspur Street, S.W., chartered accountant; R. J. Wallis Jones, 6, Hampstead Mansions, N.W., engineer; T. Petersen, 119, Worple Road, Wimbledon, electrical engineer; A. M. Billington, 7, Porchester Gardens, W., electrical engineer; A. F. Berry, 8, Heathcote Street, W.C., electrical engineer; W. A. B. Clarke, 10, Norfolk Street, Strand, solicitor; A. J. Allum, 25, Princes Road, Notting Hill, W., clerk. The number of directors is not to be less than three nor more than five; the subscribers are to appoint the first. Qualification, 500 shares; remuneration, £600 per annum and a percentage of the profits divisible. Registered by W. O. Vizard, 10, Norfolk Street, Strand, W.C.

"Volenites," Limited (57,337). — Registered May 13th, with capital £80,000 in £1 shares, to acquire the secret process and patent rights for the manufacture of "Volenites," to adopt an agreement with H. Bennett, and to manufacture, sell, and deal in oil, guano, volenite, vulcanite, railway sleepers, road and street paving, mats, railway carriage and other wheels, pulley wheels, brake blocks, carriage panels, electrical switchboards, fuse bases, electric bell bases, insulating material, electric motors, &c. The subscribers (with one share each) are: — Lurgan, 21, Lowndes Square, S.W., peer; F. B. Jameson, "The Albany," Piccadilly, gentleman; J. R. Parkington, 6, Devonshire Place, W., major; W. H. Wilson, 36, College Green, Dublin, stockbroker; T. B. C. Hardman, 74, Molesworth Street, Dublin, solicitor; J. K. Rigby, 154, Palmerston Buildings, Old Broad Street, E.C., chartered accountant; H. Fenwick, 95, Vauxhall Bridge Road, S.W., secretary; the number of directors is not to be less than three nor more than seven; the first are, Baron Lurgan, F. B. Jameson, J. R. Parkington, and G. V. Sims. Qualification, £250; remuneration, £200 each per annum, and £250 for the chairman. Registered by H. P. Becher, 26, Bedford Row, W.C.

Drake and Gorham Electric Power and Traction (Pioneer) Syndicate, Limited (57,352).—Registered May 14th, with capital £20,000 in £10 shares, to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity and manufacturers of electrical apparatus. The subscribers (with one share each) are:—B. M. Drake, 66, Victoria Street, S.W., electrical engineer; C. Poston, Highfield Stevenage, Herts, gentleman; C. J. Linas, J.P., Warnham Court, Horsham; G. T. Balfour, 2, Cushion Court, Old Broad Street, E.C., stockbroker; G. J. Poston, 10, Throgmorton Avenue, E.C., member Stock Exchange; J. F. Albright, 66, Victoria Street, S.W., civil engineer; A. F. Ashwell, 79, Queen Street, E.C., solicitor. The number of directors is not to be less than five nor more than 15; the first are the first 15 persons who subscribe for 50 shares each; qualification, £500; remuneration as fixed by the company. Registered by Ashwell & Co., 79, Queen Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

South London Electric Supply Corporation, Limited (50,392).—This company's return was filed on April 7th, when the whole capital of £325,000 in £5 shares was taken up. £2 per share has been called, and £131,334 received, including sums paid in advance of calls.

Dover Electricity Supply Company, Limited (39,779).—This company's return was filed on April 14th, when 4,860 shares were taken up out of a capital of £50,000 in £5 shares, and paid for in full.

Norwich Electricity Company, Limited (30,694).—This company's return was filed on March 30th, when 4,565 shares were taken up out of a capital of £50,000 in £10 shares, and paid for in full.

Chelsea Electricity Company, Limited (20,468).—This company's return was filed on April 28th. The capital is £200,500 in 34,000 ordinary and 6,000 preference shares of £5, and 500 founders' shares of £1 each, all of which have been taken up. 6,666 ordinary and 500 founders' shares are considered as paid, and the full amount has been called, and £166,670 paid on the rest.

Direct Spanish Telegraph Company, Limited (6,732 C).—This company's annual return was filed on April 27th. The capital is £95,000 in £5 shares (6,000 preference). 12,931 ordinary and 6,000 preference have been taken up, £5 per share has been called, and £94,655 received.

Sheffield Electric Light and Power Company, Limited (36,551).—This company's return was filed on April 12th, when 14,000 shares were taken up out of a capital of £280,000 in £7 shares; 4,000 have been issued with £5 per share considered as paid, £7 per share has been called on 10,000 and £2 per share on 4,000, resulting in the receipt of £78,000.

Guildford Electricity Supply Company, Limited (36,725).—This company's return was filed on April 21st. The capital is £20,000, in 3,900 ordinary shares of £5 each and 500 founders' shares of £1 each. 1,542 ordinary and all the founders' shares have been taken up, the full amount has been called, and £8,210 has been paid.

Windsor Electrical Installation Company, Limited (46,186).—This company's return was filed on April 6th, when 20,000 shares were taken up out of a capital of £25,000 in £1 shares. 450 are considered as paid, and £19,550 has been paid on the others. £1 7s. 6d. has been received in respect of 11 forfeited shares.

Gorseinon Electric Light Company, Limited (39,944).—This company's annual return was filed on April 15th, when the whole capital of £1,000 in £1 shares was taken up. 17s. per share has been called, and £843 15s. has been paid, leaving £6 5s. in arrears.

Oxford Electric Company, Limited (34,685).—This company's annual return was filed on April 9th, when 10,000 shares were taken up out of a capital of £100,000 in £5 shares, and paid for in full.

Ormore Valley Electric Light and Power Company, Limited (34,191).—This company's annual return was filed on April 9th, when 710 shares were taken up out of a capital of £10,000 in £5 shares. £5 per share has been called, and £3,350 received, leaving £197 unpaid.

CITY NOTES.

The New General Traction Company, Limited.

The meeting of this company, which was postponed from the 12th inst., was held at Cannon Street Hotel on Tuesday, Captain Francis Pavy presiding. The following report was taken as read:—

"At the commencement of the year the two Bills in Parliament referred to in last year's report, viz., the Norwich Electric Tramways Act and the Coventry Electric Tramways Act, received the Royal Assent. In connection therewith contracts have been entered into with responsible and competent contractors to construct both the Norwich and Coventry lines, and the work is being proceeded with as rapidly as possible. To enable the company to carry through these undertakings, the additional preference capital of £100,000, sanctioned at the last annual meeting, was created and issued at a small premium, thus permitting the directors to make contracts in exchange for shares and debentures in the Norwich and Coventry Companies, as provided in the Acts. The section of the Coventry Company already open for traffic has shown results exceeding the board's expectations, and the Douglas Southern Company in the Isle of Man, in which this company is interested, has also given satisfactory results. The gross profits of the year, including £1,681 18s. 11d. reserved last year on account of Bills before Parliament and since recovered, amount to £12,874 2s. 11d., to which must be added the sum of £2,982 19s. 1d. brought forward from last year, making a total amount of £15,857 2s. to the credit of profit and loss. The sum of £2,230 14s. 4d., representing the undivided profit of the old company, and brought forward from March, 1896, the board recommend shall be placed to a reserve account. The board has further decided to charge against the revenue of the year one-half of the cost of the issue of the new capital, amounting to £2,122 12s. 9d. This leaves a balance of £13,734 9s. 3d., from which have to be deducted £3,435 10s. 6d. and £52 15s. 9d. on account of general expenses, salaries, directors' fees, rent, travelling expenses, and legal and other charges, leaving £10,246 3s. as the amount of revenue to be dealt with. A dividend at the rate of 6 per cent. on the preference capital, calculated from the dates of payment, amounts to about £6,500, and the directors recommend that this be paid, and the balance carried forward to next year. Electric tramway business in Great Britain is still far behind that of most other countries in Europe and America, but steady progress is going on in the use of this power, and from the numerous projects submitted, and those now under consideration, the board have every reason to look forward to future profitable business."

The Chairman said that in the report they had tried to set out the facts, and it was no doubt a very satisfactory one. There were one or two things in the history of the company which he should like to mention. Some four years ago his friend Mr. Hopkins conceived the idea that there was room for a company to take up electric traction business, and with a few friends they started a company, which carried out schemes at Coventry and Douglas. So many matters, however, were submitted, that Mr. Hopkins communicated with him (the Chairman) with a view to enlarging the company's sphere. There appeared to be good business in it, and he (the Chairman) was glad to join with Mr. Hopkins in promoting his efforts. They began in a small way, and went on quietly, for they knew if good business could be secured they could put their hands on the capital to carry it out. They succeeded in getting Acts of Parliament for Norwich and for extensions at Coventry. They had been able to issue £100,000 in preference shares, and this was small for the operations they contemplated, but no doubt they would be asking the public for money later on. They regarded it necessary to move with caution, and to secure good business, and they were anxious to work in harmony with the corporations with which they were thrown in contact. It was not the amount of business but the good business which paid them. After referring to the backward state of electric tramways in this country, the chairman said he had no fear for the future. Their gross profits for last year had been £12,874; the undivided profit of the old company, amounting to £2,230, had been placed to reserve, and half the cost of issuing the new capital (£2,122) had been charged against current revenue. A dividend of 6 per cent. on the preference capital had been paid, and the balance would be carried forward.

The report was adopted.

West India and Panama Telegraph Company.

The ordinary general meeting of the West India and Panama Telegraph Company, Limited, was held at Winchester House on Wednesday, Mr. Wm. Andrews presiding.

The Chairman said that the receipts for the half-year had been £32,228, as compared with £34,053, showing a decrease of £2,000. Last year the French cable was interrupted, and that brought extra business; but, on the other hand, the disastrous state of trade in the West Indies, which had recently been intensified, had been an adverse influence. The expenditure had been £19,772, against £21,398 in the corresponding half-year, showing a decrease of £1,626. The reduction was not due to decrease of expenses, but to a smaller quantity of cable being used on the line. Owing to the falling off of receipts it had been necessary to transfer from the reserve fund £1,000 to enable them to make up the difference for the dividend. He apprehended there was no danger in that, seeing the increased value of their investments. With respect to the current period, he was sorry to tell the shareholders that, owing to the financial crisis in Antigua and St. Kitts, the subsidy had been reduced from £800 to £600. Then the subsidy of £2,000 per annum paid by the island of Jamaica had been discontinued from March 31st last, and he believed that the amount would in future go to the Bermuda and Jamaica Company. The shareholders had previously been informed, at the last meeting, of the necessity of a partial renewal of the line between Trinidad and one of the northern islands, so as to maintain the duplication of the system. They had succeeded in saving a certain mileage by the new cable. The Cuba Company had objected to them receiving messages at Jamaica for Eastern stations, and had threatened to take proceedings against them. The directors were advised they had a good case. As to the reductions in their rates, Mr. Chamberlain had made an announcement that the Government would give some support to the West Indies, and the directors, with that statement in view, thought they might also, in a small way, help the West Indies by making a reduction in the price of telegrams, and giving more facilities. He could not state the exact effect of the reductions on the revenue, but the falling off had not been much more than they anticipated, and latterly their revenue had increased, but this was consequent, probably, upon the number of messages sent over their line owing to the lamentable war between Spain and America. In anticipation of interruptions which might take place in their cables, they had taken steps to prevent interference, but in a time of war, as the shareholders knew, private, and sometimes public, interests were bound to go to the wall. They were keeping a ship on the spot in order to keep the system going.

In reply to a shareholder asking if there was still communication with Cuba, the Chairman said he did not want to define too clearly where the line might be interrupted, but they were still going on.

The report was adopted.

Mix & Genest, Limited.

On Monday, May 16th, the annual general meeting of the shareholders of Messrs. Mix & Genest, Limited, of Berlin, was held at their board room at 67, Bulow Strasse, when the directors submitted their report, recommencing a 10 per cent. dividend for the year 1897. The gross profit earned amounts to £25,000, which, after deducting expenses, and writing off £3,200 on tools and machinery, leaves a net profit of £13,570. The chairman informed the shareholders that business has been very brisk during the past year, necessitating a further extension of their newly-built factory, which up to now accommodated 1,000 hands, and which, with the additional premises, will allow of the employment of 1,500 hands. The directors state that the number and amount of Government and trade orders generally in hand are again in excess of last year's figures, and a further development can be prognosticated.

African Trans-Continental Telegraph Company, Limited.

Mr. Cecil J. Rhodes presided at a meeting of this company held yesterday at the offices of the company, 15, St. Swithin's Lane, E.C.

In speaking of the progress made by the company, the Chairman said they had gone from Umtali to Tete, and from Fort Johnson to Bandawe, and in about 15 months they expected to have carried the telegraph line to the south of Lake Tanganyika. They had had great difficulties with the line, and had abandoned the route from Salisbury to Tete, and carried the system from Umtali to Tete. The undertaking had been more expensive than was anticipated, and they had made arrangements with the directors of the Chartered Company to subscribe money to complete the line. They could not expect to make any profit till they got through to Cairo, for he did not think the local returns would pay. General Kitchener would reach Khartoum in October, and then it would be possible to carry their lines to Cairo. From Tanganyika to Uganda was only 600 miles, and from there to Cairo was 1,400 miles, and it was contemplated this could be completed in five years. The system would then enable them to send practically the whole of the African messages to London. If the cable company's charges were too excessive, they could lay an alternative cable. He thought the Government would undertake the expense of joining Khartoum by telegraph, which would not cost more than £120,000. After some further remarks the chairman proposed the adoption of the report, which was seconded by Earl Grey, and carried unanimously.

An extraordinary meeting was then held, when a resolution to increase the capital of the company to £300,000 was adopted.

Hobart Electric Tramway Company.

The report of the directors of the Hobart Electric Tramway Company, Limited, for the year 1897, which was submitted to the annual general meeting held at the registered offices on Friday last, states that the gross takings amounted to £12,380, and the working expenses to £8,853, and after deduction of debenture interest, administration, and other expenses in Hobart and London, the company has made a net profit of £301 for the year. The directors continue to receive assurances that the service provided by the line is much appreciated. The number of passengers carried by the tramway since the opening of the line in September, 1893, to September 30th last is 5,349,450, and the total number of car miles run is 1,336,157. The directors continue to receive from Mr. Parker, the company's general manager in Hobart, very complete weekly and monthly reports as to the working of the company's business, and are glad to be assured by him that the plant and rolling stock remain in an efficient condition.

The City of London Electric Lighting Company, Limited.—Return of gross revenue from supply of electricity only during quarter ended March 31st, 1898:—Gross revenue from public lighting, quarter ended March 31st, 1898, £3,162: corresponding quarter last year (under old rate of charges), £3,182. Gross revenue from private lighting, &c., less allowances to customers under reduced price and sliding scale, quarter ended March 31st, £52,132; corresponding quarter last year (under old rate of charges), £49,843; total, quarter ended March 31st, £55,294; total, corresponding quarter last year (under old rate of charges), £53,025; increase, £2,269. Equivalent of 8-C.P. lamps connected on March 31st, 1898, 310,660; increase during quarter, 14,648. Equivalent of 8-C.P. lamps connected on March 31st, 1897, 260,936: increase during corresponding quarter last year, 13,151.

New Motive Power Company.—A meeting of this company was held on Thursday at the Holborn Viaduct Hotel, but the press were not admitted. The directors' report stated that Mr. Guattari, the inventor, has settled in Belgium, and has failed to keep his promises to return to this country.

TRAFFIC RECEIPTS.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending May 13th, 1898, were £2,648 6s. 7d.; corresponding period 1897, £2,288 1s.; increase, £360 5s. 7d.

The City and South London Railway Company.—The receipts for the week ending May 15th, 1898, were £958; week ending May 16th, 1897, £1,000; decrease, £42; total receipts for half-year, 1898, £20,679; corresponding period, 1897, £20,503; increase, £176.

The Dublin Southern District (Electric) Tramways Company.—The receipts for week ending Friday, May 13th, 1898, were £528 0s. 6d.; corresponding week last year, £531 6s. 11d.; decrease, £3 6s. 5d.; passengers carried, 84,256; corresponding week last year, 95,616; aggregate to date, £8,357 17s. 9d.; aggregate to date last year, £8,697 17s. 11d.; decrease to date, £340 0s. 2d.; mileage open, 8 miles.

The Liverpool Overhead Railway Company.—The receipts for the week ending May 15th, 1898, amounted to £1,446; corresponding week last year, £1,352; increase, £94.

The Western and Brazilian Telegraph Company, Limited.—The receipts for the week ending May 13th, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £1,985.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, May 11th.	Closing Quotation, May 18th.	Business done during week ended May 18th, 1898. Highest.	Lowest
137,400*l*	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	...	...	100 104	100 —104	...	...
25,800	Amazon Telegraph, Limited, shares...	10	...	...	...	7 — 8	7 — 8	...	...
125,000	Do. do. 5% Debs. Red.	100	...	...	...	93 — 96	93 — 96	...	...
923,960*l*	Anglo-American Teleg., Ltd.	Stock	£2 9s.	£2 13s.	3 %	63 – 66	63 – 64	...	...
3,038,020*l*	Do. do. 6 % Pref.	Stock	£4 18s.	£5 6s.	6 %	113 114	112¼ 113½	114	112¾
3,038,020*l*	Do. do. Defd.	Stock	...	...	...	15¾ 16¼	14¾ - 15¼	16⅜	14½
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	7 %	7 %	15¾ 16¼	15¼ 15¾	16	15 9/16
75,000*l*	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	...	...	112 116	112 116	...	...
44,000	Chili Teleg., Ltd., Nos. 1 to 44,000	5	4 %	4 %	...	3 – 3½	3 – 3½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	8 %	8 %	160 – 170	175 – 185	183	...
918,297*l*	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	104 —106	104 —106	105	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	2 %	...	1/16 – 3/16	1/16 – 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	7 %	6½ - 7½	7 – 8	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	14½ - 15½	14½ 15½	15¼	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 11	10 — 11	...	...
30,000*l*	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	4½%	103 —106%	103 —106%	...	...
60,710	Direct United States Cable, Ltd.	20	2½%	2½%	...	10½ - 11	10¼ 10¾	10¾	...
120,000	Direct West India Cable 4½% Reg. Deb	100	...	...	...	99 —102	99 —102	...	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	...	17 – 17½	16¾ - 17¼	17 3/16	16⅞
70,000	Do. 6 % Cum. Pref.	10	6	6%	...	18 — 19	18 — 19	...	...
89,900*l*	Do. 5 % Debs., repay. August, 1899	100	5 %	5%	...	100 – 103	100 —103	...	...
1,302,615*l*	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4%	...	123 —127	123 - 127	125½	125
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7%	7 %	18 — 18½	17½ – 18	17 13/16	17½
25,200*l*	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5%	5 % 5 %	100 - 104	100 —104	...	...
100,500*l*	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5%	...	101 – 104	101 —104	...	...
320,000*l*	Do. 4 % Deb. Stock	Stock	4 %	4%	4 %	127 —130	127 – 130	...	...
35,100*l*	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5%	... ...	100 – 104	100 —104	...	...
46,500*l*	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5%	...	101 —104	101 —104	...	...
300,000*l*	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4%	...	102 —105	101 —104	101½	...
200,000*l*	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4%	...	105 —108 %	105 —108	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	4½%	11¼ – 11¾	11¼ – 11¾	11⅝	11¼
180,042	Do. do. 6 % Pref.	10	6 %	6%	6 %	16¾ – 17¼	16½ – 17	17	16 9/16
150,000	Great Northern Teleg. Company of Copenhagen	10	10 %	10%	10 %	28½ - 29½	28 — 29	28½	28¼
160,000*l*	Do. do. do. 5 % Debs.	100	5 %	5%	5 %	100 —103	100 - 103	...	...
97,000	Halifax and Bermuda Cable Co., Ltd., 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	97 —102	97 —102	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10%	10 %	50 — 53	50 — 53	51¾	...
100,000*l*	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6%	6 %	107 —110	107 – 110	107¾	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	4 %	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5½%	5½%	6 %	5⅝ – 5⅞	5⅝ - 5⅞	5¾	5 11/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5⅜ - 5⅝	5⅜ - 5⅝	5⅝	5⅜
1,329,471*l*	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	99 —104	99 —104	102¾	99
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	⅝ – ¾	⅝ – ¾	⅝	...
100,000*l*	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	105 —108	105 —108	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	5 %	8 — 9	8 — 9	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	136 – 141	136 – 141	...	..
58,000	United River Plate Teleph., Ltd.	5	4 %	5 %	...	4 — 4½	4 — 4½	...	...
146,733*l*	Do. do. 5 % Debs.	Stock	5 %	...	...	105 – 108	105 —108	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	*nil*	...	3½ - 4½	3½ - 4½	...	...
213,400*l*	Do. do. do. 5 % Debs.	100	5 %	5 %	...	99 —102	99 –102	...	...
64,269	Western and Brazilian Teleg., Ltd.	15	3 %	2 %	3¼ %	12 — 12½	11¾ - 12¼	12¼	12
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	7½ - 8	7½ - 8	7¾	...
33,129	Do. do. do. Def. Ord.	7½	1 %	*nil*	½%	4¼ – 4¾	4 — 4½	...	...
389,521	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	105 —108	105 —108	...	...
88,321	West India and Panama Teleg., Ltd.	10	¾%	1 %	¾ %	½ – ¾	½ – ¾	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	7¼ - 7¾	7¼ - 7¾	7⅝	7½
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	5 — 7	5 — 7	...	...
80,000*l*	Do. do. 5 % Debs. No. 1 to 1,600 ...	100	5 %	5 %	5 %	105 – 108	105 – 108	...	...
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7%	7 %	103 —108	103 – 108	...	...
160,100*l*	Do. do. 6 % Ster. Bonds.	100	6 %	6%	6 %	100 —105	100 – 105	...	...

ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share.	1895.	1896.	1897.	Closing Quotation, May 11th.	Closing Quotation, May 18th.	Highest.	Lowest
30,000	Charing Cross and Strand Electy. Supply	5	5 %	6 %	7 %	13 — 14	13 — 14	13⅝	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	6⅜	...
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 18,277 ...	5	5 %	5 %	6 %	9½ – 10½	9 — 10	10⅛	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	4½%	4½%	4½%	115 —117	115 —117	...	...
50,000	City of London Elec.Lightg. Co., Ltd., Ord. 40,001– 90,000	10	5 %	7 %	10 %	26 — 27	23½ - 24½	26	24½
10,000	Do. do. Prov. Certs. Nos. 90,001 to 100,000 £5.	10	...	...	...	18 — 19	16 — 17	17½	17
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17½ – 18½	16½ - 17½	...	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	129 - 134	129 —134	...	...
30,000	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—30,000	10	*nil*	*nil*	*nil*	13½ – 14½	12 — 13	13⅞	12½
10,000	Do. do. do. Nos. 30,001 to 40,000 £4 pd.	10	...	...	...	8½ – 9	6 — 7	8½	6⅞
20,000	Do. do. do. 6% Pref., 40,001—60,000	10	6 %	6 %	6 %	15 — 16	15 — 16	15½	15
17,400	Edmundsons Elec. Corp., Ld , ord. shares 1—17,400 £4 pd.	5	...	...	...	4 — 4½	3½ – 4½	...	...
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5			4 %	9½ – 10½	9 — 10	9½	9
10,000	Do. do. 7 % Cum. Pref. ...	5	7 %	7 %	7 %	11 — 12	11 — 12	...	...
62,400	*Metropolitan Electric Supply, Ltd., 101 to 62,500 ...	10	4 %	5 %	6 %	18 — 19	17 — 18	18½	17
220,000*l*	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½ %	117 —121	117 — 121	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	2 %	4 %	6 %	19½ – 20½	19 — 20	19½	...
31,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord.	5	7½%	10½%	14½ %	17½ – 18½	16½ – 17½	17⅜	16½
20,000	Do. do. 7 % Pref., 20,001 to 40,000	5	7 %	7 %	7 %	10 — 11	10 — 11	...	...
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	4 %	107 —110	107 —110	...	...
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2¼ – 2¾	1¾ – 2¼	2¼	2
79,900	Westminster Electric Supply Corp., Ord., 101 to 80,000 ...	5	7 %	9 %	12 %	16 — 17	15 — 16	16⅛	15⅜

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation May 11th.	Closing Quotation, May 18th.	Business done during week ended May 18th, 1898. Highest.	Lowest.
30,000	British Electric Traction	10	...	...	...	15½—16½	15½—16	...	...
10,000	Do. do. 6 % Cum. Pref. 30,001—40,000 £4 pd. (issued at £2 10s. prem. all paid)	10	...	...	...	7—8	7—8	...	...
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	2½%	*nil*	*nil*	1½—1¾	1¾—2	1$\frac{15}{16}$	1⅞
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	*nil*	4 %	2¼—2½	2¼—2½	2$\frac{3}{16}$	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	...	...	...	110—114	110—114	113	...
50,000	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	101—104	101—104	103¾	...
19,894	Central London Railway, Ord. Shares	10	...	...	...	10—10½	10—10½	10⅞	10⅜
129,179	Do. do. do. £6 paid	10	...	...	...	6—6½	6—6½	6¼	6⅛
59,254	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1¼—1¾	1¼—1¾	...	...
67,680	Do. do. Def. do. £5 pd. ...	...	...	...	...	4¼—4¾	4¼—4¾	...	...
630,000*l*	City and South London Railway	Stock	1$\frac{3}{16}$%	1$\frac{9}{16}$%	1⅞%	67—70	67—70	70	69½
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	...	...	2—2½	2—2½	2⅛	2
99,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 99,261	5	5 %	5½%	...	2¼—2¾	2¼—2¾	2½	...
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5½%	...	4—5	4—5	...	...
194,023	Do. do. do. 4% Deb. stock Red. ...	100	...	...	...	103—105	103—105	...	...
116,000	Electric Construction, Ltd., 1 to 116,000	2	5 %	6 %	...	2⅝—2⅞	2⅝—2⅞	2⅞	2¾
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 ...	2	7 %	7 %	...	3⅛—3⅜	3⅛—3⅜	...	...
111,100	Do. do. 4% Perpetual 1st Mort. Deb. Stock	Stock	...	...	...	106—108	106—108	...	...
91,196	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	...	...	...	½—¾	½—¾	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	...	...	...	⅜—⅝	⅜—⅝	...	...
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	10½%	7 %	7 %	9—11	9—11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	8 %	10 %	12 %	21½—22½	21½—22½	21½	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½—19½	18½—19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½%	110—115	110—115	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	21—22	21—22	21$\frac{15}{16}$	21$\frac{5}{16}$
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	102—106	102—106	104¾	...
87,500	†Liverpool Overhead Railway, Ord.	10	2⅞%	2⅞%	3¼%	10⅝—10¾	10⅝—10¾	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15¾—16¼	15¾—16¼	...	...
87,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	15 %	15 %	35—38	35—38	36¾	35¼
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102—105	102—105	103	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	...	...	133—136	133—136	134	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

* Birmingham Electric Supply Company, Ordinary £5 (fully paid) 10½.

House-to-House Company, 4½% Debentures of £100, 107—109.

Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 15½—16½; 1st Preference Cumulative 6 %, £5 (fully paid), 8—8½. Debentures, 107—110. Dividend, 1897, on Ordinary Shares 10 %.

* From Birmingham Share List.

London Electric Supply Corporation, £5 Ordinary, 3¼—3¾.

* T. Parker, Ltd., £10 (fully paid), 15¼.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8—8½. Dividend for 1896—6 %.

Bank rate of discount 4 per cent. (April 7th, 1898).

THE INSTITUTION OF ELECTRICAL ENGINEERS.

THE PREVENTION OF INTERRUPTIONS TO ELECTRICITY SUPPLY. By LEONARD ANDREWS, Associate. Read May 5th, 1898.

It is probable that some central station engineers will remark, on reading the title of this paper, that it is several years behind the times; that interruptions to the supply from a properly equipped modern station never now occur; that at their own particular stations the supply has never once been interrupted since it was started, &c.

It speaks volumes for the progress of electrical engineering during the past few years that there are several existing central stations that can show an absolutely clean sheet in this respect since their commencement, and everyone will agree that their engineers hold a very enviable position. It is very doubtful, however, if any of them can say that they have not a consumer connected to their mains who has during the past 12 months ever had his supply disconnected; and, if that is so, surely there is still sufficient room for improvement to make the matter worth discussing. After all, it is these local interruptions that are so irritating to consumers. Our experience has been that we get far more abuse from a consumer whose lights fail when his neighbour's lights are burning satisfactorily than we do if they are both suffering together.

Some of the engineers who have achieved such an excellent record attribute their immunity from failures to the fact that they use fuses made of copper of the same sectional area as the mains. There can be no doubt that a large majority of the interruptions that do occur are caused by fuses blowing when they have no business to do so. Yet it does seem rather risky to use no safety devices at all. We have already heard of more than one case where an arc of a few thousand horse-power has been started under the pavement, and would not be quieted until the supply had been switched off from the works. On the other hand, when one remembers upon what a number of fuses the continuity of an average consumer's supply is dependent, it is really wonderful that he is not more often left in darkness. It is no exaggeration to say that there are often from 15 to 20 fuses between the generators and the lamps they supply. Is it, then, to be wondered at that we are so often told that electricity supply is not to be relied upon? It would be different if we could always depend upon fuses blowing at approximately the current they are set for. But we cannot. It is no uncommon case to take two similar fuses that have been in use for some months and find that one requires about 100 per cent. more current to blow it than does the other. The fuses used on alternate current circuits appear to be particularly erratic in this respect.

The ELECTRICAL REVIEW drew attention to this fuse trouble in one of its leading articles a few months ago. Still more recently, Mr. W. B. Sayers, in an article in *Lightning* on the subject, says:—

"In a city less than 100 miles from where I live there is an electricity works which, so far as I am aware, has not failed to maintain its supply for a single minute during the last 4 or 5 years; and yet the popular belief that the 'electric light is not reliable' is maintained to this day, and with good reason. . . . . Now the only proper cause, in my opinion, for a main fuse 'blowing' is a short-circuit on the mains, and yet I have no hesitation in saying that less than 1 per cent. of the cases of main fuses 'blowing' are due to this cause."

The conclusion that we have come to at Hastings is that the only reliable conductor of electricity appears to be a copper cable; and, consequently, it seems advisable to reduce all fuses, switches, safety devices, and mechanical connections of any description to a minimum.

If any fuses that it is customary to use can be omitted, everyone will admit that they are a source of danger, and, consequently, better omitted. Take, for instance, the fuses between alternate-current generators and the bus bars: what are they used for? They cannot be necessary to protect the machines from being overloaded, because all modern makers claim that their machines may be short-circuited with impunity. Presumably they are intended to prevent a generator that fails, short-circuiting other machines working in parallel with it; but everyone knows that if two or three machines of an equal output, and equally fused, are working together, it would be the fuses of the healthy generator that would blow, and not those of the faulty one, because the former have to carry sufficient current to blow the latter, in addition to all the useful work on the mains at the time.

Now what should we think of an omnibus driver who cut the traces of one of his horses because it attempted to do more than its share of the work, or who, when one of them fell down dead, made the remaining horse drag the dead one along in addition to the extra work thrown upon it by the decease of its comrade? This sounds absurd, but it practically represents the manner in which we alternate-current station engineers have been educated to treat our machines; for are we not taught carefully to equip them with safety devices to cut them out of circuit just at the time when all their energies are required to burn out a short-circuit on the mains? whereas any device to prevent a failing machine from short-circuiting others is considered quite an unnecessary piece of apparatus.

In continuous-current stations zero cut-outs, or discriminating cut-outs, are generally used in preference to excess-current cut-outs —the word "discriminating" being used to designate a cut-out that operates only when the current is flowing through it in a reverse direction to its normal.

Magnetic cut-outs of any description have not hitherto been looked upon with much favour in this country. The majority of those now in use require too careful and delicate treatment to be popular. Only people who have attempted to design a simple and trustworthy discriminating cut-out can realise the number of difficulties that have

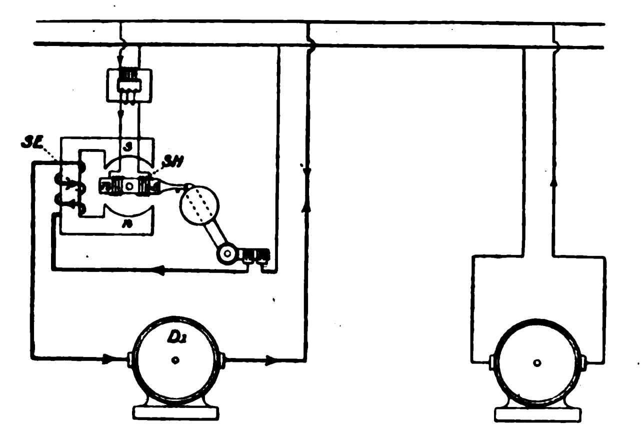


FIG. 1.

to be overcome in doing so. It is easy enough to make an apparatus that will operate under certain specific conditions in the workshops, but it is a very different matter to construct a cut-out that can be relied upon to open the circuit of a failing generator with a very small return current, and that can be guaranteed never accidentally to operate at any time when it is not required to do so. In the first place, the sectional area of the winding must be large enough to carry the maximum current of the generator without undue heating; at the same time the apparatus must be small and compact, consequently the turns must be few; and, finally, it must operate with a return current of only a small percentage of the maximum current, therefore the ampere-turns or magnetising force must be small.

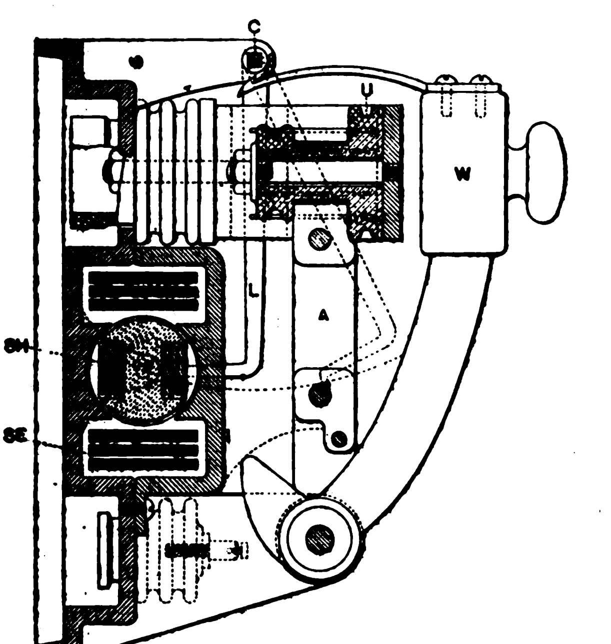


FIG. 2.

This generally involves the use of delicate releasing mechanism or relays, which require careful treatment, or they will operate at the wrong time, and not when a failure occurs. These are only workshop difficulties. The more serious are those which confront us when the apparatus is in use under actual working conditions.

Take, for instance, the case of zero magnetic cut-outs Everyone knows that these can be made to operate only when the current falls below a predetermined amount; and yet it is also well known that if a short-circuit occur on a system of mains supplied by a number of generators equipped with zero cut-outs, several of the generators will be promptly cut out of circuit. This is simply a specimen of the many troubles which it is impossible to forsee and guard against in the manufacturer's workshop.

Between three and four years ago we realised that a reliable discriminating cut-out was badly wanted, and since that time considerably over 100 different combinations of compound windings and releasing mechanisms have been experimented with. Many of these have only reached the experimental stage, but a fair proportion have had several months' actual use under working conditions before some unforeseen difficulty made it necessary to scrap them for some new and improved arrangement. The result has been that we have at last been able to secure a cut-out that appears to be perfect.

It appears at first sight impossible to design a satisfactory discriminating cut-out for use in connection with alternate current machines in which the current is reversing in direction some thousand times a minute. So long as one considers these reversals in relation to a constant polarity, it is, of course, impossible; but as soon as the direction of the current through a particular machine is considered relatively to the direction of the current in all other parts of the system, the problem becomes a comparatively simple one. *Fig.* 1 illustrates diagrammatically what we have found to be the most satisfactory method of applying this principle. The operating device in this arrangement is practically a shunt-wound motor, the thick

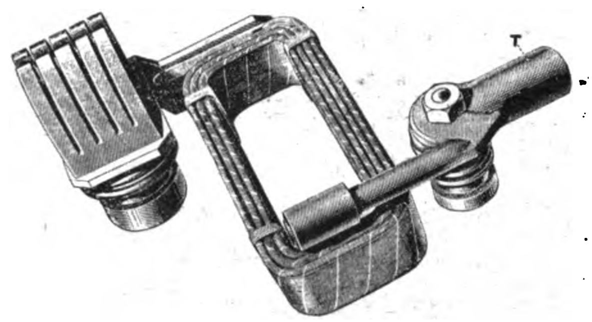


FIG. 3.

winding of which is connected in series with one of the leads from the alternator it is intended to control, and the shunt winding is connected across any transformer excited off the bus bars. Now it is obvious that the direction of the current in the shunt winding, S H, will pulsate synchronously with the current in the bus bars, and will be quite independent of the direction of the current in the series winding, S E, whereas the direction of the current in the latter relatively to the current in the bus bars will depend upon whether the machine to which it is connected is generating current or is being driven as a motor. If both machines are generating current, then the direction of the current throughout the whole system at a given moment will be represented by the arrow-heads shown full. But if, say, alternator D_1 fails, it will tend to short-circuit the rest of the system, and the current will rush back into it in the direction shown by the dotted arrow-heads, whereas the direction

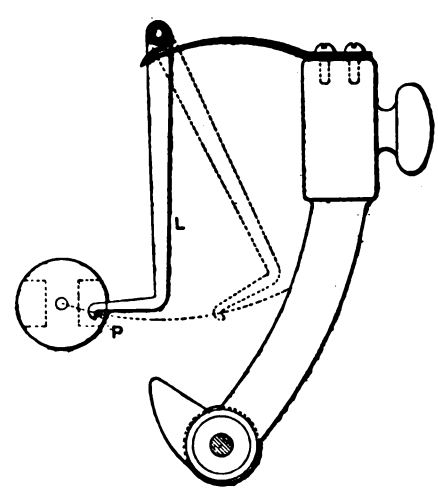


FIG. 4.

of the current in the other circuits will remain the same. In the former case the relative direction of the shunt winding to the series winding in the cut-out device will be such as to tend to make the armature rotate in a clock-wise direction, and so to lock the switch securely; but when, as in the latter case, the direction of the series current relatively to the shunt current is reversed, the armature will rotate in a contra-clockwise direction, and so open the circuit.

Fig. 2 is a sectional elevation of a mechanical application of this principle to a low-tension cut-out suitable for use with continuous-current generators, transformers, and low-tension mains. The weight, W, is held in a nearly vertical position by the catch, C. Attached to the catch is a lever, L, the free end of which engages in a pin projecting from a metal disc on the end of the armature, S H.

The series winding, S B, consists of a few turns of thick copper tape wound directly round the armature. One end of this is sweated and riveted directly on to a brass plate screwed and sweated to one of the contacts, and the other end is sweated on to a thimble, T (fig. 3), which forms one of the series terminals. The other series terminal is screwed and sweated directly on to the second contact. The whole of the series connections and contacts are supported on three corrugated porcelain insulators sulphured into the base. Fig. 3 shows these series connections removed from the rest of the cut-out. This series winding encloses a practically closed double magnetic circuit, consisting of the armature core, a portion of the base, and the cast-iron covers. For alternate-current working these parts are, of course, laminated.

An important feature of this cut-out is the releasing catch. This is shown in detail in fig. 4. The pin, P, is fixed in such a position on the armature disc that an extension of the arc described by the lever, L, will cut the pin, P, and the centre of the armature disc. The result of this arrangement is that no amount of vibration or pressure applied to the weight, W, will tend to make the disc rotate in either direction. And, consequently, when the armature is rotated by a return current, it releases the weight without having first to lift it, as it would have to do with any other form of catch. We find this an absolutely reliable and extremely sensitive form of release.

When the weight, W, is released it falls through an angle of about 60°, then with a sharp blow it strikes the arm carrying the contact connecting piece, thus overcoming any sticking of the contacts due to a good fit or to corrosion.

A specimen 500-ampere cut-out of this description is shown on the table. You will see that it is so reliable that, even when there is no forward current on to lock it in position, it may be knocked about with a mallet to show that no amount of vibration will release it, whereas it is so sensitive that the pressure of a feather upon the armature will do so.

The same general arrangement without any winding on the armature makes a very sensitive and reliable excess-current cut-out.

(To be continued.)

A Magnetic Balance for Workshop Tests of Permeability. By Prof. J. A. Ewing, F.R.S., Member. Paper read May 12th, 1898.

The author believes that the want is felt of a workshop instrument for making tests, in an easy and rapid fashion, of the magnetic permeability of cast and forged metal for dynamo magnets.

His own permeability bridge,* introduced two years ago, and now somewhat extensively used, allows the B-H curve for a given bar to be determined with very much less trouble than is needed to carry out ballistic tests. For the accurate comparison of one bar with another, throughout a wide range of magnetising forces, the permeability bridge is entirely suitable, and it furnishes as simple a means of performing that operation as can well be had. The author uses it systematically in his own testing, and is thoroughly satisfied with it as a means of determining the B-H curve. But the complete B-H curve is really more than the dynamo builder or the steel founder generally wants to know. For his purpose it would often suffice to find the induction produced by some one (fairly high) value of the magnetising force. That information is a sufficient index of the character of the specimen to allow judgment to be passed on its suitability for use in the field magnets of a dynamo.

These considerations have led the author to develop another testing instrument, which, while it tells less about the specimen than can be learnt by means of the permeability bridge, gives the most useful information in a still more easy way. To use it requires no knowledge of electrical testing, and the results need no working out. The value of the magnetic induction, in the usual units, corresponding to a single stated magnetising force, is directly read off on a divided scale.

The instrument is a magnetic balance of the traction type, making use of the principle already applied in magnetic testing in apparatus designed by Prof. S. P. Thompson, Mr. Gisbert Kapp, and Prof. H. Du Bois. In most apparatus of this kind the specimen has taken the form of a turned bar with a faced end on which the pull due to magnetisation was exerted. In the author's balance this facing of the end is not required, the magnetic pull being exerted between the side of the turned bar and a magnet pole which it touches, and from which it is pulled away. The specimen is a turned rod ½ inch in diameter, and 4 inches long. It lies across the two poles of a U-shaped electro-magnet, which is excited by a constant current of such strength as to produce a magnetising force in the rod of about 20 C.G.S. units. In one of the poles there is a V notch for the bar to rest in, and the other pole has a slightly convex surface, being curved to form a portion of a cylinder with its axis perpendicular to the direction of the length of the rod. The side of the rod touches this pole at one point only, and the tractive force at this point of contact is the force which is measured. A lever or weigh-beam is applied to pull the rod away from this pole, while the other end of the rod remains in the V notch in the other pole, forming what may be called a magnetic hinge. The tractive force is measured by means of a weight which slides along the graduated weight-beam.

When the rod is put in place, the current is reversed once or twice, to wipe out any residual effects of previous magnetisation. The weight is then moved along the beam until the beam just drops each time it is raised, so as to bring the side of the rod into contact with the pole.

The rod requires no preparation beyond turning it to the proper diameter. Its cylindrically turned side touches the convex pole-face in a perfectly definite manner, and the rod may be taken out and put back without altering the character of the contact. The lever is arranged in such a way that the rod always touches the same point of the pole-face.

The value of the magnetising force to be brought to bear on the rods under test was fixed at about 20 C.G.S. units for the following reasons:—

At forces much weaker than this, the B-H curves of different specimens often cross; in other words, the order of merit often changes when the force is varied. But the author's experience in testing dynamo steel leads him to the conclusion that with forces of 20 units and over, there is no serious change in the order of merit of various specimens. If a piece is good when H = 20, it remains good under stronger forces; if it is only fair when H = 20, it remains only fair, and a specimen that has relatively low permeability under this force does not take a materially better place when the force is increased. On the other hand, any considerably stronger force would be less convenient for testing, especially because the difference between good and bad specimens would become less well marked, and the sensitiveness of the test would consequently be reduced. The author has selected 20 as a force which, on the one hand, is sufficiently low to make the distinction wide between bad and good specimens, and on the other hand, is sufficiently high to make the order of merit substantially the same as is maintained under stronger forces.

From the measured induction at H = 20 the probable induction at higher forces can be inferred with some confidence. By examination of the results of tests of a very large number of samples of dynamo steel, including the published tests of Mr. Parshall,* as well as his own tests, the author has prepared the following table, to show the probable approximate values of B at forces of 25, 30, 40 and 50 C.G.S. units, when the value of B at a force of 20 is known. The values of B found for H = 20 range, in dynamo steel, from 16,000 in the very best specimens, down to 12,000 in specimens of decidedly low permeability. About 15,000 is representative of good dynamo steel castings, and anything below 14,000 may be pronounced poor.

Table I.—Probable Values of Magnetic Induction, B for various Amounts of Magnetising Force, H.

Magnetising force, H.	Magnetic induction, B.				
20	12,000	13,000	14,000	15,000	16,000
25	12,700	13,700	14,600	15,500	16,350
30	13,300	14,200	15,100	15,900	16,600
40	14,200	15,000	15,700	16,400	17,000
50	14,900	15,600	16,300	16,900	17,400

The range of the new magnetic balance extends (for H = 20) from 12,000 up to something over 16,000. It will test at the top of its range the very best samples that are found, and at the bottom of the range it will test steel of poorer quality than would be accepted for use in dynamo magnets.

The scale is a linear one, in which equal divisions correspond to equal differences in B, for a constant value of H. It is graduated to give by direct reading the values of B for H = 20. This uniform graduation is arrived at in consequence of the fact that with different specimens the magnetising force is not quite constant, although the current in the electro-magnet is constant. A specimen of high permeability increases the induction in the magnetic circuit, and consequently causes a larger share of the magneto-motive force to be used in that portion of the circuit which lies outside of the specimen itself. Hence the induction in the specimen is less high than its greater permeability would imply; in other words, the better specimen is exposed to a somewhat less magnetising force than the worse specimen is exposed to. The tractive force increases more rapidly than in simple proportion to the actual induction; but matters are so arranged that the lessening of the induction which comes about in the way just stated compensates for this, and the observed differences of tractive force, as measured throughout the range of the scale, stand in simple proportion to the differences in the values of B which the various specimens would exhibit if the force, H, were constant. In other words, a scale of equal parts on the weigh-beam corresponds to equal differences of B under a constant magnetising force, and the weigh-beam is accordingly lettered to read B directly in equal divisions. The readings give B for H = 20, although, in consequence of the action just explained, the actual magnetising force is barely 20 for rods of very good quality, and somewhat exceeds 20 for rods of lesser permeability. The scale is adjusted by the maker by selecting values of the sliding weight and of a fixed weight on the weigh-beam which will bring the readings into agreement with the known values of B in certain standard rods.

A single standard rod is supplied with each instrument, and the observer adjusts his current until the tractive force on that rod is such that the sliding weight stands at the place on the beam corresponding to the known value of B which a force of 20 C.G.S. units produces in that standard. The standard rod consequently serves instead of an ampere-gauge, and no other current measurer is required. A rheostat is provided in the instrument for regulating the current, and a single small storage cell forms the necessary battery. The observer puts in the standard rod, and turns the rheostat until he finds that the weigh-beam just drops each time it is

* Described in the author's paper on "The Magnetic Testing of Iron and Steel," *Min. Proc. Inst. C.E.*, May, 1896. See also the *Electrician*, May 8th, 1896.

* *Min. Proc. Inst. C.E.*, May, 1896.

lifted, while the sliding weight indicates the known value of B. He then puts in the rod which is to be tested, and finds the position which the sliding weight has to take for it, no change being made in the current. The constancy of the current is checked at the end of the tests by again putting in the standard rod.

The complete instrument is shown in the figure (fig. 1). The weigh-beam lifts the rod by means of a V-shaped stirrup close to the pole-piece, from which it is to be pulled away. When the rod is pulled away the beam comes immediately against a stop which limits the motion. A hinged piece is provided under the far end of the weigh-beam, to hold it up while a rod is being taken out or put in. The weigh-beam can readily be lifted out of the way when it is desired to clean the pole-faces, and care has to be taken to keep them, as well as the side of the rod where it touches them, free of dust and rust.

In the following table a comparison is made, for a number of rods of different qualities, of the values of B known to be produced by a magnetising force of 20 units with the values as measured by this magnetic balance. The known values of B were determined by means of the permeability bridge, by comparing each rod with a standard whose B-H curve had been found in the first instance by ballistic tests. The range covered by these examples is as wide as is likely to be met with in the practical testing of dynamo steel.

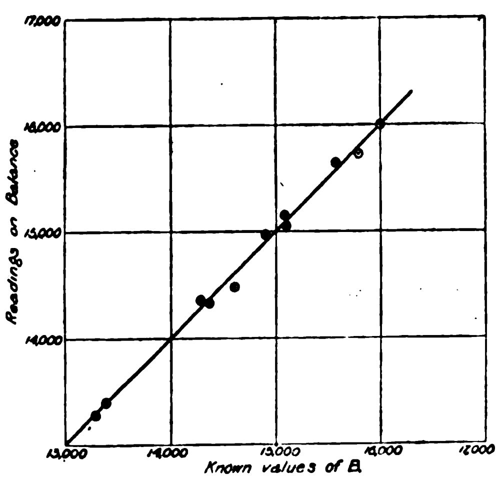


FIG. 2.

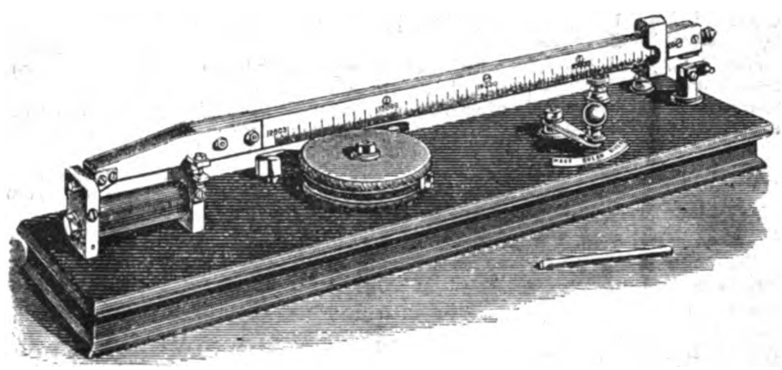


FIG 1.

TABLE II.—CALIBRATION OF THE BALANCE.

Induction, B, at H = 20, determined from independent measurements.		Induction, B, read from balance.
13,300	... ...	13,280
13,400	... ...	13,400
14,340	... ...	14,360
14,350	... ...	14,290
14,600	... ...	14,470
14,900	... ...	14,960
15,100	... ...	15,060
15,080	... ...	15,150
15,570	... ...	15,650
15,800	... ...	15,720
16,000	... ...	16,000

These tests relate to different specimens, all tested with one constant current in the magnet of the balance. The agreement between the scale readings and the known values of B is satisfactory. Fig. 2 exhibits the same tests graphically, the readings of the balance being plotted against the known values of B for H = 20. They show that within this range of B the values of the induction (under constant H) are fairly represented by the readings on the uniformly divided scale of the balance. Such irregularities as occur lie equally, so far as can be judged, on both sides of the straight line. The readings of the balance may be accepted as giving values of B for H = 20 at least as accurately as these are required in the uses which the balance is meant to serve.

TRAMWAY BILLS IN PARLIAMENT.*

Aberdeen Corporation Tramways.—To authorise the Aberdeen Corporation to acquire, and the Aberdeen District Tramways Company to sell their undertaking; to empower the Corporation to work or lease the tramways; and for other purposes.

New Capital—by Loan, £150,000.

Blackburn Corporation Tramways.—*Inter alia*, to authorise the Blackburn Corporation to acquire, and the Blackburn Corporation Tramways Company to sell their undertaking; to empower the Corporation to make additional Tramways, to use electrical or any mechanical power, and to work their tramway undertaking.

New Capital—by Loan, £187,000.

New Lines—1 m. 5 chs, double; 3 m. 37 chs., single—Total track, 5 m. 47 chs.

* *Railway World.*

Blackpool and Fleetwood Tramroad (Tramway Extensions.)—To authorise the Blackpool and Fleetwood Tramways Company to construct tramways at Blackpool, to be worked by animal, electrical, or any mechanical power not being steam power; to empower the Company to supply electrical energy in bulk, and to raise additional capital; and for other purposes.

New Capital—by Shares, £75,000; by Loan, £25,000.

New Lines—The part of the Bill relating to extensions has been dropped.

Blackpool Improvement.—*Inter alia*, to authorise the Blackpool Corporation to make additional tramways, to be worked by electrical, animal, or any other mechanical power; and to empower the Corporation to work the tramways.

New Capital—by Loan, £12,500.

New Line—58 chs., double; 2 chs., single—Total track, 1 m. 38 chs.

Bristol Tramways (Electrical Power, &c.)—To authorise the use of electrical or mechanical power on the tramways of the Bristol Tramways and Carriage Company, Limited, and the compulsory purchase of land; and for other purposes.

Bristol Tramways (Extensions).—To authorise the Bristol Tramways and Carriage Company, Limited, to construct additional tramways, and to widen certain streets and roads; and for other purposes.

New Line—6 m. 55 chs., double; 32 chs., single—Total track, 13 m. 30 chs.

Burnley Corporation Tramways.—*Inter alia*, to authorise the Burnley Corporation to work their tramways, if and when they acquire the tramways authorised by the Burnley and District Tramways Order, 1879, to use electrical or any mechanical power thereon, to generate electricity, and to enter into agreements with regards to the tramways in the Borough of Nelson, the Districts of Padiham and Brierfield, and the Township of Reedley Hallows.

Bury Corporation.—*Inter alia*, to authorise the Bury Corporation to work their tramways, if and when they acquire the tramways in the Borough; and to construct electric works.

Cardiff Corporation.—*Inter alia*, to authorise the Cardiff Corporation to construct tramways; to use electrical and other mechanical power to work their tramways; and to enter into working agreement with certain tramway companies.

New Capital—by Loan, £261,510.

New Lines—6 m. 48 chs., double; 1 m. 69 chs., single—Total track, 14 m. 5 chs.

Clontarf and Hill of Howth Tramroad.—To incorporate the Clontarf and Hill of Howth Tramroad Company; to authorise the construction of tramroads, to be worked by electrical or any mechanical power, except steam power; to confer power to acquire land; and for other purposes.

New Capital—by Shares, £50,000; by Loan, £25,000.

New Line—1 m. 16 chs., double; 4 m. 38 chs., single—Total track, 6 m. 70 chs.

Corporation of London (Foreign Cattle Market) Deptford.—*Inter alia*, to empower the Corporation of the City of London to construct a tramway between the Foreign Cattle Market at Deptford, and the Deptford Wharf Branch of the London, Brighton, and South Coast Railway; to be worked by animal power, or, subject to the approval of the Board of Trade, by electrical or other mechanical power, not being steam power.

New Capital—included with other works. New Line—22 chs., single.

Devonport, Plymouth, and Stoke Tramways.—To incorporate the Devonport, Plymouth, and Stoke Tramways Company; to authorise the construction of tramways, to be worked by animal or mechanical power; and for other purposes.

New Capital—by Shares, £150,000; by Loan, £37,500.

New Line—5 m. 61 chs., double; 31 chs., single—Total track, 11 m. 73 chs.

Dublin Southern District Tramways.—To amend the provisions of the Dublin Southern Tramways Act, 1893, relating to the speed at which engines, carriages, and trucks may be driven or propelled on the Dublin Southern District Tramways Company.

Dundee Corporation Tramways.—To confirm an agreement between the Dundee Corporation and the Dundee and District Tramway Company, Limited, to empower the Corporation to work their tramways; to use electrical or any mechanical power; and for other purposes.

East Ham Improvement.—*Inter alia*, to empower the East Ham Urban District Council to purchase any tramway in their district, upon the terms and conditions set forth in Section 43 of the Tramways Act, 1870, as if the period of years therein stated elapsed on the day of the passing of this Act, and to authorise the Council to use mechanical power, and to work tramways.

New Capital—by Loan, £8,000.

Folkestone Electric Tramways.—To incorporate the Folkestone Electric Tramways Company; to authorise the Company to construct tramways in Folkestone, Sandgate, and Hythe, to be worked by animal, electrical, or any mechanical power, and to acquire land; to provide for the supply of electrical energy by or to the Company; to confer power to enter into working agreements; and for other purposes.

New Capital—by Shares, £200,000; by Loan, £50,000.

New Lines—3 m. 41 chs., double; 9 m. 8 chs., single—Total track, 16 m. 10 chs.

Great Orme Tramway and Tramroad.—To incorporate the Great Orme Tramways Company; to empower the Company to construct a tramway and a tramroad, to be worked by animal, electrical, or any mechanical power, and to acquire land; to confer power to enter into agreements as to supply of electrical or other power by or to the Company; and for other purposes.

New Capital—by Shares, £25,000; by Loan, £6,250.

New Line—Total track, 77 chs.

Halifax Corporation.—*Inter alia*, to authorise the Halifax Corporation to construct new tramways, and to apply certain provisions of the Act of 1897.

New Capital—by Loan, £77,270.

New Line—1 m. 66 chs., double; 10 m. 20 chs., single—Total track, 13 m. 62 chs.

Hastings and St. Leonard's Tramways Company.—To incorporate the Hastings and St. Leonard's Tramways Company; to authorise the Company to construct tramways, to be worked by animal or other mechanical power; and for other purposes.

New Line—2 m. 21 chs., double; 5 m. 1 ch., single—Total track, 9 m. 43 chs.

New Capital—by Shares, £125,000; by Loan, £31,250.

Ilford Improvement.—*Inter alia*, to empower the Ilford Urban District Council to work tramways for the time being belonging to them, and to use mechanical power thereon.

Ipswich Dock Commission.—*Inter alia*, to authorise the Ipswich Dock Commissioners to make tramways, to be worked by locomotive engines, and to enter into agreements with the Great Eastern Railway with respect to working.

New Capital—Included with other works.

New Line—36 chs., double; 37 chs., single—Total track, 1 m. 29 chs.

Keighley Corporation.—*Inter alia*, to empower the Keighley Corporation to maintain a certain existing Tramway; to work their tramways; to use electrical or any mechanical power thereon; and to construct works for generating electricity.

New Capital—Included with other works.

Leyton Urban District Council.—*Inter alia*, to empower the Leyton Urban District Council to work tramways for the time being owned by them within their district, and to use electrical or other mechanical power thereon.

London County Council (Northern Tramways).—To authorise the London County Council to construct tramways in the County of London; and for other purposes.

New Capital—by Loan, £32,000.

New Lines—2 m. 3 chs., double; 6 chs., single—Total track, 4 m. 12 chs.

London County Council (Westminster Bridge and Embankment Tramways).—To authorise the London County Council to construct tramways over Westminster Bridge and along Victoria Embankment, in the administrative County of London; and for other purposes.

New Capital—by Loan, £24,000.

New Line—1 m. 49 chs, double—Total track, 3 m. 19 chs.

London United Tramways.—To authorise the London United Tramways, Limited, to construct additional tramways; to acquire land; and to use electrical or any mechanical power; to confer power as to the supply of electrical energy by or to the Company; and for other purposes.

New Lines—15 m. 4 chs., double; 68 chs., single—Total track, 30 m. 76 chs.

Manchester Carriage and Tramways Company.—To authorise the Manchester Carriage and Tramways Company to use electrical or any mechanical power on their tramways; to enter into agreement as to the supply of electrical power by or to the Company; and to raise additional capital; and for other purposes.

New Capital—by Shares, £100,000; by Loan, £25,000.

Norwich Electric Tramways.—To authorise the Norwich Electric Tramways Company to construct additional tramways and to make street widenings; to apply certain provisions of the Act of 1897; to provide for the purchase of the tramways within and without the City Borough, by the Norwich Corporation, and for the raising of additional capital; and for other purposes.

New Capital—by Shares, £24,000; by Loan, £6,000.

New Lines—14 chs., double; 68 chs., single—Total track, 1 m. 18 chs.

Oldham Corporation.—*Inter alia*, to empower the Oldham Corporation to work their tramways; to use electrical or any mechanical power thereon, and to construct electric works.

Plymouth Corporation.—*Inter alia*, to authorise the Plymouth Corporation to construct an additional tramway; to use electrical or any mechanical power; to construct electric works; and to work their tramways; and to apply certain provisions of the Order of 1893.

New Capital—by Loan, £4,000.

New Lines—35 chs, double.

Portsmouth Corporation.—To empower the Portsmouth Corporation to purchase the tramways undertaking authorised by the Landport and Southsea Act, 1863, to construct new tramways, to use electrical or any mechanical power, to work their tramways, to acquire land, to generate electricity, and to borrow money; and for other purposes.

New Capital—by Loan, £88,800.

New Lines—1 m. 7 chs., double; 1 m. 1 ch., single—Total track, 3 m. 15 chs.

St. Helens Corporation.—*Inter alia*, to authorise the St. Helens Corporation to construct tramways in and near the borough, to use electrical or any mechanical power, to construct electric works, and to work their tramways; to enable the Corporation to purchase or take on lease tramways within or outside the borough; and to empower the Board of Trade in certain cases to make provisional orders for the construction of tramways outside the borough.

New Capital—by Loan, £50,000.

New Lines—72 chs., double; 8 m. 41 chs., single—Total track, 10 m. 25 chs.

West Ham Corporation.—*Inter alia*, to empower the West Ham Corporation to work tramways which they may acquire within the borough, to use electrical or any mechanical power thereon, and to construct electric works.

Wigan Corporation.—*Inter alia*, to authorise the Wigan Corporation to construct additional tramways, to use the electrical or any mechanical power thereon, to purchase tramways authorised by the Order of 1895, to construct electric works, and to work their tramways; and to empower the Abram, Ince-in-Makerfield, and Standish-with-Langtree District Councils to purchase the tramways within their respective districts.

New Capital—by Loan, £38,000.

New Lines—40 chs., double; 5 m. 41 chs., single—Total track, 6 m. 1 ch.

BLAST FURNACE GAS FOR MOTIVE POWER PURPOSES.

A PAPER on this subject, by M. A. Greiner, was read recently before the Iron and Steel Institute. As this subject has been discussed in previous issues of the REVIEW, it may be interesting if we give an abstract of the paper. The author first referred to the experiments made with an 8 H.P. gas engine at Seraing, and to those at Wishaw, described by Mr. Galbraith in December last. Proceeding, the author said:—A short description of the great 200 horse-power engine at Seraing may be of interest. Gas from the blast-furnace gas mains is led through three pairs of coke scrubbers, 1·5 metres in diameter and 6 metres high (5 feet × 19¾ feet). The coke is washed with water delivered by Koerting spray-producers. The gas passes successively through the two scrubbers of each of the three pairs, and then straight to the engine. It may be sent at will through a gas-holder which is used for testing, or as a reservoir in case of eventualities. The gas-holder is 12 metres (39½ feet) in diameter, and has a lift of 3 metres (10 feet). It holds 300 cubic metres (10,600 cubic feet). Gas is drawn through it by a fan driven by an electromotor. The gas engine is of the four-cycle type, with a single horizontal cylinder 800 millimetres (31½ inches) in diameter, and a stroke of 1 metre (39·37 inches). It runs 100 revolutions per minute. The connecting rod works on to a counterbalanced crank shaft. The fly-wheel is 4 metres (13 feet) in diameter, and weighs 15 tons. Compression in the cylinder is carried up to 8 kilogrammes per square centimetre (about 114 lbs. per square inch). Ignition is produced electrically, and is adjustable; the governor is outside, and the whole build of the engine is simple and strong.

It was proposed to utilise this engine for running a belt-driven dynamo for power and lighting purposes, but this will be done with the second engine, and the first will be used for driving an air compressor directly off the main shaft. The air compressed to five atmospheres will be led by pipes to different machines and pumps, which are now driven by steam at the same pressure. A simple cock will enable steam or compressed air to be used at pleasure.

A number of objections have been offered to the use of gas engines driven by blast-furnace gas. The chief of these is the trouble that may arise from the dust carried by the gas. At Seraing the gas from the furnaces is no cleaner than in other places, but rather the contrary.

As regards the impalpable dust carried forward by the gas into the gas engine, no details of its amount are available. According to Mr. Lurmann, of the Gutehoffnungshutte, there remains about two grammes of dust in the washed gas after all possible means of purification. At the Georg-Marienhutte, Osnabruck, an average of 2·91 grammes of dust was found in a cubic metre of washed gas. Round figures of 2 grammes and a 200 horse-power engine using 4 cubic metres of gas per horse-power-hour would give 40 kilogrammes, or 88 lbs. of dust daily. Happily, nearly all this will pass out with the exhaust, as is shown by the 8 horse-power engine, which ran for four months without necessitating a clean up of the cylinder. All the dust was thrown out in the form of a translucent white smoke. It would be difficult to find gas-fired boilers which had run four months without cleaning. Besides, it is no more requisite to use thoroughly clean gas in a gas engine than it is to use distilled water in a boiler.

The second objection attributes a destructive action to the dust, due to the acid matters, especially sulphuric acid, that it contains. Analysis, indeed, shows sulphuric and phosphoric acids, besides chlorine; but the alkalies and lime also present probably neutralise their effect. It is not necessary to use an inordinate quantity of water for washing purposes, and no corrosive action has been observed in two years. The only part that requires cleaning after a few months is the ignition appliance; but even that shows no sign of corrosion, and it can readily be replaced in a few hours. A comparison with the time taken for cleaning and repairing a boiler and its setting leaves no doubt on which side the advantage lies.

A third objection to the use of blast-furnace gas depends on the irregularity of its composition. This objection is not so serious as it appears. In the first place, the gas engine readily accommodates itself to the variable condition of the gas, and experience has shown that when the gas ignites with difficulty under the boilers, it is not too bad to affect the regular operation of the engines. Even if the furnace is not running well, and the gas becomes non-inflammable, the same inconveniences occur with both boilers and engines. Coal has to be burnt on the boiler-grates, and it would have to be used in gas producers for the engines.

In conclusion, a summary of the advantages accruing from the use of gas may be given. Gas is, above all other means, the most suitable for transmission of power. In a factory where motive power is required at scattered points, there are many advantages in a central producer plant from which gas is led to gas engines at the requisite places. Blast-furnaces are gas producers ready to hand, and when there are two or three together, there is not much danger of very great variations in the quality of the gas. Gas can be supplied with ease under a low pressure, and without appreciable loss by leakage or condensation, to considerable distances. The mains and pipes are simple, light, and economical. Boilers, and the dangers accessory to their use, may be abolished. Gas shares with electricity the advantage of directly giving light, heat, and power, and this alone is sufficient to ensure its use by manufacturers, and its general application in metallurgical works.

THE INSTITUTION OF JUNIOR ENGINEERS.

A numerously attended meeting of this Institution was held at the Westminster Palace Hotel on Friday, May 6th, when a paper on "Evaporative Condensers, and Independent Air Pumps for same," was read by Mr. Harry Fraser, of Millwall, Member. The chairman, Mr. H. Bloomfield Vorley, presided.

In introducing the subject, the author alluded to the increasing field which was opening up for the use of the evaporative form of condenser through the establishment of electric central stations for power and illumination purposes. These stations generally being placed in crowded districts, so as to be convenient for distributing the current, difficulties in obtaining an adequate water supply usually arose where surface condensers were employed. The evaporative condenser, if properly designed, would do its work with a water supply equal to three-fourths of the weight of steam which it condensed, and descriptions of such condensers producing vacuums up to 26 inches were given.

In designing the apparatus, it was necessary to bear in mind the boiling points of water at various pressures less than that of the atmosphere, as, should the water trickling over the outside of the tubes become too hot when nearing the bottom, the condensed water inside would be re-evaporated, and the vacuum destroyed. An arrangement of compound condenser, in which the coldest water was first brought in contact with the coldest part of the condenser and the hottest water against the hottest part, thereby obtaining the greatest possible exchange of temperature between the inside and outside surfaces, was described, and tabulated figures given showing its advantages.

It was of great importance to have all the joints well made, and easily accessible; a very small air leak would seriously affect the working of the apparatus, and the average deposit on the outside of the tubes left by the evaporating water amounting to 25 ounces per square foot per annum, provision for cleaning was most essential. Specimens of the author's devices for cleaning the outside of the tubes, and distributing the steam through the inside of the condenser were exhibited. No fixed condition as to design could be determined, as the spaces available for the erection of the condensers varied through such wide limits. It had been found that horizontal tubes were more advantageous than vertical, but that the space occupied by a condenser with horizontal tubes was larger than that necessary for the erection of a vertical tube condenser. The distance between the condenser and steam engine was of no consequence, provided that due area was allowed in the exhaust pipe and in the air pump suction pipes.

Most of the inventions in connection with evaporative condensers simply dealt with various arrangements for the distribution of the cooling water over the outer surface of the tubes, it being difficult to direct water to flow with an even film over a hot tube. Illustrated descriptions of some of these arrangements were given.

It being necessary that the evaporative condenser should have a much larger surface to do a given amount of work than an ordinary surface condenser, the cost of construction per square foot of surface was an important consideration. As indicating the effect of improvements in construction, it was stated that some of the latest designed apparatus cost about one-half per square foot of surface as compared with earlier ones, without the efficiency of the condenser being impaired. By experiment it had been found that artificial fan draught improved the efficiency of the apparatus by about 50 per cent., and a fan draught was recommended when the load varied to any considerable extent, as then the fan need only be run during the heaviest load.

With a properly designed condenser, the proportions of air pump used for a surface condensing apparatus would be found equally satisfactory with an evaporative plant. The idea that it was requisite to have a much larger air pump for the latter probably arose from some of the earlier condensers having been put up with not sufficient surface to fully deal with the volume of exhaust steam entering them. If the condenser were not large enough, putting in a bigger air-pump would not prove a remedy. Models and designs of the various air-pumps constructed by the Worthington Company, Blake & Knowles Company, Browett & Lindley Company, and others, were exhibited, all of them being of the balanced beam system, which arrangement largely helped to overcome the natural inequality of the turning moment of an independent air-pump.

With reference to the increasing popularity of air-pumps having one set of valves only, and that set being above the piston, the author pointed out that while such an arrangement might work satisfactorily with marine type surface condensers, it was not certain that they would be equally favourable with evaporative condensers; but as his firm were now building two sets on this principle for a 1,500 H.P. plant, he hoped later on to be able to give some more reliable information on this single-valve pump question.

A discussion followed the reading of the paper, in which Mr. A. H. Stanley, Mr. T. C. Morewood, Mr. A. E. Carry, Mr. J. H. Pearson, Mr. R. Marshall, Mr. S. Boulding, and Mr. W. J. Tennant took part. The author having replied, and a vote of thanks having been accorded him, the proceedings then concluded.

THE PARSONS TURBINE PATENT.

In our issue of April 22nd we gave briefly the decision of the Judicial Committee of the Privy Council to extend the Parsons turbine patent for a period of five years.

On Saturday Lord Macnaghten gave their Lordships' reasons. He stated, says the *Times*, the invention which was the subject of the patent was one of conspicuous merit. It had solved a problem which for 100 years and more had exercised and baffled the ingenuity of inventors. Many persons had endeavoured to employ the velocity of steam for the purpose of causing rotary motion without the intervention of any reciprocating apparatus. But no one before Mr. Parsons ever succeeded in producing a steam turbine of practical utility. Mr. Parsons had his attention directed to the subject while he was a student at Cambridge, and he devoted much time and thought to it then. But it was only after prolonged research and many experiments that he was able to determine the conditions of success. Mr. Parsons stated in his specification that motors according to his invention were applicable to a variety of purposes. Practically, however, up to the present time they had been applied only to the two purposes of electric lighting and marine propulsion. For the purpose of electric lighting the invention seemed to be specially adapted. In dispensing with reciprocating action Mr. Parsons got rid of vibration. It thus became possible to establish electrical stations in populous places and to use the most powerful engines there without fear of being stopped by an injunction on the ground of nuisance. As regards marine propulsion, only one vessel so far had been equipped with Mr. Parsons's invention. The success of that experiment had, however (as their Lordships were informed), induced the Admiralty to order two vessels of a similar type, one of which was guaranteed to attain the speed of 35 knots. Lord Kelvin, when examined as a witness, expressed his opinion that there was a great future for steam turbines, and that, for some purposes, Mr. Parsons's invention was likely to supersede the reciprocating type of engines. So far the case was clear. The difficulty began when the question of remuneration came to be considered. It would not be easy under any circumstances to appraise the value of such an invention or to assess even approximately the amount of remuneration which it deserved. The task was not rendered lighter by the circumstance that it was impossible to measure with anything like accuracy "the profits made by the patentee as such." If the invention had been less meritorious, their Lordships would have been disposed to consider that circumstance fatal to the application, as it certainly would have been if the difficulty had been attributable to any fault on the part of the patentee. But their Lordships were satisfied that the patentee's accounts had been fairly kept and fairly presented, and that Mr. Parsons had given their Lordships all the assistance in his power. The general accounts of receipts and expenditure in respect of the English patent, exclusive of its application to marine propulsion, brought a result showing that the total expenditure had exceeded the gross profits by £1,107 13s. 10d., after allowing interest on capital at 7 per cent. per annum, but without charging anything for the patentee's services. In regard to foreign patents corresponding to the English patent, the patentee's accounts brought out a loss of £202 4s. 11d. The Belgian, German, Italian, and Swedish patents were allowed to lapse in the interval between July, 1890, and December, 1893, when Mr. Parsons's patent rights were in the hands of his late partners, from whom they were repurchased in December, 1893, in consideration of £1,500. In September, 1895, Mr. Parsons sold to the

Westinghouse Machine Company, of Pittsburg, the United States and Canadian patents, together with other valuable patent rights belonging to him, but reserved the right to use all the patents comprised in the sale for the purpose of marine propulsion. The consideration was a lump sum of £5,000 and certain royalties in respect of which £850 had been received. The total amount received from the sale, after deducting expenses, was £5,263 18s. 8d., of which one-fifth was attributed in the accounts to the patent No. 6,735, 1884. Even if the whole proceeds of the sale were attributed to the original patent, it appeared to their Lordships that the gain on the foreign patents would not counterbalance the loss on the English patent if any reasonable allowance was to be made to the patentee for his services. The result so far, in a pecuniary point of view, was disappointing. Their Lordships were, however, satisfied that Mr. Parsons had done his best to push his invention. Its slow progress in public favour was in accordance with all experience. New methods were not welcomed by workmen or manufacturers, or even by mechanical engineers. The greater the novelty, the greater the apathy and hostility to be overcome. The circumstances relating to the application of the patent to the purposes of marine propulsion, and the results in the shape of profits attributable to that application, required a more detailed statement. In 1893, Mr. Parsons made numerous experiments in order to test the applicability of steam turbines for marine propulsion. In January, 1894, he granted to the Marine Steam Turbine Company, Limited, an exclusive license to use for marine propulsion only the patent in question, with a large number of others belonging to him. In consideration of that license he received £9,000 in fully paid-up shares in the company, which had an issued capital of £24,000 out of a nominal capital of £25,000, so that Mr. Parsons became interested in three-eighths of the issued capital of the company. In order to demonstrate the effect of steam turbines as applied to marine propulsion, the company built and equipped the *Turbinia*, at a cost of about £16,000. Mr. Parsons executed all the work for the company at net cost, and without making any charge for his own services. When the success of the *Turbinia* was established, a new company, called Parsons's Marine Steam Turbine Company, Limited, with a nominal capital of £500,000, divided into 5,000 shares of the nominal value of £100 each, was formed for the purpose of purchasing from the old company the license which they held from Mr. Parsons, together with the *Turbinia*, and all the tools and effects of the company. The purchase price was £30,000 in cash, and £80,000 in shares, together with certain royalties and certain rights to further shares in the event of further issues of capital. After repayment of the outlay on the *Turbinia*, the sum received in cash by Mr. Parsons in respect of his shares in the old company did not seem to have been more than sufficient to pay him a fair remuneration for his services in connection with the *Turbinia*. The result appeared to be that the remuneration which Mr. Parsons had received for his invention consisted of so much of his interest in the new company and so much of his remaining interest in the old company as might be properly attributable to the patent No. 6,735, 1884. As regarded Mr. Parsons's interest in the old company, he was entitled to certain royalties which no doubt might prove extremely valuable, but from which no profit had hitherto been derived. His shares in the new company, 300 in all, reduced in number by a few shares given by him to his employés, were admittedly of considerable value. Shares in the company were not on the market, and had never been sold. Their Lordships, however, thought they ought to be taken at their par value. The question then arose how much of Mr. Parsons's interest in the old company and in the new company was properly attributable to the patent No. 6,735, 1884. That was a very difficult question. But, having regard to all the circumstances, and having considered the evidence of the gentleman who assessed the value of the patents comprised in the sale to the new company for the purpose of apportioning the price between them, their Lordships had come to the conclusion that the amount should be taken at not more than one-half and not less than one-fourth. Having arrived at that conclusion, considering the position of the new company, bearing in mind that it could not commence operations at the earliest before August next, and that the value of the shares in the new company must depend to a large extent on the prolongation of the original patent, and weighing all the other circumstances of the case, their Lordships were of opinion that Mr. Parsons had not been adequately remunerated, and they would consequently make their report to that effect. They had already intimated that the patent should be prolonged for five years.

NEW PATENTS.—1898.

Compiled expressly for this journal by W. P. Thompson & Co., *Electrical Patent Agents*, 322, *High Holborn, London, W.C., to whom all inquiries should be addressed.*

10,022. "Improvements in the manufacture of carbons and filaments for electric lamps." G. Daubenspeck. Dated May 2nd.

10,034. "A new or improved primary electrical battery." A. Frazer and G. A. Smith. Dated May 2nd.

10,065. "An electric double-pole fuse plug and combination grid connection." A. Walters. Dated May 3rd. (*Complete.*)

10,089. "Improvements in electric telephony." C. Adams-Randall. Dated May 3rd.

10,094. "Improvements in the art of making plates for electric battery purposes." A. C. Croftan. Dated May 3rd. (*Complete.*)

10,110. "Improvements in electric arc lamps." C. Oliver. Dated May 3rd.

10,121. "Improvements in, and connected with, arc lamps." J. F. Wakelin. Dated May 3rd.

10,225. "An improved method of casting accumulator plates and apparatus therefor." J. Hesse and J. Kershaul. Dated May 4th. (*Complete.*)

10,236. "Improvements in electric arc lamps." W. J. L. Sandy, D. C. Bate, and T. Gibbs. Dated May 4th.

10,245. "An improved automatic electric cut-in and cut-out." A. E. R. Bottone. Dated May 5th.

10,248. "Improvements in electrical time checking and registering apparatus." C. Miles. Dated May 5th.

10,269. "Improvements in alternating current induction motors." The British Thomson-Houston Company, Limited. (C. P. Steinmetz United States.) Dated May 5th. (*Complete.*)

10,270. "Improvements in alternating current induction motors." The British Thomson-Houston Company, Limited. (C. P. Steinmetz, United States.) Dated May 5th. (*Complete.*)

10,291. "Rheostats for electric circuits." C. Wirt. Dated May 5th.

10,308. "Improvements in appliances for automatically replacing fuses in electric installations for lighting or transmission of power." S Harrison. Dated May 5th.

10,314. "Improvements in, or relating to, electric motors." H. H. Lake. (R Arno and A. Caramagna, Italy.) Dated May 5th.

10,333. "Improvements relating to electric signalling and similar apparatus." L. S. Crandall. Dated May 5th. (*Complete.*)

10,346. "Improved apparatus for automatically cutting off current of electric overhead or other like wires." R. Bostock and F. A. Cheetham. Dated May 6th.

10,352. "An improved magnetic motor engine." E. J. Knight. Dated May 6th.

10,428. "Improvements in electro-therapeutic exercising apparatus." A. Martin. Dated May 6th.

10,437. "Improvements relating to cut-outs and switches for electric motors and other electrical apparatus." G. A. Moore. (H. H. Cutler, United States.) Dated May 6th. (*Complete.*)

10,440. "An improved detachable ceiling rose for use with arc lamps and other electrical apparatus." A. L. Davis. Dated May 7th.

10,450. "Improvements in the construction of dynamo-electric machines and motors." M. W. W. Mackie. Dated May 7th.

10,457. "Improvements in galvanic batteries." E. Habermann. Dated May 7th.

10,475. "Improvement in electrical accumulators." W. Peck. Dated May 7th.

10,477. "Improvements in quick-break switches or cut-outs for electric lines." G. Jaeger, C. Jaeger, and H. Bender. Dated May 7th. (*Complete.*)

10,453. "Improvements in and relating to electrical switches." F. W. Abbott and R. W. Bill. Dated May 7th.

10,496. "A new or improved maximum electric current self-recording instrument." F. M. Staunton. Dated May 7th.

10,511. "Improvements in and apparatus for producing mechanical energy from alternating electric currents." A. Heyland. Dated May 7th.

10,523. "Improvements in apparatus for regulating electric arc lamps." I. H. Hegnar. Dated May 7th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free,* 9d. *(in stamps).*

1897.

19,035. "Improvements in electrolytic apparatus." H. S. Johns. (E. Balbach.) Dated August 17th, 1897. This consists of a cathode case composed of a trough having its bottom divided in two portions, one of which is horizontal. The other portion sloping down and connecting the horizontal portion throughout its length. It is provided with a cathode plate and an anode suspended therein, arranged to cover the horizontal portion of the bottom only. The anode case is composed of an exterior frame which has a grated bottom, and an inner frame fitting into the exterior case, with a filter cloth bottom. Instead of one anode case there may be a series, arranged transversely side by side. 5 claims.

20,041. "Improvements in metal for telegraph and other poles." G. W. Glazier. Dated August 31st, 1897. This consists of a pole, to the end of which is secured segmental metal base sections, by means of bolts. The lower ends of these sections are made outwardly flaring, and are provided with a series of perforations through which the earth is rammed after these sections have been placed in a cavity in the ground. On the outside of these sections are strengthening ribs which, besides serving to increase the strength, also in a measure conceal and protect the heads and nuts of the fastening bolts. 2 claims.

1898.

3,796. "Improved means for displacing, dispersing, or extinguishing arcs formed in breaking electric circuits." S. H. Short. Dated February 15th, 1898. Relatively stationary co-operating contacts are mounted on the controller of a cylinder and conducting coils comprising spiral convolutions, are arranged in the circuit to be broken adjacent to each pair of contacts. There is a shunt circuit for these coils and contacts controlling the shunt circuit, so that when the controller is in "running" position the coils are cut out of the working circuit and are replaced in circuit in advance of the opening of the circuit. 10 claims.

THE

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THE STANDARDISING OF GENERATORS, MOTORS, AND TRANSFORMERS.

THE title of this article names the subject set for discussion at a recent meeting of the American Institute of Electrical Engineers at New York, and in opening this meeting the president said that, although the general desirability of standardising electrical apparatus had often been spoken of, and seemed to be generally believed in, yet people were by no means agreed as to the feasibility or policy of the Institute taking steps in that direction; and he, therefore, suggested to the meeting, as proper subjects for discussion, the general question of the advisability of fixing standards, what standards should be fixed, and how far they should go. Mr. E. W. Rice, jun., then opened the discussion, and after referring to the great advantages which accrued from establishing certain standard types and sizes of apparatus, said that, in his opinion, standardising in this direction was a matter which the Institute should not deal with. There were, however, certain features of the subject under discussion which, it seemed to him, could and should properly be considered by the Institute; and he then suggested seven subjects, as follows:—

1. *Definition of Efficiency.*—Mr. Rice stated that electrical efficiency was still sometimes confused with commercial efficiency, and that a more exact definition of the term "commercial efficiency" was wanted, as in the United States the mechanical losses, friction, and windage of the dynamo were debited to the prime mover in the case of direct-coupled machinery, and to the dynamo in the case of belt-driven machinery.

2. *Heating Limits, and Methods of Determining the Same.*—Mr. Rice did not advocate the adoption of any definite number of degrees rise of temperature as a standard, but pointed out the necessity of better defining the methods to be employed for measuring this rise of temperature.

3. *Regulation.*—As an illustration of the necessity of a more accurate definition of what was meant when it was stated that a machine should regulate within a certain percentage, it was mentioned that many different definitions of the term regulation, as applied to alternating current machinery, were in actual use by different engineers; amongst them being the percentage drop in terminal pressure from no load to full load, with constant open circuit excitation; the percentage rise of terminal pressure from full load to no load with constant full load excitation; and the percentage increase or decrease of excitation required to maintain a constant terminal pressure from no load to full load, or *vice versâ*.

4. *Sparking.*—Mr. Rice thought they must all admit that this was a difficult matter to standardise; but he suggested

that the meeting might consider whether they could not define the limits between which freedom from sparking should be demanded for commutating machinery.

5. *Insulation and Methods of Testing.*—As it was frequently specified that the insulation of a generator or motor should withstand certain breakdown tests by being subjected to a pressure considerably higher than its working pressure; Mr. Rice suggested that, although it was perhaps too early, in view of the rapid development of the industry, to determine definitely the limits and conditions of such tests; yet the subject might be discussed with profit, and perhaps some useful recommendations be made.

6. *Rating.*—As an illustration, Mr. Rice mentioned that it was customary in the United States to rate alternating current machinery on the basis of volt-amperes output, whereas in other countries the rating was often based upon the volt-amperes output multiplied by an assumed cosine of the angle of lag, and he suggested that some standard method should be adopted.

7. *Frequency of Alternating Current Machinery.*—Mr. Rice said that alternators were being built in the United States for frequencies of 25, 30, 35, 40, 50, 60, 66, 125 and 133, and he suggested that three or four frequencies might be selected which would practically meet all requirements under the different conditions of generation, transmission and service, and that great advantages would accrue if it were possible to agree on such a limited number of standard frequencies.

In concluding his remarks, Mr. Rice laid much stress on the advisability of referring the question to a small committee of members, which would be instructed to confer with manufacturers, consulting engineers, and prominent users of electrical apparatus, and to report its recommendations to the Institute. The discussion which followed, and adjourned without any definite resolution being adopted, showed considerable divergence of opinion both as to what should be standardised, and as to the best way of dealing with the questions suggested for consideration; indeed, a great part of the time was spent in discussing the momentous question of whether manufacturers should or should not be admitted as members of the committee to which it was proposed to refer this question of standardising. The reason for objecting to manufacturers as members of the committee was apparently the fear that they would each have an axe of their own to grind, and that they would devote too much of their energies to this same grinding operation. It appears to us that consulting engineers, professors, and other non-manufacturing engineers will also have their special axes, and it does not seem fair to assume that one class is more likely than the other to try and use the committee for its own purposes, especially when it is borne in mind that the committee should be composed of the best men of each class. As the questions to be examined by the committee were the stricter definition of terms used in specifications and contracts, and the standardising of methods of testing, of rating of machines, and of frequencies of alternating current plant, all of them questions of great importance to the manufacturer; we certainly agree with Dr. Kennelly when he said in the course of the discussion that, "having a committee to recommend how manufacturers should make apparatus, without having any manufacturers on that committee, was something like playing Hamlet with Hamlet left out."

Although there were several speakers who thought that something might be done in the way of standardising types of apparatus, the general consensus of opinion was decidedly that any attempt by the committee at standardising apparatus would be a wrong policy. With this we entirely agree, as we consider that, with very few exceptions, the buyer's engineer should confine himself to defining what the apparatus has to do and how its capabilities of fulfilling the specified conditions will be verified, and that the construction of the machine should be left to the manufacturer. If this were done more in England, manufacturers would in their own interests standardise to a greater extent than they do now, and the buyer would undoubtedly benefit thereby, as machines would be made at less cost and more quickly than at present. Of course there always will be certain cases where the conditions of working will demand that a machine be designed specially to fulfil these requirements; but one finds too frequently that specifications for machines for ordinary lighting work are issued which demand that various details of the apparatus shall be constructed in a way which does not allow of the use of standard patterns. That this is so is to a great extent the fault of the manufacturers themselves, because they are so keen on getting the order that they do not make a sufficient difference in price between their standard apparatus and the one which embodies the alterations asked for; and we think that in this respect we might take a lesson from American manufacturers, who stick much more closely to their stock sizes, make these in large numbers, and, therefore, at reduced cost, and charge very considerable extras for any departure from their standard design.

With regard to the subjects enumerated by Mr. Rice, we think there is need also in this country for a better definition of terms and of methods of verifying whether electrical machinery fulfils the conditions laid down in the specifications. In the matter of efficiency, for example, although most specifications fix a commercial efficiency which has to be guaranteed, or require that the contractor shall fix it in his tender, very few state how it is to be measured; and anyone who has had practical experience of efficiency testing of belt-driven machines, knows that very varying results may be obtained by employing different methods of testing, such as the Swinburne method of measuring the stray power, and adding thereto the calculated $C^2 R$ losses; or the Hopkinson method of coupling two similar machines mechanically and electrically, and measuring the extra energy supplied to enable one machine to act as a motor and drive the other as a dynamo; or, again, the older way of trying to arrive at the efficiency of the dynamo by indicating the engine. Again, with regard to rise of temperature of the armature and magnet coils, we have the thermometer method, and the method of determining the rise of temperature by the increase of the conductor resistance, and these two methods give very different results. Each method has its advantages, and it does not matter much which is used, so long as the temperature limit is fixed in accordance with the method to be employed, and this method is clearly defined as is done, for example, in the Admiralty specification for dynamos. We know, however, of cases where the method of testing has not been specified, and the manufacturer has considered that his machine has fulfilled the conditions, whilst the receiving engineer has held that it was not to specification, because one wanted to test with a thermometer and the other by conductor resistance.

The rating of the output of a direct-current dynamo, and the limits within which it should regulate, are also points deserving of attention, as we believe there are great variations in these respects between machines listed at the same output by different makers; and the buyer who wants a 200-light dynamo and gets quotations for its supply, often has nothing to tell him, whether the machine he buys will do its full load with a rise of temperature of, say, 60° F., and an increase of speed of 5 per cent. after a six hours' run, or with a rise of 80° or 90° F., and an increase of speed of perhaps 10 to 15 per cent.

Another point where greater uniformity would be an advantage is in the specification of insulation. In some cases it is specified that the insulation shall stand a breakdown test with a pressure which may be several times the working pressure, and in others a minimum resistance is fixed. In neither case does there appear to be any uniformity in the requirements—that is to say, that different engineers specify different ratios of testing pressure to working pressure; and whereas one specification will require an insulation resistance of half a megohm or less, another will ask for 5 megohms for machines working at the same voltage. If half a megohm is sufficient (and it may well happen that a machine having an insulation resistance less than that will stand a high pressure test better, and will be a more durable machine than one giving an insulation resistance of 5 megohms), it surely is unnecessarily increasing the price of the machine to insist that a manufacturer shall change his standard methods of insulation, so as to be able to get five megohms after carefully drying and cleaning all surfaces over which leakage may take place, and so putting the machine into a condition altogether different from that in which it ordinarily works.

The last point mentioned by Mr. Rice is the frequency of alternating current plant, and although we do not think that the frequencies used in this country vary so widely as appears to be the case in the United States, yet, as the differences which do exist are often found to be very inconvenient by makers of apparatus to be used on alternating current circuits, we think, as we have often said, that the fixing of certain standard frequencies would be advantageous, as it would enable such apparatus to be supplied more quickly and at lower costs.

There are, no doubt, other questions which will occur to our readers, such, for instance, as whether there is any serious advantage gained by the use of lamp voltages, which differ very little from one another, as, for example, 100, 110, and 115 volts, or the corresponding 200, 220 and 230 volts; but we do not propose to go further into the matter, as our object is not to discuss these various questions in detail, but rather to draw attention to what is taking place in America, and to invite our readers to consider whether it would not be to the advantage of the electrical industry if some similar steps were taken in England in the direction of fixing certain standard definitions and methods of testing; and even in some special cases of standardising apparatus, not by interfering in any way with the details of construction, but by agreeing to a more uniform specification with regard to voltage, frequency, and other kindred matters.

Telegraphy by Electric Oscillations.

ELENKONSKY, in an article on "Telegraphy by Means of Electric Oscillations," which appears in the last issue of our Russian contemporary, *Elektrotechnik*, describes the progress realised since Hertz by Righi, Sarasin, De la Rive, Boltzmann, and Zender. He points out the influence of metallic powders on the electric waves, and tells us how, in 1890, Branly discovered his radio-conductor, and Lodge, after him, constructed his coherer, which is a kind of microphone. Branly demonstrated in 1890 that his radio-conductor can be used for revealing the electric waves, produced at a distance. Narkievitch Iodko had succeeded before Popoff in transmitting signals by means of a modified Lodge apparatus, at a distance of more than 2 kilometres. According to his articles in different papers, and to his letter to Ducretet, Popoff stated in the *Proceedings of the Russian Society of Physics and Chemistry* (December, 1895) that his apparatus can be utilised for transmitting signals by means of rapid electric oscillations when a sufficiently strong discharger of these oscillations is available. When Marconi made public his discovery, Popoff, in the journal *Kotlin*, declared that he had already succeeded in transmitting signals on land at a distance of one nautical mile and on sea at three miles. Therefore, the conclusion is:—1st, that Marconi utilised for his apparatus the principles discovered by other experimenters; 2nd, that before Marconi, many experimenters had demonstrated the possible adaptation of the electric vibrations to the transmission of signals. No one will assert that Branly, Lodge, and Popoff would not have been able to find the practical solution of the problem if they had taken the subject in hand, and if they had *believed* in the practical future of telegraphy by means of electric vibrations. Marconi's merit is that he *believed* in the future of wireless telegraphy, and that in view of this practical object, he developed and simplified apparatus which, until then, had only been employed for theoretical work.

Economy Test of a Central Station.—Before the American Institute of Electrical Engineers, Prof. Goldsborough, of Purdue University, read a paper on the economy test of the West Pratt Street station of the Edison Electric Illuminating Company, of Baltimore, Ind. The paper is abstracted in the *Electrical World*. "While the station is not by any means a model up-to-date one, it is perhaps representative of the average lighting station of gradual growth and moderate size. The engine equipment, for example, consists of one 600-H.P. horizontal cross-compound Ball & Wood engine, one high speed Russell simple engine of 170 horse-power, one of 125 horse-power, one 300-H.P. tandem-compound Ideal engine, one 300-H.P. cross-compound Ball & Wood engine, two 145-H.P. Buckeye engines, and one 300-H.P. Ide engine. The generators are series arc and 1,000-volt alternating machines of as wide a range of makes and sizes, all being belted machines. The tests were most complete, and some of their results are of interest, in that they show the low economy to be expected of such a heterogeneous equipment. The boiler tests showed that the equivalent water evaporated per pound of combustible from and at 212° Fahr., varied from 6·83 lbs. to 12 lbs., averaging between 8 and 9 lbs. The all-day efficiency of the plant or ratio of the electrical horse-power at the switchboard to the indicated horse-power at the engines was found to be about 68 per cent., which is commented upon as 'excellent, in showing that the station is operated far more efficiently than could be expected, when the numerous drawbacks which have to be contended with are remembered.' The electrical output per pound of coal is given for one test as 150·5 watt-hours, and for another test as 157·3. This figure is compared with the data given in the report of the committee of the National Electric Light Association in 1896, in which the average efficiency of 81 stations, using coal as fuel, was given as 108 watt-hours per pound of coal."

THE INSTITUTION OF ELECTRICAL ENGINEERS.

At the meeting of the Institution of Electrical Engineers held on the 12th inst. at the Society of Arts, Prof. Ewing gave a summary of his paper on "A Magnetic Balance for Workshop Tests of Permeability," and exhibited the apparatus in use. After the discussion on this paper closed, Mr. A. H. Gibbings, borough electrical engineer of Bradford, described the supply meter, based on the decomposition of an aqueous acidified electrolyte, which formed the subject of his paper on "The Registration of Small Currents Used for Electric Lighting or other Purposes."

Prof. Ayrton opened the discussion on Prof. Ewing's paper, and congratulated the writer on the many ingenious instruments he had devised for electrical measurements. The speaker was surprised to find that the magnetic balance had so open a scale for so small a range with the same magnetising force. In the paper it was stated that "the range of the balance extends (for H = 20) from 12,000 up to something over 16,000. He would have thought the instrument would have been less sensitive, and therefore less valuable, and would like to know the actual force of detachment employed for a given position, also how the actual force (H) is divided up. Lastly, it would be interesting to be informed how far there is risk of error being introduced from the presence of dirt, &c., at the point of contact between the specimen and the magnet pole; as there are curved surfaces the reluctance may be small. The interesting question is the kind of error—how far a slight trace of oil or dirt would interfere with the accuracy of the instrument, which seemed to be, from the experiments shown, very great.

Prof. Perry remarked that he understood Prof. Ewing was satisfied, and that we were told an accuracy of 1 per cent. could be obtained. The speaker should hardly have expected such accuracy. Throughout the discussion the feeling was prevalent that what Prof. Ewing considered could be obtained from the balance would be got; the invention of such an able and illustrious worker in magnetics being certain to prove accurate and highly useful. This was the tone in which Prof. S. P. Thompson spoke when joining in the congratulations to the author: "If Prof. Ewing is satisfied, no one else ought to be dissatisfied." Long ago Prof. Thompson had devised the permeameter, and he felt gratified that Prof. Ewing was now converted to traction methods, the instrument before the meeting being a much better and more refined apparatus than others working on similar principles. He would return another compliment paid him when placing his instrument before the public—namely, criticise the balance. The criticism originally was that he ought to have cut the bar in the permeameter in the middle; he had placed the contact right outside. To make the contact on the top of a projecting pole-piece, however, certainly surpassed Prof. Thompson! Again, in the permeameter a faced joint was required, but the reluctance of the lead joint was so small it made no perceptible difference, and Prof. Ewing had again gone one better. Whether by such a very small contact—that between the side of a turned bar ½ inch in diameter and a pole having a slightly convex surface, the side of the rod touching the pole at one point only—there would not be some error due to gathering of the magnetic flux was a question.

Prof. Ewing has taken the value of the force H as 20. Prof. Thompson supposed it was good to have a fixed value; the instrument does not pretend to give points along the magnetic curve, but one frequently wants values in other fields than one, and in large multipolar machines B is often lower than 13,000 and the fields are lower than 20, while in the teeth of core discs B runs up to 20,000, far beyond the limits of this instrument at the upper end. The last and only other point Prof. Thompson made was that he wished he could induce Prof. Ewing to use Clarendon type. This brought Prof. Perry to his feet with an emphatic protest against the use of Clarendon type, and the expression of a pious hope that Prof. Ewing would do nothing of the sort.

Mr. Mordey was glad to see how Prof. Ewing was adding practical instructions to valuable theoretical work, and desired to direct attention to iron testing in bulk. He thought the instrument shown that evening was one of the simplest and best, but what one wants is to take a big casting and make a test of its magnetic quality before it goes in the tools; cutting a piece out of it may affect the character of the sample; he asked Prof. Ewing to increase our indebtedness to him by enabling us to test iron in bulk. Cast-iron varies enormously in its magnetic qualities. Identical machines may vary 70 per cent. in exciting current, and such differences are very serious indeed when a strict specification has to be complied with. He wanted to know whether it was necessary to be particular as to the time the current was on, or the time taken to detect the best piece in the balance.

He would say we should get out an instrument that would enable one to order iron and steel of certain definite magnetic qualities and pay for what is got, and not for what makers like to give one. When he started making transformers Swedish iron was very good, but afterwards iron all over the world got very much worse with some very uncomfortable results; orders were accepted which stipulated for a certain loss, but iron got poorer in quality, the losses went up, and makers were penalised heavily through no fault of their own. He had advised that material should be ordered of a certain magnetic quality, but makers did not like the specification at first; in six months, however, the result was that the quality crept up, and came within 5 per cent. of the specification, owing to a penalty and bonus clause giving in shillings per cwt. an allowance for the losses (in watts per pound) due to magnetic qualities. He thought if one could specify iron for magnets in any way like that a very great service would be rendered.

Mr. Swinburne pointed out that the mistake with some forms of traction instruments for magnetic testing was that the pull would be too high if any unevenness existed at the contact. Obviously, the contact is more highly saturated than anywhere else, and there is thus the chance of a pretty big error. Prof. Ayrton interpolated the remark that this was the whole interest of the apparatus before the meeting, within its range this crowding together compensated for the variation in the distribution of the magnetising force in the circuit. That is not what one would have expected *à priori*. Mr. Evershed thought that the natural criticism of the balance had been very well put by Mr. Mordey.

In his reply Prof. Ewing said that Prof. Ayrton had commented upon the comparatively large range of scale, the large preponderance of force was due to the beam of the balance itself, and the weight served to make small differences. The magneto-motive force is no doubt mainly used to overcome the reluctance of the specimen at the point of contact, and there is great crowding, therefore the instrument might not serve very well to make tests with low values of magneto-motive force. As things are, one has a force which is high in the specimen itself. What one has is a force of 20 on most of the specimen and a force very much higher than 20 at the contact; but if the bar has good permeability for one of these points it will be relatively good at others. Prof. Ewing deprecated the determination of B in absolute methods except by ballistic determination. All he did was to use a traction method to compare two bars, one of which had been carefully tested ballistically. It was true that points on the B H curve were not obtained; if such were wanted, his permeability bridge was distinctly the instrument to be employed. There was no difficulty in wiping the contact clean. He closed with some remarks on the increase in magnetic losses of sheet iron due to continued use in a variable magnetic field.

Mr. Gibbings then gave a description of the electrolytic meter devised by Mr. Bastian, which was the subject of an article in the Electrical Review of the 13th inst. Mr. Evershed was at a loss to know how far he could praise this meter, being interested in a meter of his own. He had expressed a desire to see a meter that could be made for 40s. or 50s. (see remarks by Mr. Evershed, *Municipal Electrical Association Proceedings*, 1897, p. 64, and reprint in Mr. Gibbings's paper). The principal question was how long this meter was going to last. One and all electrolytic meters had failed from causes difficult to trace, generally, however, the end was a general disintegration of the electrodes. Another criticism was as regards evaporation of the water. Although oil had been used on the surface of acid in accumulators, he had found that this did not get rid of spray. The large drop in volts was not so serious as one would expect, being only ½ per cent. from no load to full load. The nearly all the energy is spent in heating conductors. He had found that in well known types only $\frac{1}{300}$th of the total power went to drive the gear, the rest was wasted in heating, so that in the motor-meter one has an absurdly inefficient means of integration. Then materials necessarily cost a lot, a thermometer could be sold for 1s. 6d., but as one must have a considerable amount of copper to get losses down to a reasonable amount a meter must be costly. Gas meters were relatively efficient and fairly accurate, whereas the Hookham meter absorbs 5 and the Thomson 12 watts. Some interesting but rather irrelevant figures as to gas meters were then given, which it is unnecessary to reproduce.

Mr. Swinburne had been accused of having tried to make every kind of meter, but none would work; he *had* got a meter that worked, however, although someone else had patented it before him. One's first inclination in discussing a matter of this kind is to say, "Oh! that was done years ago." He replied: "Don't believe it." Every crude idea is not an invention; any fool can make an invention; it takes a clever man to work out the details, and a genius to sell it!

Mr. Arthur Wright thanked Mr. Gibbings for bringing before them a meter which will help to sell their product. The efficiency of a meter never seems to occur to his friends in central stations; the question is, will it register? and does it cost very much to keep in order? He had heard that the question of the volt-drop was immaterial; it seemed to him that the objection was that 1 per cent. of the station output was wasted in making gas.

Mr. Hirst had had a good deal of experience with central station engineers, and found they looked at the cost of maintenance closely. He thought the use of oil on the top of the water would mean cleaning frequently, and that the refilling meant the loss of previous readings. Every meter maker felt the want of a small meter for small consumers. The Board of Trade had insisted upon unnecessary accuracy in electricity, as compared with gas meters. Then as to the lost or wasted power; this had been mentioned as 10 to 12 or 15 watts. He knew of a meter—whose name need not be given—which only required 1 watt. The audience fully realised the force of Mr. Hirst's argument, and whence it was directed. Mr. J. W. Swan thought the meter well deserved a trial.

Mr. Gibbings, in his reply, stated that six months' experience of the meter had been obtained. He attributed the avoidance of error to the small surface exposed to evaporation, and considered the great merit of the apparatus to be the certainty of registration with small C.P. lamps on "high voltage" circuits.

UNIVERSAL SHUNT.

By J. RYMER-JONES.

IN the ELECTRICAL REVIEW of April 10th, 1896, p. 467, is a description and illustration of a convenient adjustable "universal" shunt, with a X power of any value from 1 to 10,000; and which when not required for a shunt can be employed for all tests, based on the "Fall of potential" principle, for which the Kelvin-Varley slides are applicable.

Although this form of shunt leaves nothing to be desired in point of convenience, and has been employed during the last two years for testing cable in the factory with very satisfactory results, yet owing to the cost being an important consideration, the writer has lately turned his attention again to the subject, with a view to including the slide proper and the so-called *vernier* slide in one box, and at the same time considerably reducing the price of construction. The present object, however, in again referring to the above subject, is not so much to draw attention to simplification effected, as to point out and correct an error when speaking of the K-V slides as not being applicable for a *universal* shunt.

Although shunting two of the *main* coils r_2 of the K-V slides with 100 *vernier* coils $x + y$—the sum of which latter gives an equal resistance—produces a *fall of potential* in these two parallel circuits equal to that in one of the main coils, so that a sliding contact on the *vernier* branch (divided into 100 parts) gives the potential at each of the subdivisions (figs. 1 and 2), yet it appeared at first sight equally evident that, while suitable for *potentials*, the conditions would be entirely changed if employed as a universal shunt; *i.e.*, for a continuous current flowing through the system; and that not only would the resistance *permanently* shunting

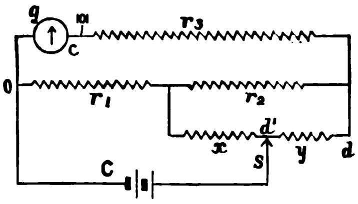


FIG. 1.

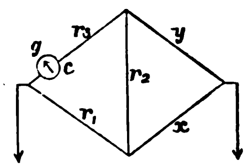


FIG. 2.

the galvanometer vary somewhat—when, for instance, the the vernier contact s is at d to when it is at d' or some other intermediate point—but that the X power of the shunt would not be strictly proportional to the scale reading.

To ascertain what the difference actually was, the writer calculated the current c passing through the galvanometer for various positions of the vernier contact when shunting different parts of the main resistance by the following formula obtained from the laws of dynamic electric circuits:—

$$c = \frac{r_1 (x+y+r_2) + x\,r_2}{(x+y+r_2)(r_3+g) + r_1 (x+y+r_2) + r_2 (x+y)}\ \mathrm{C}, \text{ or}$$

$$\frac{r_1 (y+r_2) + x (r_1+r_2)}{(r_1+r_3+g)(x+y) + r_2 (r_1+r_3+g+x+y)}\ \mathrm{C},$$

where $r_1 + r_2 + r_3 = 1,100^{\omega}$ = total resistance of the *slides* proper; r_2 = two coils of 100^{ω} each = 200^{ω}; $x + y = 100$ vernier coils of 2^{ω} each; $g = 1,200^{\omega}$; C = current from battery; c = current through galvanometer.

It was no little surprise to find that the calculated X powers are in every case identical to the values obtained with the ordinary simple univeral shunt as shown by the following examples:—

(1) Slide reading = 10,000, *i.e.*, $r_1 = 9,900$, $r_3 = 0$, $x = 200$, and $y = 0$.

X power ratio.

$$\begin{array}{lll}
y + r_2 = 200 & 200\,r_1 = 1,980,000 & \\
r_1 + r_2 = 10,100 & 10,100\,x = 2,020,000 & \\
 & \quad 4,000,000 & \\
x + y = 200 & 11,100\,(x+y) = 2,220,000 & \\
r_1 + r_3 + g = 11,100 & & \\
r_1 + r_3 + g + x + y = 11,300 & 11,300\,r_2 = 2,260,000 & \\
 & \quad 4,480,000 &
\end{array}$$

$$c = \frac{4,000,000}{4,480,000} = \frac{1}{1{\cdot}12}\ \mathrm{C} \qquad 1.$$

(2) Slide reading = 100, *i.e.*, $r_1 = 0$, $r_3 = 9,900$, $x = 200$, and $y = 0$.

$$\begin{array}{ll}
y + r_2 = 200 & 200\,r_1 = 0 \\
r_1 + r_2 = 200 & 200\,x = 40,000 \\
x + y = 200 & \\
r_1 + r_3 + g = 11,100 & 11,100\,(x+y) = 2,220,000 \\
r_1 + r_3 + g + x + y = 11,300 & 11,300\,r_2 = 2,260,000 \\
 & \quad 4,480,000
\end{array}$$

$$c = \frac{40,000}{4,480,000} = \frac{1}{112}\ \mathrm{C} \qquad 100.$$

(3) Slide reading = 1, *i.e.*, $r_1 = 0$, $r_3 = 9,900$, $x = 2$, and $y = 198$.

$$\begin{array}{ll}
y + r_2 = 398 & 398\,r_1 = 0 \\
r_1 + r_2 = 200 & 200\,x = 400 \\
x + y = 200 & \\
r_1 + r_3 + g = 11,100 & 11,100\,(x+y) = 2,220,000 \\
r_1 + r_3 + g + x + y = 11,300 & 11,300\,r_2 = 2,260,000 \\
 & \quad 4,480,000
\end{array}$$

$$c = \frac{400}{4,480,000} = \frac{1}{11,200}\ \mathrm{C} \qquad 10,000$$

Investigating the subject more closely, the following consideration clearly proves that the two arrangements of shunt are equally correct.

Referring to the examples worked out with the above formula for a K-V form of shunt, it will be seen that the efficiency of a meter was low; consider a motor-meter, denominator is a constant value for all positions of the slide contact; so that the current through the galvanometer is always proportional to $r_1(x + y + r_3) + x\,r_3$; in which $x + y = r_3$, viz., a constant value of 200, or $2\,r_1\,r_3 + x\,r_3$, *i.e.*, $2\,r_3\left(r_1 + \frac{x}{2}\right)$, or $400\left(r_1 + \frac{x}{2}\right)$.

For the ordinary simple universal shunt (fig. 3) where each coil has a resistance equal to two of the K-V coils (r_3) *when*

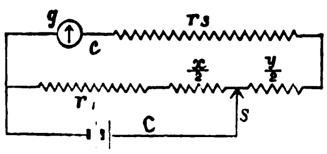


Fig. 3.

shunted with an equivalent resistance in the vernier coils $(x + y)$—that is only half their combined resistance *without* this parallel circuit—the two portions on either side of the contact s may be represented by respectively $\frac{x}{2}$ and $\frac{y}{2}$.

In this arrangement $r_1 + \frac{x}{2} + \frac{y}{2} + r_3 = 10{,}000^{\omega}$; and $\frac{x}{2} + \frac{y}{2} = 100$ vernier coils of 1^{ω} each.

For such a simple shunted galvanometer circuit, the fractional value c of the current passing through the galvanometer for any position of the slide contact is proportional to the shunt resistance, viz.:—

$$\frac{c}{C} = \frac{r_1 + \frac{x}{2}}{r_1 + r_3 + g + \frac{x}{2} + \frac{y}{2}}$$

[in which the denominator has a *constant* value].

Hence the current c through the galvanometer is also proportional to $r_1 + \frac{x}{2}$ as when the K-V slides are employed. As the resistance of the *ordinary* K-V slides ($100{,}000^{\omega}$) is, however, undesirably high for a universal shunt, it is preferable to reduce the resistance of all coils to $\frac{1}{10}$th of their usual value; viz., to a total of $10{,}000^{\omega}$, as for the examples worked out above.

Fig. 4 shows a modified form of K-V slides in which 101 coils of 100^{ω} each are arranged around the circumference of the central *vernier* slide having 100 coils of 2^{ω} each. The former are fixed and the latter can be moved bodily round on the circular ebonite slab to which they are attached,

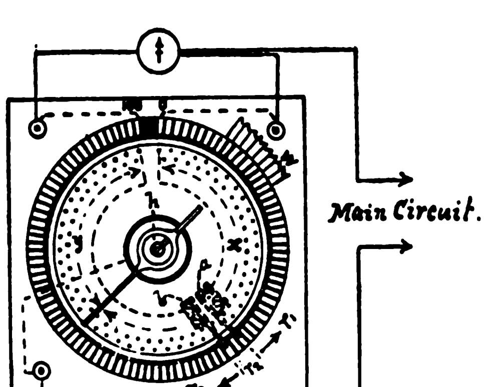
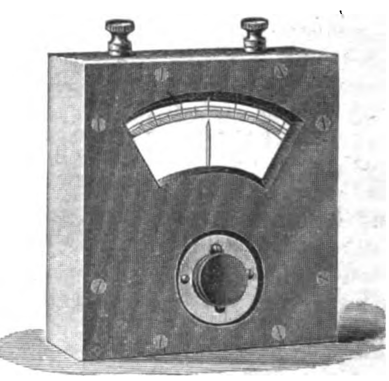


Fig. 4.

so that two radial spring arms, a and b, connected respectively to the 0 and 100 terminals of the vernier coils, press in their circular movement against platinum contact wires affixed to the top surface of the 101 segmental pieces to which the main resistance bobbins, as shown at W, are connected, and shunt *two* of them with an equal resistance (200^{ω}) in the same manner as the K-V slides provide for. The *vernier* slab is moved round by a central handle, h (the *vernier* contact meanwhile remaining on its zero stud) until the two radial spring contacts, a and b, reach a position which gives an approximately suitable shunt value, which can be more exactly adjusted, if necessary, by the vernier slide contact. This is moved round by the same handle, because the detent which before clamped it to the spindle rising from the centre of the ebonite slab is now withdrawn, so as to allow the vernier contact spring to be moved round freely without altering the position of a and b. Thus if 3,526 be the full shunt reading, 35 will be read off the brass segments outside and 26 on the vernier scale. The amount of friction with which the vernier slab moves round can be regulated by screws from outside the case.

DEAD-BEAT SENSITIVE INDICATING GALVANOMETER.

The want of a dead-beat sensitive *indicating* galvanometer has for some time been felt. There are so many purposes to which it could be put both in experimental and practical work, that the introduction of a cheap reliable instrument of this nature has become a necessity, therefore Messrs. Crompton, who have for some years past manufactured for use in their laboratory at Kensington Court, and to order, an instrument of the D'Arsonval or moving coil type, have



now decided to place it upon the market at a reasonable price. The instrument is as illustrated herewith, and can be supplied to any reasonable degree of sensibility, that usual with an instrument of 200 to 300 ohms resistance being a deflection of 1·75 millimetres with $\frac{1}{1000}$th of a volt applied to its terminals.

The same type of instrument can be supplied divided off as a milli-voltmeter or ammeter, so that by means of suitable shunts the instrument becomes direct reading in the matter of amperes or volts, or it can be calibrated direct as a low reading volt or amperemeter, its absolute dead-beatness enabling very fast work to be done. It is in this latter respect admirably suited as a "cell volt tester," in which case the zero is placed in the centre of the scale so that readings may be taken either side, so obviating the necessity of a reversing key.

ELECTRIC RAILWAY MOTORS.

It seems that the subject of Prof. Carus-Wilson's paper, on "The Design of Electric Railway Motors for Rapid Acceleration," has not been treated very rigorously from the experienced electrical tramway engineer's point of view.

In the first place the torque can be more conveniently expressed by the magnetic flux per pole, times the number of current turns opposite pole; this multiplied by the number of poles gives the total torque of the armature.

In the designing of motors for rapid acceleration it has been found necessary to get out a set of diagrams showing exactly the total effort required to produce a good acceleration, and have then designed a motor with proper torque to give this acceleration.

It does not appear that the question of the fly-wheel effect on the armature and driving wheels has been considered in determining the total starting effort. For rapid acceleration it is of the utmost importance that the moment of inertia of the armature and driving wheels be limited to the smallest possible amount. For this reason best traction practice has been directed towards diminishing the diameter of the armature. The first single reduction motors were built with an armature of 18 inches diameter, whereas at the present time motors of the same capacity have an armature of 10 inches in diameter, so that the effort to start the armature itself and the rotation has been tremendously diminished.

Another point we should have liked to see discussed in the paper is the difference between saturated and non-saturated motors for rapid acceleration. The saturated motor acts very much like a shunt motor, consequently the torque varies approximately with the current; whereas, with a non-saturated motor the torque varies approximately with the square of the current. Obviously then, for very rapid acceleration the degree of magnetisation has to be carefully considered.

Most traction motors built to this time have been very highly saturated, but this was brought about primarily from consideration of weight. When, however, such high accelerations as 2 or 3 feet per second have to be considered, it is found that the non-saturated motor, on account of its greater efficiency, gives greater acceleration for the same weight.

The paper will probably be of some interest to many members of the Institution, but those particularly interested in electric traction will, no doubt, expect a more rigorous treatment of the subject.

ALUMINIUM AND OTHER ELECTRO-CHEMICAL INDUSTRIES AT FOYERS.

A SPECIAL meeting was convened a few weeks ago by the London section of the Society of Chemical Industry for the purpose of receiving a paper by R. W. Wallace, Esq., Q.C., on the work that has been done by the British Aluminium Company at Foyers. Much of the information given in this paper is old news to most of our readers,* but it is all well and carefully put, Mr. Wallace by no means erring on the side of exaggeration; and a study of the paper cannot fail to be instructive as well as suggestive.

From our special point of view, perhaps the most important result of the operations at Foyers is that contained in Mr. Wallace's statement that the British Aluminium Company is able to produce electrical energy, including all costs and interest on capital, at less than one-third the cost that the same could be produced by coal and steam. To demonstrate this is an achievement of great significance, for not only will it enable many manufactures to be carried on under remunerative conditions, but it will attract capitalists to the exploiting of natural sources of power now running to waste, and result without doubt in their utilisation. The successes which have been achieved at Foyers will give a great impetus to electrical engineering generally.

Remembering that his audience was chiefly composed of chemists, Mr. Wallace touched rather lightly upon the engineering aspects of the industry at Foyers, and mainly concerned himself with an account of the electro-chemical industries which are carried on there. He discussed the history of aluminium at some length, comparing the various methods which have been from time to time proposed and worked. The process used at Foyers was carefully explained. Our readers are familiar with this, so we need not follow his description of it; we may note, however, his statement that the practical yield is 1 lb. of aluminium metal per 12 E.H.P. hours.

The aluminium industry is one of the most remarkable of modern times as regards rapid development. Just 12 years ago the total output of the whole world was about 5 tons. Even as late as 1890 only 40 tons were produced, and the price was £1,083 per ton. Last year 2,500 tons were produced, and the price was £148 per ton.

* See ELECTRICAL REVIEW for May 14th, 1897.

Mr. Wallace claims that the aluminium produced at Foyers is practically pure, though a large quantity is produced of a somewhat lower grade, namely, containing 98·5 99·0 per cent. of aluminium. The various chemical and physical properties of the metal were of course described, and amongst these we may notice that Lord Kelvin's latest results for the electrical resistance of aluminium (99 69 per cent. pure) show $6{\cdot}997 + 10^{-6}$ Board of Trade ohms per gramme-length (*i.e.*, for a length of wire weighing 1 gramme) at 0° C.; or 2 58 microhms per cubic centimetre. Taking Dewar's value for pure copper ($1{\cdot}563 + 10^{-6}$ Board of Trade ohms at 0° C.), the relative resistance of the aluminium becomes 165·3 per cent.; that is to say, its conductivity, volume for volume, is 60·5 per cent., and, weight for weight, double that of copper.

Mr. Wallace entered very carefully into the subject of the materials used in the industry, and defended the company against the charge of their having been unwise in their selection, not only of materials, but of the sites of some of their various works. He divided the various uses of aluminium into three general classes, pointing out that it may be employed alone, as an ingredient in alloys, and as a metallurgical re-agent in the purification of other metals.

At Foyers carbide of calcium is now made, and there is plenty of spare horse-power which may be utilised in the production of cyanides, chlorate of potash, sodium, caustic soda, carborundum, &c., not to mention phosphorus, the manufacture of which has left this country to go to Niagara. These and other processes require for their chemical success the use of cheap electrical energy. The cost of the power to produce this energy is the all important factor, and the experience of the British Aluminium Company gained from the development of the water-power in Foyers, proves that this power costs but a fraction of that produced from coal or any other known source. This statement did not pass without challenge in the discussion which followed, when one speaker pointed out that it had recently been claimed at a meeting of the Institution of Civil Engineers, that at the present price of coal in this country, it was possible, near the pits, to produce power cheaper than by water. Mr. Wallace replied very carefully to those who took part in the discussion, and stated that, with regard to the cost of producing electrical energy from coal and steam-power *versus* water, he could only say that, roughly speaking, the cost per horse-power at Foyers was about 30s. per annum, exclusive of interest on capital, whilst Prof. Kennedy had put the lowest price for producing it in Scotland, coal costing 3s. 6d. per ton, at £9 per horse-power per annum.

Mr. Wallace's paper certainly forms an extremely interesting *resumé* of work done in a new direction, which marks an epoch in the history of electrical enterprise in this country.

SOCIÉTÉ INTERNATIONALE DES ELECTRICIENS.

MONTHLY SITTING.

THE monthly sitting of the Société des Electriciens was held on May 4th, M. R. V. Picou then entering upon his duties as president. After the reading of the report, M. Picou made his speech. He promised to work for the good of the society, and spoke in praise of his predecessor, Dr. d'Arsonval.

M. LAPORTE then gave the results of some experiments which he had performed at the Central Electrical Laboratory on photometric standards. He studied first the Violle standard, and then the Carcel standard, and found that a decimal candle is equivalent to ·104 Carcel. He received some lamps standardised at the Electro-technical Institute of Berlin, and standardised them again himself. The results were as follows:—

	Electro-technical Institute.		Central Laboratory.	
	I.	II.	I.	II.
Difference of potential in volts ...	108 5	111 5	108·5	111
Amperes	·338	·489	·338	·487
Luminous intensity	10 hefner	16	8 7 candles	14·2

He then made various experiments on the Hefner and Carcel lamps and on the paraffin candle; he then compared the same incandescence lamp with a special standard, A, with a Carcel, with a Hefner, and with a paraffin candle, and found:—

·194 A
·341 Carcel
·72 Hefner
3·13 paraffin candle.

M. P. Girault then read a paper on "Commutation in Continuous Current Dynamos." He brought forward with regard to this question a series of somewhat intricate calculations which we cannot particularise here.

THE TELEPHONE INQUIRY.

The Select Committee of the House of Commons appointed to inquire into and report upon the question of the acquisition of the telephone service by municipal authorities, sat for the first time on Tuesday of last week for the purpose of taking evidence, Mr. Hanbury, secretary to the Treasury, presiding. The inquiries of the Committee are to be directed more particularly to the question as to whether the telephone service is, or is calculated to become, of such general benefit as to justify its being undertaken by municipal and other local authorities, regard being had to local finance; and if so, whether they should have power to undertake such service in the districts of other local authorities outside the area of their own jurisdiction, but comprised wholly or partially in the same telephone area, and what powers, duties, and obligations ought to be conferred or imposed upon such local authorities.

Sir Robert Hunter, solicitor to the Post Office, was the first witness, his evidence continuing throughout the whole of the sitting. Examined by the Chairman, he gave a history of the dealings of the Post Office with the various telephone companies. He said that in 1880 the Postmaster was advised that spoken communications by telephone were to be regarded as telegrams within the meaning of the Act, and an action was commenced—"The Attorney-General *v.* The Edison Telephone Company." In that suit it was decided that every organised system of communication by means of electricity, and any communication by means of wires, according to a preconcerted system of signals, was within the Act of 1869, and that telephones came within the monopoly enjoyed by the Post Office, and that every telephonic communication was a telegram. Immediately after that decision, licenses were granted to various companies by the Postmaster-General. The system at first was to grant a separate license for every district, but those licenses were only granted to a comparatively few companies. There was a limitation as to the distance through which telegrams should be sent. That system lasted until 1884. The licenses reserved the right of the Postmaster to compete within these districts, and no kind of monopoly had ever been granted by them. The companies had no special wayleaves, and had to take their chance with regard to them. Licenses were also granted for trunk wires. In 1884 representations were made as to the hardship of these restricted licenses, and it was then decided that all licenses should in future be general in their character, and should enable any body to whom they were granted to transmit telephonic communications anywhere within the United Kingdom. The consideration had always been that 10 per cent. of the gross receipts should be paid to the Post Office. In 1892 the Government announced another change of policy. After 1884 the telephone companies became gradually amalgamated, and at the beginning of 1892 practically all the telephone business of the country, both exchange and trunk wire, were in the hands of the National Telephone Company. It was not the only company in existence, but the others were comparatively very small. No limitation was imposed by Government such as that on gas and water companies. The telephone companies could make any charge they liked, and they could supply whom they liked, as opposed to the legislation with regard to the gas and water companies, which allowed only such charges to be made as were settled by Act of Parliament, and required that if a company raised its dividend it should lower its charges. There were no such limitations with respect to the telephone companies. On the other hand, the gas and water companies had specific powers for opening streets independently of the consent of the local authorities, which was not the case with the telephone companies. If the owner of a house refused to have a pole placed upon his property he thought the telephone company could refuse to serve him. In 1892 an arrangement was come to with the National Telephone Company and the New Company. The general principle of that arrangement was that the Post Office should take into its hands all the trunk wires and leave in the hands of the companies all the exchanges within areas. That policy was recognised by Parliament by the Telegram Act of 1892. The areas were composed originally of urban districts, and in addition there were tracts of country in connection with the urban districts where the telephone company had been carrying on business, and these were embodied in the deed. The next step was that the National Telephone Company sold to the Postmaster-General all the trunk wires outside certain areas, £459,000 being paid. By this arrangement the trunk messages practically came into the hands of the Government, the National Telephone Company having still the right to send messages within the exchange districts. They also had the right to telephone messages to the Post Office which were written down and sent as telegrams. If there was any recognised delay on the part of the telephone company in sending a message which came off the Post Office wires it would be a breach of their agreement with the Post Office, and the Post Office would have the right to remonstrate with the telephone company and to state what the remedy was. That would be a matter for grave consideration. He should think the National Telephone Company would say that there never was any undue delay. There was no proviso as to delivering a message within a specified time. If the telephone company put any difficulty in the way of the free use of their wires in connection with the Post Office that would be a breach of the agreement of 1892, and he had no doubt the Post Office would find a remedy.

The Chairman: It might occur all the same that the company would prefer to give precedence to a message sent by one of their own subscribers.

Witness said that would be a breach of their agreement. He thought it would be very difficult to frame a provision which would prevent a company in competition with the National Telephone Company from amalgamating with it or of being acquired by it. The New Company went into liquidation, and he thought he was right in saying that the secretary of the National Telephone Company was the liquidator. Originally it had been contemplated that the New Company should have precisely the same agreement with the Post Office as the National Telephone Company, but as the New Company was in *articulis mortis*, and were expected to surrender their agreement, they were informed that the Post Office would not interfere with their business in certain towns, as it would gradually die out. When Mr. Raikes was Postmaster he had a very strong feeling against the companies combining, and was very anxious to keep up competition amongst the various companies, but he found he could not prevent the amalgamation. There was a very strong feeling on the part of Mr. Raikes that these amalgamations ought not to be permitted. In 1892 the principle was laid down that fresh licenses should not be granted substantially without the support of the municipal bodies. Up till then licenses had been granted freely without difficulty. In Mr. Raikes's time opinion was taken as to whether the Post Office could prevent the amalgamations, and they were advised that they could not do so. With regard to competition, the Postmaster-General was perfectly at liberty to establish competition in any exchange area, and he was perfectly free to grant licenses to any other body in any area.

The Chairman: We have got the fact that the company has no limit to its rights, and there is no provision as to any preferential rights.

Witness said that was so. The National Telephone Company's rights terminated on December 31st, 1910. On that date their rights terminated and they had no business to dispose of.

Assuming that the year 1911 is reached and the Government had not bought up the company, what is the position of the National Telephone Company in the face of the Post Office?—In the first place the license absolutely lapses.

Is the Postmaster under obligation to buy any portion of the plant?—None whatever, and on the other hand there is no power of buying it compulsorily; the two parties are absolutely like ordinary persons, two parties to a bargain.

In 1911 the license will have ceased. The National Telephone Company could no longer send messages and therefore could not use its plant.—Quite so.

The only person who could buy the plant to put it to any probable use would be the Government, and they are not under obligation to buy any portion of it?—Not the least.

Witness continuing, said the Postmaster-General had power to purchase the business of the National Telephone Company in 1904, provided he gave notice of that purchase, and in the case of difference as to the price the matter was to be determined by arbitration. In the agreement of 1896 there was a special provision that it should terminate at the same time as the original license, and upon the purchase any additional powers derived under the agreement of 1896 shall not be property to be purchased by the Postmaster-General. The Postmaster-General derived his wayleaves power from various Acts. He had power to place his telegraphs either over or under roads with the consent of the local authorities. If the local authorities refused such consent, there was an appeal to the police magistrates, or the justices, and a further appeal to the High Court. This provision applied all over the country, England, Scotland and Ireland. The Postmaster-General always objected strongly to paying any rent for poles. Of course, in the case of private property, the Post Office was in the hands of the owner, and if he would not let them place the poles on his property, they could not do it. They could put up telegraphs on a public road in the country without the consent of the local authority, but in other places the consent of the local authority was necessary. Speaking generally, the Post Office could not make any attachment of wires or erect posts on private property without the consent of the owner. In the country they could not take a wire over private property without the consent of the owner, but in towns, when the Post Office had obtained the consent of the road authority for carrying wires along the street, then they could carry the wires over the property of private owners. The Post Office had an exclusive wayleave over most of the important lines of railway, and also over the canals. Over some lines of railway the Post Office had a wayleave, but it was not exclusive. The telephone companies had no right over the railways, or over private property, except that, assuming they had attachments on opposite sides of the road, they could carry their wires over without the consent of the local authority, provided they did not interfere with the use of the road. If they had the consent of the local authority, they could not then use the roads. It was the law that no obstruction could be made in the road, even with the consent of the local authority, except under Act of Parliament. It had been decided that the erection of poles upon the greensward at the side of the road, even with the consent of the local authority, was not permissible except under Act of Parliament. Up to 1892 there ought not to have been any wires laid under the ground by the company. Strictly speaking, there ought not to have been any overhead wires either, though he believed there were. Before 1892 they had practically no wayleaves at all, except over private property with the consent of the owner. In 1892 they got certain rights of wayleaves. It was part of the arrangement that the Postmaster-General should be empowered to grant his license to exercise the same powers he had. There was no special consideration of this; it was part of the arrangement as to the trunk wires and exchange areas. In 1892 the Act was passed authorising the Postmaster-General to give the companies wayleaves, but they had no authority to exercise wayleave power until 1896. The Act referred not merely to the National Telephone Company but to all licensees. The National Telephone Company on more than one occasion endeavoured to obtain wayleaves from Parliament before 1892, and these Bills were opposed by the Postmaster-General on the ground that it was not desirable licensees of his should have an independent statutory provision. The powers the National Telephone Company applied for were really stronger than any the Postmaster-General had. The National Telephone Company could not exercise any wayleave powers except under the special license of the Postmaster-General.

What are the powers which the Postmaster-General is authorised to give to the National Telephone Company, or any other company? —Just the same powers as regarded roads, buildings, and towns, and so on, as he himself possessed, but these powers were qualified by provisos. The fact was, that the powers the Postmaster-General gave could only be exercised in an urban sanitary district or such area adjoining as was prescribed in the license. The second proviso was that the licensee should not exercise any power without the consent of the County Council, or other authority, and should be subject to such terms as they might exact. Another condition of the Act was that the Postmaster-General should not give any wayleave powers over the railways or canals. The Postmaster-General was under contract to give the National Telephone Company all he could give under the Act. In London the company would have first to get the consent of the London County Council and then of the road authority. Any authority could say that as a condition of giving their consent the charge to subscribers should be reduced to, say, £5.

Take the case of Glasgow. Supposing the company wanted to lay underground wires between its exchange and the house of a subscriber, what is the position of the company?—They would first apply to the Postmaster-General for the authority to exercise wayleave powers. Having obtained that they would apply to the Glasgow Corporation for leave to exercise the powers obtained from the Postmaster-General.

With regard to the National Telephone Company is it the practice to do that?—It is. The Glasgow Corporation could make any condition they pleased. This would be by virtue of their right to refuse the original consent, and there would be no appeal. They would not refuse the Postmaster-General in the same way, because he would not apply to them generally, but only for the right of a particular street, and then if they refused he would appeal. If the Corporation or County Council refused a general consent, no company had any right whatever to lay wires between the exchange and a subscriber's house. The London County Council might give this general permission, but as regarded laying the wires between the exchange and the subscriber's house the company would have to get the further authority of the Vestry or District Board subject to appeal. As to the wires between two exchanges of the company, both in the Treasury minute of 1892 or the agreement of 1896, there was a special provision. The Treasury minute said that the Post Office would provide underground wires so that the local authorities might not have to complain of their streets being disturbed. In pursuance of that announcement of policy in the deed of 1896, the Postmaster-General covenanted so far as practicable to connect by underground wires any wires of the company in the same exchange.

The Post Office would not have the power to take up the streets and lay a wire for the company between the exchange and the subscriber's house, how does it get the power to lay a wire between exchange and exchange?—I don't know that there is that power. They contended that the Postmaster-General was the judge whether he wanted a wire, it was not for the local authority to deal with.

Do you contend that the Postmaster-General would have the power to take up the streets between the exchange and a subscriber's house without the permission of the local authority?—No! He would have to go to the local authority in any case, subject to appeal the Post Office would claim the right to lay their wire from the exchange to a subscriber's house, and that would be discussed on appeal. The Post Office had never contemplated such a thing, and therefore the question had not arisen. The Post Office had laid wires for the company between exchange and exchange, and between exchange and Post Office. The Post Office could exercise on behalf of its licensees all the rights and privileges it could exercise for itself, subject only to the right of appeal against the local authority.

By Sir J. WOODHOUSE: If the Postmaster-General undertook to lay wires for the company and the local authority declined to give its general consent, then the Postmaster could appeal against the refusal. The Post Office in their covenant had undertaken to lay wires between the exchanges for the companies.

So that you are enabling the company to get behind the consent of the local authority?—We were bound to do so under our covenant.

By Sir HENRY HOWORTH: There was nothing in the agreements between the telephone companies and the Post Office to prevent the former from charging differential rates. The Post Office do not enter into their charges except to see that they paid over the 10 per cent. of the receipts. The National Telephone Company claimed to have the right to exclude a private individual from the supply. There was nothing in their arrangements with the Postmaster-General to prevent it. There was nothing to prevent the Postmaster from granting a license to another company to work within the same area.

By Mr. TULLY: The Post Office had always made it clear to the National Telephone Company that the Post Office was perfectly free to grant competing licenses at any time. There had never been any substantial competition with the National Telephone Company.

By Mr. BARTLEY: A corporation with a license from the Postmaster-General, and with authority to exercise his rights of wayleave, could take up its own streets for the purpose of laying telephone wires; but without the license the corporation could not so act. The telephone companies were in possession of lines all over the kingdom, and the Post Office had to acquire them, and if they had made certain conditions the telephone companies would have said, "Well, we will go on as we are."

By the CHAIRMAN: In the case of a company determining to work the telephones it would have to get from the Postmaster-General the authority for wayleave powers, then if it were carrying on business within its own area of course there would be no veto on the part of the local authority, because the local authority possessing the veto would be the same. Then as to taking up the streets, in the majority of cases the road authority would be the same body. Therefore, there would be free control of the streets. In the case of a municipality carrying on business outside its own district, in some other borough, for instance, it would be in the same position as the National Telephone Company. It would have to get permission to go into the borough, and if it was granted it would have to go to the road authority to get its consent to take up the roads, and if that were refused it would have to go to the tribunals. In its own area it would to a certain extent adjudicate on its own case. He did not see any legal difficulty in the way of judging their case as suggested.

The Committee adjourned until Thursday.

The Committee of the House of Commons sat for the second time on Thursday, 19th inst., Mr. Hanbury, the chairman, presiding.

The CHAIRMAN, at the opening of the proceedings, said the Committee had been considering an application from the National Telephone Company and from the Direct Telephone Company to be heard by counsel, but the Committe were unanimous in the opinion that they could not accede to the application.

Sir HENRY HUNTER, solicitor to the General Post Office, again attended, with the object of supplementing the evidence given by him at the former sitting. He said that on that occasion Prof. Stuart had raised a question as to whether London came within Section 5 of the Telephone Act of 1892, and had suggested that the words there used were not wide enough to cover London. He (Sir Henry Hunter) read the section in question, and said that in his opinion London came within the meaning of the words "urban sanitary authority." With regard to the suggestion that the Treasury Minute of 1892 contemplated competition between various telephone companies, and that all the enactments in the Telegraphs Act, 1896, were authorised and passed in contemplation of competition, he said that the draft agreements between the Post Office and the National Telephone Company and the New Telephone Company were laid before Parliament. It appeared from the debate that followed, and from the minutes of the Select Committee, that the National Telephone Company had absorbed the New Telephone Company. The Committee reported in July, 1895, and the agreement with the National Telephone Company alone was entered into on March 25th, 1896. On August 19th, 1896, the Act was passed which authorised the raising of an additional £300,000 to carry out the policy of handing over the trunk wires to the Government and leaving the exchanges to the companies. The point was that he thought it was perfectly well known that there was only one company, and that the business would be practically divided between that company and the Post Office, and that Parliament granted additional money with that knowledge.

Sir HY. HOWORTH: Was it not granted for the purchase of plant actually in existence at the time?—The preamble to the Act of 1892 stated that it was expedient to raise money with a view of carrying into effect the scheme of the Post Office for acquiring the telephones, and particularly with a view of raising money for the trunk lines. The Act of 1896 said the Treasury might issue a sum not exceeding £300,000 for the Postmaster-General's use for the purposes of the Telegraph Acts, and he submitted that that was an express confirmation of the policy outlined in 1892 of buying up the trunk wires in 1896, and that it was known that there was only one company.

By Mr. GRIFFITH-BOSCAWEN: The £300,000 was solely for the purchase of the trunk wires.

By the CHAIRMAN: His evidence went to show that Parliament was duly seised of knowledge that the two companies had become one at the time. It was moved in the House of Commons that the agreement should not be confirmed, and the mover based his case upon the fact that the National Telephone Company had absorbed the New Telephone Company, and that there was practically only one company, and the Government was carrying out a bad policy when there was only one company. The arrangement was solely in reference to trunk lines. Parliament was aware at the time that there was no competition, apart from the Post Office, with the one company, and it might have challenged the policy of the Government when this money was granted.

By Mr. TULLY: The agreement was not executed until 1896. He did not think there was any understanding on the part of the Government and the Post Office that the execution of the agreement should be suspended.

By the CHAIRMAN: With regard to the trunk wires, he had said on the last occasion that he thought that if the National Telephone Company gave preference to the messages of its subscribers, that would be a breach of the agreement. He had since referred more closely to the agreement of 1896, and had found that there was a distinct covenant on the part of the company that they would do everything to enable messages to be carried over trunk wires, not only between their own subscribers but between subscribers to other exchanges also.

By Mr. Bartley: To postpone the sending of other messages in favour of those of their own subscribers would be a breach of the agreement, as that was over the trunk wires.

By the Chairman: In 1884, when the form of the new license was being debated, it was considered whether the Government should insert in that license a clause preventing the Telephone Company from giving favour or preference to one over another. It was eventually decided not to insert such a clause. The reason was obvious. At the time of the draft public opinion was in the direction of giving the telephone companies a free hand. Up to that time the Post Office had imposed a great number of restrictions, and it was proposed to remove all these restrictions, and give the telephone companies a free hand.

By Mr. Cohen: His opinion was that if the Telephone Company gave preferential treatment to their own subscribers they would not be carrying out their contract. They would be deliberately delaying a message, and would not be doing all the necessary acts and things to carry out the agreement.

Prof. Stuart: Would a breach of that clause by the company entitle you to revoke the license?—I think not, but we could bring an action against them.

Do you think it completely safeguards the public in that respect?—I think so.

Do you mean to say you think the Telephone Company would object to words being put in to prevent them by any possibility giving preference to their own subscribers?—I really cannot say. All these questions were minutely considered at the time. He would not say that these particular words were considered, but the whole of the arrangements between the Post Office and the company were most elaborately debated. He thought the clause he had referred to was sufficient to safeguard the interests of the public.

By the Chairman: Preference in time would constitute a branch of the agreement, but he could not say that a preference in rates and charges would do so.

I do not see where the difference comes in.—They must not do anything that delays one message for another.

Surely the principle of preference applies to rates and charges as well?—That was not dealt with.

I want to get it clearly that the preference in time of one person over another would constitute a breach of the agreement, but the preference in charges would not.—I do not think it would.

By Mr. Fry: The breaches which would entitle the Post Office to determine a license would be the non-payment of the royalty and the sending of messages out as telegrams, writing them down as telegrams.

By Prof. Stuart: No doubt these were points to secure the specific interest of the Post Office, not points to protect the public. There was no intention in the agreement to fix the rates the company should charge. He would not say the question of preference was considered from this point of view when the agreement was drawn, but it was considered. He did not think that the company would have submitted to any restriction on the way in which they were carrying on their business as between themselves and their subscribers. The view in 1884 was that the telephone could be best dealt with by throwing it open to free action.

How is it the Post Office can give its licensee the power of charging preferential rates which, by law, it does not possess itself?—The Post Office did not give its licensees the right of making preferential rates. All that the Post Office did by its license of 1884 was to remove the restrictions which would otherwise make every telegram which was transmitted illegal. But for that, all these telephonic messages would be illegal. It was thought in 1824 that the best thing to do was to leave the companies open to make any terms they liked. There was nothing to prevent the company giving a preferential rate to a man doing a large business over one doing a small business. Whey they got their exchange license it was thought better to give them a free hand. From 1892 to 1896 it was a matter for negotiation. The Government could not make the companies accept any terms they thought fit.

By Mr. Bartley: He would rather not give any opinion as to whether it was fair that the same restrictions should be imposed upon the companies as were imposed upon the Post Office. As to whether it was right that they should have privileges which were not possessed by the Post Office, it seemed to him a question of policy.

By the Chairman: The question of policy was fully considered in 1884. He would prefer that Mr. Lamb should answer the question as to whether it was considered in 1892.

Mr. F. T. Lamb, second secretary of the Post Office, examined by the Chairman, said his special department was the telegraph and telephone service. He was in charge of the telegraph department, which position he had occupied since April, 1889, and for many years before he had had a great deal to do with it. He had been concerned in the administration of the telegraphs since 1870. He gave evidence before the Committee of 1892, and also before that of 1895. The principal recommendation of the Committee of 1892 was that the license of the Telephone Company should not be extended beyond 1911. It left the Government the responsibility of entering into arrangements with the telephone companies, and made that recommendation that the license should not extend beyond 1911. He had a hand in drawing up the Treasury Minute, in the sense that he prepared the information for the Post Office, which was embodied in that minute nearly word for word. That information was prepared in view, at any rate, of limited competition. All along the Post Office and the Treasury had in view competition, and freedom of competition was reserved carefully from the earliest date, and it was again reserved in that minute. In 1892 agreements were drawn up. They were not signed, but they were initialled by the Postmaster-General and the representatives of the two companies. That was in August, 1892. The Postmaster-General, Sir James Fergusson, initialled them on behalf of the Government. The Duke of Marlborough initialled one document on behalf of the New Telephone Company, and Mr. Forbes the other document on behalf of the National Telephone Company on August 11th, 1892. The heads of the agreement so signed were embodied in the agreement of March 25th, 1896. The final agreement was with one company.

Did the Post Office encourage the amalgamation of these two companies? - It was not a question of the Post Office. It was a question of the Government, who gave direct instructions to the Postmaster-General. The Postmaster-General was in constant communication with the Chancellor of the Exchequer, and acting for the Government, he facilitated the amalgamation of these companies. Practically, the amalgamation had taken place when the heads of the agreement were signed.

In 1889 Mr. Raikes was Postmaster-General, and offered strong opposition to the amalgamation. Was the same opposition offered by the Postmaster-General to the amalgamation in 1892?—No, certainly not. Not only was there no opposition to amalgamation, but it was rather encouraged; but that was not the Post Office, but the Postmaster-General acting on behalf of the Government. The agreement undoubtedly facilitated the amalgamation of the National Telephone Company with the New Telephone Company, and was signed with the full knowledge of the Chancellor of the Exchequer and, he believed, other members of the Government. The formal signatures were attached on August 11th, 1892, in Sir Jas. Fergusson's room in the House of Commons. He would not say that the Ministry had authorised an agreement which was contrary to the Treasury Minute issued in March, 1892. He was in constant attendance at the House of Commons with the Postmaster-General, and was present at discussions, and he knew that the Postmaster-General acquainted the Chancellor of the Exchequer of what was going on.

The examination of the witness had not concluded when the Committee rose.

CORRESPONDENCE.

Limerick Electric Tramway Scheme.

As a subscriber to your esteemed periodical, which I regularly receive through your Berlin agency, I take the liberty to put the following before you.

In your number (No. 1,067, May 6th, 1898, page 622) I find this notice:—

"*Limerick.*—The firm of Zietz, of Hamburg, are stated to have written to the Corporation in quaint English, offering to establish an electric tram system all over the city, 'without any cost, on getting a lease of the streets.' This is cool! We guess many an English promoter would like to get tramway concessions on these terms."

There is no doubt that my firm is alluded to, and as I cannot allow to be ridiculed in anybody's eyes, I beg to hand copy of two letters, which are the only ones I addressed to the Corporation of Limerick, and from which you will learn that there is nothing like any "cool offers," but only a commercial offer of my services.

As to the Liverpool order you refer to just under the Limerick notice, I beg to state that same was given to me, respectively to my friends the Wagenbauanstalt und Waggonfabrik für Elektrische Bahnen (vormabs W. C. F. Busch) of our place.

As it cannot be in the interest of your Review to give any wrong information, or to allow anybody to ridicule any of your subscribers or to harm their interests or position, I should thank you to make use of my to-day's information in such way as you may think fit.

Ed. Zietz.

[copy].

To the Town Clerk
Of the City of
Limerick (Ireland).

Sir,—I take the liberty to inform you that I have provided the Liverpool Tramways Corporation with some samples of *Cars for electric traffic*, completely fitted out.

The respective Committee will visit this city at the beginning of March to look over our electric car traffic, which is the best and largest on the Continent, as we are running about 700 cars with overhead system.

Supposing that ere long your Corporation also intend to transform your horse tramcars into electrical cars, I beg to offer you my services for anything you may require to this purpose. Any details will be given with pleasure on application.

Hoping to be favoured with your reply.

I am, Sir,
Yours respectfully,
(Signed) Ed. Zietz.

[COPY].

Hamburg, *April 22nd*, 1898.

To the Town Clerk
Of the City of
Limerick (Ireland).

Sir,—Referring to my respects of February 19th, I beg to inform you that since then the Liverpool Committee have inspected our electric tramcars traffic, and that at the meeting held at Liverpool a resolution has been taken to order from me for their trial line 14 *motor cars and* 14 *trailer cars fully equipped*. This order gives you a full proof that I am in the position to provide you with the necessary, and I am looking forward to your good news.

Yours respectfully,
(Signed) Ed. Zietz.

[Our brief comments were made on the information—now shown to be very meagre—received from a local source. The correspondence printed contains no mention of terms proposed by Messrs. Zietz, therefore the reference to cost and lease seems to be a mere fabrication of the Irish mind. We offer our apologies to our correspondent.—Eds. Elec. Rev.]

Testing of Magnet Steel in Bulk.

With reference to the point raised by Mr. Mordey in the discussion on Prof. Ewing's paper on the importance of knowing the magnetic qualities of soft magnet steel in bulk. It would appear that the variations in magnetic quality has much improved of late owing to the steel makers having come to the conclusion that it pays them to make special blows of steel instead of using any mixture they may have in hand at the time.

The South Staffordshire Steel and Ingot Company, for example, who turn out very large quantities of soft magnet steel appear to have found out exactly what is wanted, and by taking a little trouble with the mixture and with the chemical analyses, the quality is practically constant for each "magnet steel blow," which they now make at frequent intervals. At the same time it would undoubtedly be a great advantage for electrical firms to be able to make their own tests of the magnetic quality of castings and ingots *in bulk*, and in the absence of any such method, the writer thinks that perhaps the following suggestion may be interesting:—

An electro-magnet similar to those which are now taking the place of crane hooks, but with tapered and rounded poles, is suspended over an ordinary weigh table. When the ingot or casting comes forward to be "weighed in" by the the stores department, two places are fettled up at, say, a foot apart, for the electro-magnet poles to rest against. After the casting has been weighed in the usual way, the magnet is brought against it and a known current is switched on. The weights are then run off the scale beam in the weigh office until the casting drops away from the electro-magnet.

It seems to the writer that this is roughly analogous to the traction method of testing as used in Prof. Ewing's instrument, and that the difference between the actual weight and the weight at which contact is broken is a measure of the magnetic quality of the steel lying adjacent to the pole-pieces of the electro-magnet.

E. Kilburn Scott.

The South Staffordshire Steel and Ingot Company, Limited, turn out over 50 tons of soft magnet steel per week in ingots, &c., weighing up to 7 tons each. The following is the average chemical analysis:—

Carbon	·075 %
Manganese	·380 %
Sulphur	·075 %
Phosphorus	·060 %
Silicon	trace.

"Honour to whom Honour is Due."

An article in your issue of last week, entitled "Honour to whom Honour is due," seems scarcely fair to James Wimshurst. Since 1775, when Volta invented the electrophorus, induction machines have, by common consent, been named after those who have introduced improvements in the mechanical and electrical details of the development of the cardinal idea. Thus, Toepler and Carré, Kelvin and Varley, are all credited with having invented induction machines; and induction machines have been named after them. In all these cases the right and honour of invention goes to the man who fashions a machine qualified, by its details, for specific purposes, or for convenience in its mode of operation.

Experiment has determined that the machine made by Wimshurst possesses the following *simultaneous* characteristics: (1) It is self-exciting. (2) Its polarity is subject to no capricious reversals. (3) It does its work well in all weathers. (4) Its discharges can be regulated as to quantity, potential, and rate of interruption. (5) It is, for some purposes, the best possible exciter for Röntgen-ray tubes (see *Proc. Röntgen Soc.*) and allied phenomena. It is upon these *simultaneous* characteristics that the right and honour of invention is ascribed to him.

The skeleton figure, accompanying your article, no doubt represents the best that could be attained before 1883. But, unfortunately for your argument, that machine would not possess the *simultaneous* characteristics (1) (2) (3) (4) and (5). We can afford to give Prof. Holtz much credit for his work, but the merit of having invented the "Wimshurst" machine should no less be given to our own esteemed countryman, James Wimshurst.

Rollo Appleyard.

May 23rd, 1898.

Alternating Arc Lamp.

I have been experimenting with an alternating arc lamp, and find my greatest trouble is that the current has a tendency to run up the side of the carbon. Could you or any of your readers inform me any means of keeping this down, and the cause? Is it the quality of the carbon, or the E.M.F. in the too (?) high which is 72 volts at 7 amperes, 13 mm. cored carbons are used? This lamp burns fairly steady till it flares, when the light changes from a white to a violet colour for the instant. The lamp burns at 100 volts on its terminals, no impedance coil is necessary, and I am therefore anxious to get it to burn steady. I shall be much obliged if I can obtain any information.

W. Addley.

[Our correspondent has apparently left out the word "arc."—Eds. Elec. Rev.]

THE "HART" SECONDARY BATTERY.

We announced a few weeks since that Mr. E. J. Clark had left the Electrical Power Storage Company to take the management of the business of the "Hart" Secondary Battery Syndicate, Limited. At that time the Syndicate had just taken possession of premises at Crispin's Wharf, Stratford, London, which, though admirably adapted for its purpose, required a considerable amount of fitting up. That the Syndicate is now in a position to execute orders indicates the possession of energy which deserves success.

At present arrangements have been made to manufacture three types of battery, namely, for traction, lighting, and central station purposes. The traction cell consists of 11 plates, weighing 38 lbs., with a capacity of 150 ampere-hours at a discharge of 50 amperes, equal to ·4 H.P. for one hour. The lighting type has a capacity of 40 ampere-hours per positive at a discharge rate of 15·6 amperes; at half rate a capacity of 55 ampere-hours. The central station cell is constructed to meet the demand of consulting and central station engineers for a battery that will stand a very heavy discharge for a short period. The plate is calculated to sustain a discharge at 100 amperes for one hour, as a maximum, and at the same time leave a safe working margin.

With all kinds of cells a novelty is supplied in the shape of a non-corrosive connection decreasing the resistance and saving much trouble in cleaning.

The principal improvement claimed in connection with the construction of the plates is that by some process not explained, the active material is hardened and does not suffer disintegration under heavy strains.

The plates for the traction cells are also provided with an additional protection to the active material, little lugs being arranged so as to fold over and hold the contents of the plates in rigid position.

By decreasing the weight of the grids and increasing the proportion of active material as compared with the inactive, it is claimed that for a given weight of cells at least 40 per cent. is gained in capacity.

With respect to the Syndicate it is composed of some of the leading public men in West Ham and the neighbourhood, and is putting down plant for an output of 6,000 or 7,000 plates per week. The works are very favourably situated just off the main Stratford Road, with a canal by which heavy material can be brought to the gates. Every department is well lighted, and all the operations can be carried on under healthy and wholesome conditions.

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending May 24th, 1897.

	£	s.
Alexandria. Teleph. mat.	75	0
Amsterdam	150	0
Bombay	7	0
Brisbane. Tele. cable ...	1,217	0
" Teleph. (joint boxes)	420	0
Buenos Ayres	25	0
Calcutta...	19	0
Cape Town	580	0
Christiana	17	0
Copenhagen	21	0
Durban	729	0
East London	46	0
Hamburg	150	0
Madeira	526	0
Melbourne	229	0
Piræus. Teleg. mat. ...	40	0
Port Elizabeth	80	0
Shanghai	26	0
" Teleph. mat.	47	0
Singapore	180	0
" Teleph. mat.	31	0
Sydney	70	0
Wellington	888	0
" Teleg. mat.	248	0
Total ...	£5,749	0

Week Ending May 24th, 1898.

	£	s.
Amsterdam	83	0
Antwerp	138	0
" Elec. fuses	283	0
Beira	256	0
Bombay	45	0
Boulogne	39	0
Calcutta...	379	0
Cape Town	623	0
Copenhagen	12	0
Delagoa Bay	57	0
Durban	51	0
East London	149	0
Flushing	15	0
Fremantle	215	0
Gibraltar	75	0
Gothenburg	47	0
Halifax	820	0
Hamburg	195	0
Hong Kong	58	0
Madras	208	0
Melbourne	32	0
Natal	1,360	0
North Atlantic. Teleg. cable	10,800	0
Port Elizabeth	1,403	0
Rotterdam	42	0
St. Petersburg. Elec. launch	420	0
Singapore	170	0
Stockholm	232	0
Sydney	610	0
Trieste	240	0
Wellington	49	0
Yokohama	160	0
Total ...	£19,266	0

Foreign Goods Transhipped.

	£	s.
Durban	19	0

Alleged Fraud.—At the Manchester City Police Court this week Thomas Scott was charged with obtaining sums of money from Manchester tradesmen by false pretences, among them being Mr. Geo. Margetts, manager for the district of Drake & Gorham. Prisoner was remanded.

Cable Making in Germany.—A company has just been formed in Berlin, with a capital of £300,000, to be known as the See-Kabel Gesellschaft, to manufacture electric cables, and to acquire and carry on the works and business of Herr Franz Clouth at Nippes.

Cowper-Coles Parabolic Reflector.—A sole license has been granted to MM. Sautter, Harle & Cie, of Paris, for manufacturing parabolic reflectors by this process for searchlights in France, Russia, and Spain.

Dissolutions of Partnerships.—Messrs. F. Reid, F. S. Reid & W. H. Ferens, carrying on business as electrical engineers and agents, at Newcastle-on-Tyne, under the style of F. Reid, Ferens and Co., have dissolved partnership by mutual consent. Debts will be attended to by Messrs. F. Reid & W. H. Ferens, who will carry on the business under the old style.

Messrs. B. Wild, J. H. Clarke, and W. Rothwell, carrying on business as general electrical engineers at 6, Virginia Street, Southport, as Wild, Rothwell & Co., have dissolved partnership by mutual consent. Debts will be attended to by Messrs. Wild and Clarke.

Drake & Gorham Electric Power and Traction (Pioneer) Syndicate, Limited.—In order to deal with the motive power transmission schemes and light railways and tramways which are brought to Messrs. Drake & Gorham in the course of their business, they have formed a powerful syndicate to deal with the preliminaries, and arrangements are being made for a company with a capital of about £250,000. Mr. J. F. Albright, late managing director of Crompton & Co., has joined the syndicate as joint managing director with Mr. Drake, and the syndicate is already in negotiation for acquiring several important schemes for electric traction, power transmission, &c. To avoid misunderstanding, we are asked to state that, while the name of the syndicate is the Drake & Gorham Electric Power and Traction (Pioneer) Syndicate, the business and organisation are quite separate from Messrs. Drake & Gorham's own business, and the syndicate will deal direct with any persons, firms, or local authorities who may wish to negotiate for the promotion or financing of electric traction or power schemes. Offices have been taken at 66, Victoria Street, Westminster, to which all inquiries should be addressed.

Devon County Agricultural Show.—At the above show, which was opened last week at Newton Abbott, Messrs. Lord and Shand, electrical engineers, of Plymouth, shewed a number of electric motors driving a variety of agricultural and domestic machines, such as cream separator, chaff cutter, coke crusher, and horse clipper. The necessary current was obtained from a Taunton dynamo, driven by a Hornsby-Ackroyd oil engine exhibited by Messrs. Beare & Sons, agents at Newton Abbott. The current was supplied to two 1½-H.P. Taunton motors, manufactured by the Newton Electrical Works, Limited, and 10 Lundell motors of various sizes by Messrs. Veritys, Limited.

Electric Clock Switches.—We understand that Messrs. James & Browne have just despatched a dozen of their patent automatic electric clock switches for use in the arc lamp standards at Exeter. A description of these switches, which are for automatically putting current on and off at any desired time, appeared in our issue of February 18th last.

Electric Power in Shipyards.—An installation of electrical transmission of power has recently been carried out by Messrs. W. H. Allen, Son & Co., of Bedford, at the well-known shipbuilding yard of Messrs. Harland & Wolff, Limited, of Belfast, comprising a direct current 500-volt belt-driven generator, and five motors, varying in size from 12 B.H.P., all of Messrs. Allen's manufacture. The generator is compound wound, and the motors shunt wound, whilst the cables run for a distance of 100 yards on steel tubular poles. Messrs. Allen have now secured an additional order from the same firm. This new installation will be one of the largest of its kind in the United Kingdom when completed, and will consist of a 550 I.H.P. compound three-crank forced lubrication engine, running at 300 revolutions per minute, direct coupled to a three-phase 350 kilowatt generator. There will also be seven three-phase motors, four of 100-H.P., one of 75-H.P., one of 50-H.P., and one of 20-H.P., distributed throughout the shipyard for driving the various departments.

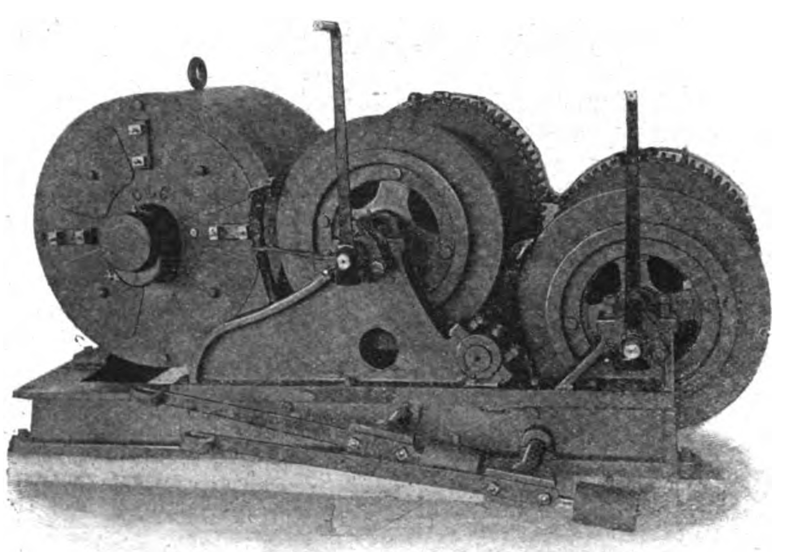
The Electrophone.—The Princess of Wales and Princess Victoria upon two evenings last week listened to the leading London theatres through the electrophone which is installed in the private boudoir of the Princess of Wales at Marlborough House.

Hammond v. The Electricity Supply Company for Spain, Limited.—This was a motion on the part of Mr. Robert Hammond, the plaintiff, heard before Mr. Justice North in the Chancery Division, on Tuesday, to restrain registration of a transfer of shares in the defendant company, of which he claimed to be beneficial owner. The defendants, other than the company, were Don Pedro Pastor y Landero, the transferor, and Mr. R. C. Wyatt, the transferee. Owing to the fact that the Spanish Government would not permit service of a concurrent writ on Don Pedro Pastor y Landero, who is in Spain, it appeared the plaintiff had not been able to bring him before the Court, and the motion therefore stood over. Mr. Kirby was for the plaintiff; Mr. Martelli for the defendant, Wyatt; and Mr. K. H. Leach for the company.

London County Council and the Smoke Nuisance.—At the weekly meeting on Tuesday, the Public Control Committee brought up a report in reference to the smoky atmosphere of the metropolis during the past few weeks. In this connection the committee mentioned that they had addressed to 23 Vestries and District Boards a letter stating that many complaints have been made during the past few weeks of the "very serious nuisance caused by the emission of black smoke in large volume from chimney shafts in various parts of London. The nuisance has probably been most serious in the central districts, and has largely proceeded from electric light generating stations and hotels. The cause is almost invariably attributed to the difficulty now experienced in obtaining smokeless coal, and to the consequent necessity of using bituminous coal in the furnaces of steam engines. If this difficulty had proved to be of a very temporary nature, it might not have been desirable during its continuance to strictly enforce the law as to smoke consumption, but it has already lasted upwards of six weeks, and there appears to be no indication of its speedy cessation. Meanwhile the most serious inconvenience continues to be caused, apparently without any attempt being made to mitigate the evil, notwithstanding that by proper precautions and careful stoking, much of the nuisance might be prevented. In some districts legal proceedings have already been instituted, and the Council believes it to be necessary in the public interest that steps should now be taken for strictly enforcing the law in every serious case which may occur." Sir Harry Poland moved that the report should be referred back, in order that the committee might bring up a recommendation with a view to stopping the nuisance. Mr. Lawson, who seconded, suggested that the Council should initiate legislation next year in order to deal with the question. Mr. H. Ward attributed the large volumes of dense smoke to the fact of the steam at the electric light stations not being condensed. The result was that the steam was discharged into the stacks, and assisted in driving the carbon particles into the atmosphere. On a show of hands, the report was referred back to the

Committee by 23 votes to 21. The Council approved on the recommendation of the Building Act Committee the plans submitted for the extension of the Carnaby Street station of the St. James's and Pall Mall Electric Lighting Company. Formal consent was given to the laying of new mains by the Metropolitan, the House-to-House, and the County of London Electric Lighting Companies.

C. & C. Electric Hoist.—The hoist shown in the illustration was supplied to Messrs. Belshaw & Co., of Victoria Street, by the C. & C. Electric Company, of New York, through their representative for the United Kingdom, Mr. C. R. Heap, 47, Victoria Street, London, S.W. The motor, which is stated to possess several novel features, is of the "C. & C." direct current (compound wound and over compounded) ironclad totally enclosed four-pole slow-speed type. It develops 40 H.P. on the brake, with 450 volts at the terminals, running at a speed of about 750 revolutions per minute. The hoist is of the double drum type. Either drum may be worked independently in either direction, there being a separate friction clutch, brake, and reversing gear for each. Thus raising or lowering may be accomplished as required by either drum. The duty of the machine is to raise 1 ton plus the weight of 500 feet of steel wire rope up an incline of 60° at a speed of 300 feet per minute. The motor will run at practically a constant speed, the power and speed of hoisting being varied, as well as the direction of travel of drums by the brakes, clutches, and gear. Thus the working is said to be simple and reliable. There are no complicated controlling and reversing resistances, and the hoist can be managed with safety by an unskilled operator. For starting the motor the "C. & C." standard starting box is used. It comprises, besides a double-pole switch and safety fuse, a graduated shunt resistance with 10 steps, and an automatic "overload" and "no load" release. Through this apparatus, if the current to the motor is interrupted, the starting handle will return quickly and automatically to the "off" position, and the motor can only be restarted in a proper manner through the "step-by-step" resistances, thus preventing any danger of injury to the motor by starting again with load on and motor at rest. The same action occurs with an overload, and thus a finely graduated fuse is unnecessary. The whole machine is compact, and massive in build, and is mounted on one solid bedplate. The weight of the whole is about 8,000 lbs. Owing to its entirely enclosed form, the motor is damp- and dust-proof. It is provided with self-feeding carbon brushes, requiring no change of lead under any variation of load, and needing the minimum of attention. The bearings are oiled by "ring lubrication," the oil reservoirs carrying an ample supply of oil, and are fitted with visible oil gauges and drain cocks all accessible from outside. By the removal of close-fitting hand-hole covers at both ends the armature is readily accessible. These hoists are made in standard sizes, from 5 to 50 brake horse-power, and are made on the "interchangeable" plan throughout.



Lists.—The Simplex Steel Conduit Company, Limited, of Coventry Street, Birmingham, have issued lists of their "ideal" system of wiring for electric light, power, bells, and telephones. The lists detail the various advantages claimed for the system, and give particulars of some installations carried out. The company has equipped works capable of a large output of steel conduit, together with all accessories in the way of T's, bends, and inspection pieces.

New Electrical Works.—It is stated that the old cotton mill on the Buxton Road, Bakewell, and land adjacent, have been purchased by Messrs. Drake & Gorham, electrical engineers. The necessary alterations are to be made to adapt the buildings to Messrs. Drake & Gorham's business. As a cotton mill the place gave employment to about 100 hands. There is ample water-power obtainable from the River Wye. The site is (or was up to the time of the purchase) the property of the Duke of Devonshire.

Patent Litigation.—The Comptroller gave his decision on 17th inst. in the matter of the Electrolytic Plating Apparatus Company's (Walsall) opposition to the grant of letters patent upon G. H. Nash's (W. Canning & Co., Limited, Birmingham) patent application No. 14,708 of 1897, for "An improved apparatus for the electro-plating of small articles." Messrs. W. P. Thompson & Co., of Birmingham, appeared for the opponents at the hearing, and Mr. A. J. Walter (instructed by Bedfern & Co., London) appeared for the applicant. The grant of letters patent was opposed on the grounds that the applicant (Nash) had obtained the invention from the Electrolytic Plating Apparatus Company, Limited, and that the invention had been patented in this country on an application of prior date, viz, by British patent No. 5,274, of 1896, vested in the Electrolytic Company. The Comptroller by his decision ordered Nash to insert a disclaiming clause in his complete specification, and also to strike out a certain portion of the existing letterpress thereof; subject to this being done he would seal him a patent.

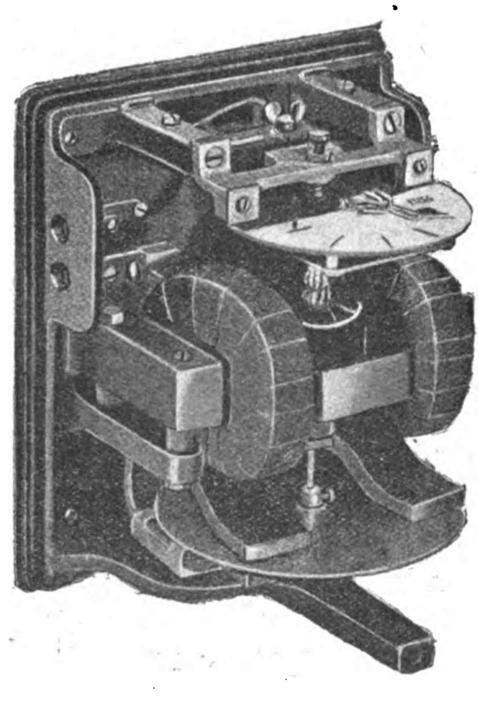
Personal.—Mr. John Hunter, late electrician to the Allan Line Shipping Company, Liverpool, has been appointed manager of the Liverpool Electric Lighting and Fittings Corporation, Limited.

Private Installations.—Messrs. Archer, New & Co., of Liverpool, have carried out a number of installations connected with the Liverpool, Birkenhead, and Southport Corporation mains, under the supervision of Mr. F. W. Rayner, late Liverpool manager of Messrs. New & Mayne. They have also put down a complete installation for the cotton warehouse of the Liverpool Warehousing Company, Limited, a 30-ampere Parker dynamo being run from a hoisting engine. The buildings are wired on the wrought-iron conduit system. A 30-ampere dynamo and Crossley oil engine has also been installed at Aigburth for Mr. Hollbrook Gaskell. They have fitted up Leasowe Castle Hotel and Hydro, Cheshire, for 500 lights, and six enclosed arc lamps in the grounds. An Edison and Swan dynamo, 200 amperes, and engine room switchboards, 60 E.P.S. K 21 accumulators, British Insulated Wire Company's underground paper insulation mains, and a Robey horizontal engine and Lancashire boiler, make up the installation. The Prince of Wales Hotel, Southport, has been fitted with 390 lights to be supplied from the Corporation mains; also 130 electric bell communications. Messrs. New's business is to be absorbed shortly by Messrs. New & Byrd, Limited.

Submarine Miners and the Electric Light.—The *Western Mail* says that a party consisting of two officers and 10 men of the Severn Division Royal Engineers (Volunteer Submarine Miners), whose headquarters are at Cardiff, are at present undergoing a month's course of instruction at Plymouth in electric lighting. The course consists of a series of lectures on the theory of magnetism and electricity, and the construction of the various kinds of dynamos and lamps used in the service for electric lighting. The practical work consists of instruction in the running of steam and oil engines, the working of dynamos, and the manipulation of "fixed beam" and "search" lights. The practical work takes place by day and night in connection with the forts, &c, at the entrance to Plymouth Sound.

Veritys, Limited, v. Sharp.—On Friday, in the Queen's Bench Division, before Mr. Justice Day, sitting for the trial of non-jury causes, the case of Veritys, Limited, *v.* Sharp came on for hearing. This was an action brought by Messrs. Veritys, Limited, who are electric lighting engineers, of King Street, against the defendant, who is an electric lighting engineer, to recover £90 8s. 8d. in respect of electric light fittings sold and delivered to the defendant for an installation at 56, Ludgate Hill. Mr. W. W. Thompson was counsel for the plaintiff, but the defendant did not appear, nor was he professionally represented.—Mr. Lionel George Conter, traveller for the plaintiff company, deposed to receiving the order from the defendant, in response to which the goods were delivered to him at Ludgate Hill. Mr. Sharp acknowledged the receipt of the goods. The plaintiffs had frequently applied for payment of the account, but it had not been paid.—His Lordship gave judgment for the amount claimed, with costs.

Wattmeters for Storage Batteries.—The increasing application of storage batteries to electric light and railway station use, as well as to street cars, motor carriages, electric launches, &c., where a portable source of power is requisite, has led the General Electric Company, of Schenectady, to develop a special type of meter, which will show at a glance the amount of energy available in the battery. The Thomson recording storage battery meter, as described in the *Street Railway Journal*, resembles in general appearance the standard Thomson recording wattmeter, and is, in fact, a development from it, the mechanism being almost exactly similar. The accuracy and durability characteristic of the standard type have both been maintained, while additional precaution is provided against injury from shock or vibration. The meter is provided with a single indicating needle moving over a horizontal semi-circular dial. The essential requirement for a storage battery meter is that the armature shall rotate in either direction and give equally accurate readings in both. In this meter this requisite is obtained. The reading of the meter represents not the amount of energy put into the battery, but the amount available, and when the needle points to zero on the dial, it shows that the battery is completely discharged. For motor carriage, street car, and electric launch service a meter of this character is a most necessary adjunct. Without it the operator is absolutely ignorant of the power upon which he can depend, and would run serious risk of finding himself at a standstill far from home with no means of getting either forward or backward



without recourse to some mechanical method. These meters are manufactured with any desired percentage difference between charging and discharging rates, and in all of the standard sizes in which two-wire Thomson recording wattmeters are built. Since, however, this percentage varies in almost every case, the General Electric Company manufactures them only to order. One size, that reading to 50 amperes, however, may be considered as standard, and will be more promptly furnished than any other.

Wireless Telegraphy.—Some experiments were made from the Terrace of the House of Commons on the morning of the 20th inst. The apparatus was fixed in a private smoke room just off the Terrace and in the treasurer's office of St. Thomas's Hospital, on the other side of the Thames.

ELECTRIC LIGHTING NOTES.

Barmouth.—Mr. T. Blackburn, C.E., and Mr. David Davies have each prepared a dust destructor and electric lighting scheme for the town. The District Council has appointed the Lighting Committee to consider both proposals and report.

Belfast.—Last week the electrical engineer was instructed to communicate with the contractors for new engines, requesting them to have the engines forwarded at once, the tests already made being of a satisfactory nature.

Blackpool.—Mr. Quin, the Blackpool borough electrical engineer, has just issued his report for the year ending March 31st last. The total revenue was £12,827, which included public and private lighting. The expenditure on working account was £7,152, and £3,856 was set aside for interest and sinking fund, being at the rate of 5¾ per cent. for these items. This leaves the sum of £1,819 as the net actual profit on the year's working. As the profit last year was only £828, there is a substantial increase. The units sold have gone up from 429,669 to 707,965, but the "generation costs" have gone down from 2·61d. per unit to 1·87d., a highly creditable result. The "general costs," too, have gone down from 64d. per unit to ·39d. The "total costs" of working per unit have gone down from 3·41d. to 2·42d. Mr. Quin deserves every credit for these reductions in costs of working. The total revenue has gone down from 5·5d. to 5·13d. per unit.

Cardiff.—The Electric Lighting Committee last week instructed the engineer to report on the question of the electric lighting of Newport Road.

Chelmsford.—The Board of Trade have confirmed the provisional order promoted by the Chelmsford Electric Lighting Company for the extension of their mains into the districts surrounding the borough, and have specified Springfield as a compulsory area.

Chester.—The Council last week authorised the Lighting Committee to have an electric main for street and private lighting, and for supplying motive power to compress air for the ejectors at the Infectious Diseases Hospital, Sealand, laid at an estimated cost of £1,100, of which £460 is to be charged to cost of the Infectious Diseases Hospital; to carry the new main to be laid along Brook Street, past the station, and connect it with the main in City Road, at the estimated cost of £55; to have a small addition made to the switchboard at the electric light station, at the estimated cost of £36, and to accept the tender of Messrs. Johnson & Phillips to supply 11 arc lamps for the Lower Bridge Street and Castle Esplanade extensions, for £136 11s.

Chiswick.—The District Council had a discussion last week regarding the "alleged scandal" in respect to the electric lighting order, and ultimately a Committee was appointed to interview Messrs. Bourne & Grant on the matter.

Conway.—At a meeting of the Conway and Colwyn Bay Water Board last Friday, a member expressed the opinion that the Board had valuable water rights which could be utilised for electric lighting purposes, and he moved that a committee visit the place and inquire into the matter. It was also proposed that a professional man be engaged to advise the Board. The Mayor was of opinion that the Board should carry a scheme through, or a company would soon be formed for the purpose. Mr. T. T. Marks, C.E., was appointed to advise the committee.

Coventry.—The statement of the Electric Light Committee shows the progress of the undertaking as follows:—Electricity supplied during quarter ending December 31st, 1897, 34,895 units; 1896, 25,685 units. Rentals for quarter, 1897, £830 8s. 9d.; 1896, £618 5s. 6d. Number of consumers on December 31st, 1897, 100; 1896, 72. Mileage of mains on December 31st, 1897—high tension, 2 miles 687 yards; low tension, 2 miles 1,331 yards; 1896, high tension, 2 miles 77 yards; low tension, 2 miles 332 yards. Electricity supplied during quarter ending March 31st, 1898, 35,090 units; 1897, 21,516 units. Rentals for quarter, 1898, £891 4s. 5d.; 1897, £547 6s. 5d. Number of consumers on March 31st, 1898, 112; 1897, 76. Mileage of mains on March 31st, 1898—high tension, 2 miles 1,592 yards; low tension, 3 miles 791 yards; 1897, high tension, 2 miles 337 yards; low tension, 2 miles 432 yards.

Darfield.—The Council will oppose the scheme of the Electric Lighting Syndicate so far as it may concern the Darfield district.

Dewsbury.—The Corporation are extending their system of street electric lighting, and already eight additional lamps have been erected. The improvement which has thus been effected has met with general approbation, and already many desires have been expressed in favour of a further extension. Householders and shopkeepers are asking for the extension of the mains to the outlying portions of the borough.

Doncaster.—The District Council will oppose the General Power Distributing Company's scheme for electric lighting in the district.

Dunoon.—The Police Commission has resolved, on the recommendation of the Pier and Parks Committee, to use the balance of current from the Castle dynamo for lighting the pier electrically. The offer of Messrs. Dixon to erect wires and lamps at £15 odd has been accepted.

East Stonehouse.—The Bill confirming the East Stonehouse provisional order was certified for second reading last week.

Greenock.—At a recent Police Board meeting the minutes contained a report of the conference with the Board of Trade on the subject of supplying electricity in the burgh. The Provost said it was absolutely necessary, if they should retain their provisional order, that steps be taken towards the installation of electricity within a year. They were clearly led to understand that the opposing company would in a year hence be in a much more favourable position if the Council showed they were not in earnest in the resolution passed to proceed with the installation. They felt very much indebted to the authorities of Port Glasgow and Gourock for the assistance which they gave them, and they made it clear to the Board of Trade that they would prefer to have the electricity supplied by Greenock rather than by a private company. Mr. John Cameron said the Board of Trade were surprised that in a large commercial town like Greenock electricity had not already been established, and when the argument was pressed upon them that the Corporation were the owners of the gas works, and that they must take great care of them, they were met by the retort that the universal experience of the Board of Trade was that wherever electricity was introduced it did not prejudicially affect the Gas Trust, but, on the contrary, both lights seemed to develop and pay corporations. There was no reason why they should have fresh taxation placed on the ratepayers, but if Greenock was to take its place along with other large towns, the time had arrived for the installation being formed. The matter was remitted to the Sub-Committee on Electricity to report their views on the best method of carrying out the details of the proposed installation.

Hertford.—The Corporation is inviting offers for a lease of its electric lighting order from persons competent to carry out same. See our "Official Notices" this week for particulars.

High Wycombe.—The Town Council had before it last week a report by the Electric Light Committee on general matters regarding the undertaking of the Electric Light Company. The Committee is to draw up a plan of proposed positions of public lamps.

Huddersfield.—The Hill Top Co-operative Society, Paddock, Huddersfield, have resolved to obtain estimates for the lighting of the premises by electricity. The Board of Trade has given formal permission to the Huddersfield Corporation to alter the standard pressure upon the low tension electric lighting mains in the central portion of the town from 100 to 200 volts.

Ilfracombe.—The Ilfracombe Electric Lighting Bill has passed through Committee of the House of Commons.

Kingswinford.—The Board of Trade has issued a provisional order to the District Council. The Bill has yet to be confirmed by Parliament.

Leeds.—The Local Government Board has intimated that the provisional order enabling the Corporation to issue stock, irredeemable or otherwise, for the purchase of the undertaking of the Yorkshire House-to-House Electricity Company had been made, and would shortly be submitted to Parliament for confirmation.

Lymington.—Messrs. Edmundson's Electricity Corporation have placed a proposal before the Town Council regarding electric lighting. They propose applying for a provisional order, and, with the consent of the Council, are ready to start work at once. The public lighting would be done at 4d. per unit, and private lighting at 7d. A special committee has been going into the matter, and was to report to the Council this week.

Lynn.—The whole Council in committee recommended this week that the offer of Prof. Robinson to prepare drawings, specifications, &c., and supervise the electric lighting installation, should be accepted. They also recommended that another site besides that near the walks should be selected for the central station works. The proposals were adopted.

Maidstone.—The Electric Lighting Committee has further considered the question of a combined dust destructor and electric lighting station, and is anxious for more information before reporting definitely to the Council. A small Sub-committee has been therefore appointed to visit Norwich and Leyton with a view of inspecting the works at those places.

Margam.—The Electric Lighting Bill has been certified for second reading.

Melbourne.—The Lighting Committee of the City Council recommends the purchase of the undertakings of the electric lighting companies. The Electric Light and Power Act provides that each company shall receive 10 per cent. beyond the total value of its undertaking. The assets of the two companies are roughly estimated at £150,000.

Metropolitan Asylums Board.—At the fortnightly meeting on Saturday, a letter was read from the Local Government Board asking for information as to the grounds which have led the managers to decide to substitute electric light for gas at the Northern Hospital at an estimated cost of £10,350. The Board also asked for a description showing the extent of the scheme. It was resolved to refer the letter to the Works Committee for consideration.

Newport.—The Electricity Committee on Tuesday morning decided to recommend the Corporation to sanction the purchase of emergency plant, in order to meet the demand for light which will have to be faced in the autumn. The present plant is already overloaded, and as the demand shows a steady increase, the works will be inadequate to supply light for next season even for the present area. The Chairman (Alderman Moses) and the consulting engineer (Mr. R. Hammond) have made inquiries and inspected plant, and the Committee have adopted their suggestion that to meet the emergency second-hand Brush plant, which can be obtained for £1,150, after being put in thorough repair, shall be purchased. As the new plant cannot be delivered in time to meet the necessity, it is necessary to obtain some additional plant, and in the opinion of the Committee this is the best that can be done.

North Berwick.—Prof. Kennedy recently wrote to the Town Council regretting that he would be unable, owing to pressure of business, to give time for a report on electric lighting at present, and recommending the firm of Messrs. Burstall & Monkhouse, Westminster. After discussion it was agreed to ask Messrs. Burstall and Monkhouse to report.

Nottingham.—A reduction is to be made in the charges for electrical energy from June 30th. The Corporation will in future charge for lighting purposes for any quantity not exceeding the equivalent of 100 hours per quarter 4d. per unit, and 2d. afterwards. For power purposes it will be 2d. per unit for four hours' average daily use, and 1d. beyond.

Ossett.—The new mill premises of Mr. R. E. Phillips, mungo manufacturer and rag merchant, at Gedham, have been lighted electrically. The plant comprises a Robey 30-H.P. nominal horizontal engine, and a multipolar dynamo, capable of supplying current for about 200 16-C.P. lamps, and a 12-H.P. electric motor. At present just over 100 lamps are installed. The lights are arranged in groups of eight, and all circuits controlled by single-pole switches. The premises have been fitted up with telephones on the "Ennunciator" plug-board system. The work has been carried out by Mr. Walter Robb, of Ossett.

Paris and Berlin.—Some recently published statistics show that in Berlin there are some 300,000 16-C.P. incandescent lamps installed, besides several thousand arc lamps. The length of mains is about 186 miles, and the power developed is about 28,000 H.P. There are also some 1,600 motors, taking 6,450 H.P. The price for lighting is 7·5d. per kilowatt-hour, for power 2d. per kilowatt-hour. Paris demands some 25,000 H.P. for about 418,000 lamps of 10 candles, and 7,448 arc lamps, with about 240 miles of mains. The motors number 513, requiring 1,940 H.P., and the price is 11½d. per kilowatt-hour.

Peterborough.—The Peterborough Electric Light and Power Company is prepared, if the Council does not commence to put its electric lighting order into effect by June, to make application for the order to be revoked. As, however, Mr. Gill, the engineer, has prepared plans for the proposed electricity works in Queen Street, the site having been already purchased by the Corporation, the company's application will probably be unnecessary.

Petersfield.—For some time past the Petersfield Urban District Council (Hants) have had under discussion the advisability of applying for a provisional electric lighting order. At the last Council meeting on the 19th inst. it was decided to communicate with different firms of electrical engineers to ascertain the terms for advice and report as to the practicability of an electric lighting system for the town.

The District Council has referred a proposal that it should apply for an electric lighting provisional order to the Lighting Committee.

Plymouth.—The work of laying the electric cables is going on in the principal thoroughfares.

Portsmouth.—It is stated that a scheme has now been prepared for introducing incandescent electric lighting into rather more than 100 streets in which gas is now the sole illuminant. The idea is to utilise the present gas standards, to the top of which two incandescent lamps would be affixed. It is estimated that the cables could be laid, the lamps converted and the lights supplied on precisely the same terms as is now charged for gas. It is further understood that the balance-sheet of the Electric Light Committee, which will shortly be issued, is likely to be more satisfactory than expected. Owing to the engineering strike last year, the new works were delayed for seven months, and the Committee were put to great expense in hiring machinery to keep the station in full operation. The surplus over all liabilities will not reach £1,000.

Salford.—At last week's Council meeting, Mr. A. Haworth, chairman of the Electric Light Committee, moved the adoption of plans for the erection of a new generating station on land in Strawberry Road, at an estimated cost of £28,161. He said they were considering plans for the application of electric traction to the tramways, and as they had already gone as far as they dared in supplying the current to consumers, they had to decide between extending the old station and erecting a new one. He believed that, unless perhaps for the first year, the proposed new station would not entail any charge on the rates, for as soon as they commenced working, interest and sinking fund would be provided out of the revenue. The electricity works were making gratifying progress, and the loss during the past year had been reduced by £900. The motion was seconded by Mr. Boys and adopted.

Sheffield.—The residents have this week been voting on the electric lighting question. The papers were collected on Monday. The voting was as follows:—For Corporation purchase, 28,130 votes; against ditto, 1,965 votes; majority, 26,165 in favour.

In accordance with the resolution of the City Council, an expert inspection of the water reservoirs was commenced on 23rd inst. by Mr. Frederick Nell, of London, with a view to advising the Council upon the question of utilising the water-power available for generating electricity.

Southampton.—The Court of Arbitration appointed to decide what compensation shall be paid by the Corporation to the Southampton Tramways Company for their undertaking, held its first sitting on 14th inst. to fix the course of procedure. Sir Henry Oakley sat as umpire, Messrs. G. Hopkins, C.E., and J. Kincaid, C.E., as arbitrators, and Mr. W. Phipson Beale, Q.C., as legal assessor.

Stockport.—The Gas and Electric Lighting Committee received 54 applications for the post of clerk of works for the electricity undertaking. They are being considered, and will be dealt with this week.

Stonehouse.—The District Council has disapproved of plans submitted by a company for the erection of an electric lighting station at the corner of Phœnix Street.

St. Pancras.—Mr. H. J. Menzies, chairman of the Electricity and Public Lighting Committee during the past year, was elected chairman of the Vestry at the first meeting after the election on Wednesday evening. It was decided, on the recommendation of the Electricity Committee, to sanction the expenditure of £414 for the installation of a coal conveyer at the King's Road station, in order to deal with the increasing output. The resignation of Mr. J. C. A. Ward, inspector of works, who has obtained an appointment under the Corporation of Glasgow, was accepted, and it was resolved to give him a testimonial under the seal of the Vestry.

Tynemouth.—The Tynemouth Aquarium is being fitted up by its new proprietor with a complete electric light and power installation, including engines, dynamos, motors, and boilers. The work has been placed in the hands of Messrs. W. Dalzell & Co., electrical engineers, of Newcastle. The Aquarium will be lighted by 14 arc lamps, each of 2,000 C.P., besides numerous smaller lamps.

Winchester.—The directors of the Winchester Electric Light Company announce that a supply of current is now available. They are prepared to fit up any premises on the free wiring principle. No charge is to be made for any current used prior to July 1st.

A committee recommends the Council to accept the tender of the Gas Company for lighting the streets of the city for a further period of three years. This company's offer amounts to £1,240 per annum, while that of the Electric Lighting Company is £1,313.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Blackpool.—The report has been issued of the electric tramway for the year ending March 31st, 1898. The estimated receipts for the year were £14,575; they actually were £15,496—an increase of £921. The estimated expenditure was £9,776, and the actual £10,206, increase £360. This increase includes £119 as the tramway share of the expenses of the Continental deputation. The gross profit is £5,290. Deduct from this £2,984 as interest and sinking fund, and there is a net profit of £2,306 Deduct again 1 per cent. for depreciation on a capital of £58,900, which is £589, and we get £1,717 as the available balance of profit for the year, a sum equal to 1½d. in the £ on the rates. 2,279,209 passengers were carried—an enormous increase on the previous year. The growth of the tramway receipts is as follows:—1895-6, £9,869; 1896-7, £13,223; 1897-8, £15,496. In the last report, for 1896-7, although the receipts had grown by £3,500, the profits fell off by £360. This year they have jumped up from £230 to £1,717. The car miles run for the year ending March 31st of the present year were 220,818. The receipts per car mile were 16·9d., and the expenses 11·1d., giving a profit of 5·8d. per car mile. The trams cost for electrical energy, coal, water, &c., £2,172; wages, £3,120; channel repairs, which were kept down in view of the overhead system being adopted, £658; repairs to motors and gearing, £2,145, and to cars and wheels, £675.

Brighton. — At last week's Council meeting the Works Committee's report was adopted, in which it was recommended that 2,100 feet of the electric railway lying between the Camelford Street groyne and the east end enclosures should be carried on piles on the seaward side of the new breastwork. The estimated cost to Mr. Volk is £1,500 additional. This was agreed to, and it was also resolved that the Corporation should grant Mr. Volk a lease for the period of 21 years of the arch now in his occupation, and a license for the same period for the railway, at a rent for the whole of £120 per annum. The license to be subject to conditions providing for its determination in the event of its being judicially decided that the railway is a nuisance, annoyance, injury, or danger to the public. Mr. Volk was to maintain the railway, which, at the expiration of the 21 years' lease and license would become the property of the Corporation. A table showed the compensation to be paid to Mr. Volk in the event of the Corporation at any time taking possession of the railway at six months' notice. The scale ranged from £3,000 in the first year, to £200 in the 21st year. The terms also prescribed that the maximum fare should be 2d. for the single journey, and 3d. for the double journey.

Bristol.—A requisition on behalf of the Corporation of Bristol for leave to withdraw their opposition to the Bristol Tramways (Electrical Power, &c., Bill) has been deposited in the Private Bill Office of the House of Commons.

Cardiff and Penarth.—A deputation from the Penarth Chamber of Trade will support the Cardiff and Penarth light railway scheme at the Board of Trade inquiry on June 1st.

Clacton-on-Sea.—The Coast Development Company has been formed with a capital of £500,000 for various purposes, one of which is to enlarge the pier at Clacton-on-Sea, and to construct an electric tramway. The company proposes to also put down an electric line at Walton-on-the-Naze.

Dundee-Broughty Ferry.—Mr. R. O. Ritchie, of Messrs. Greenwood & Batley, electrical engineers of Leeds, who are the promoters of the electric light railway scheme to connect Dundee and Broughty Ferry, paid a further visit to Dundee last week. The *Dundee Courier* interviewed him and he made some general comments regarding the scheme.

Dublin.—Rapid progress is being made with the electric tramway lines in the city, and it is expected that in about four weeks the connection between O'Connell Street and Haddington Road will be completed. The trip can then be made direct from Nelson's Pillar to Dalkey without changing the car.

East London (South Africa).—The East London Town Council have prepared specifications for tramlines and electric light, and, we understand from a contemporary, that tenders are being called for in England and in the colony.

Gillingham.—At the meeting of the Gillingham Urban District Council on the 19th ult, the clerk read a letter from Messrs. Ashurst, Morris, Crisp & Co., to the effect that the promoters of the electric trams were prepared to proceed with the remainder of their scheme for running trams throughout the Gillingham district, and with reference to the proposed improvements in the High Street, they were prepared to contribute £2,000 towards the cost. The question of providing weekly tickets for workmen at a cost of 9d. for 24 journeys was also discussed, and the promoters propose to provide two special trams on each route for the workmen at stated hours during the day. The Civic Union sent a copy of a resolution passed at their last meeting, calling upon the Council to oppose the scheme, and take the necessary steps for laying down electric trams of their own. Several members of the Council were in favour of the promoters carrying out their scheme in its entirety for the whole of Gillingham. There was a great deal of discussion on the subject, and the whole matter was eventually referred to a sub-committee. The adjourned public inquiry into the scheme will take place on June 4th, and there is very little doubt that although strong opposition will prevent the electric trams being adopted throughout the whole of the combined districts of Rochester, Chatham, and the neighbourhood, still the trams will appear at Gillingham, and most likely through Old Brompton, and from a part of Chatham to Luton.

Glasgow.—The laying of plant for the introduction of electric cars upon the Springburn route proceeds fairly satisfactorily but, adds a local paper, not quite so quickly as some anticipated The Tramways Committee is stated to have hopes of opening the route from Mitchell Street under the trolley system by the Fair holidays. The lines, which have been relaid, are now pretty nearly completed. The poles, which were commenced to be erected at the Springburn end, are gradually planted citywards. The engines and dynamos are now complete at the works, and some of them are being delivered. The carriages are being constructed at the Corporation's own workshops, and are well forward. One of the large sheds at Springburn is being altered and made suitable for the power house. Good progress is being made with the lowering of the road under the railway arch at St. Rollox.

Hastings.—Mr. Murphy appeared before the Town Council on 19th inst. and explained his proposed light electric railway scheme for Hastings. He would put down a line of 3 feet 6 inches gauge, with 18 cars, and his company would agree to a 25 years' lease. The Corporation could use the overhead wire standards for the purpose of electric lighting. Mr. Murphy's interview lasted some considerable time, and numerous questions were put and answered. In a subsequent discussion the Council went into various points in connection with the matter, and ultimately passed a resolution supporting the Hastings, Bexhill, and district light railways (electric) scheme, which is Mr. Murphy's proposal. A committee is to go into the matter of terms with the promoters and report on June 3rd.

Huddersfield.—The County Borough Council has instructed the Tramways Manager and Borough Electrical Engineer to prepare and submit a report as to the application of electric traction on one or more of the sections of the present steam tramway system, having regard to capital expenditure and the present rolling stock.

Hull.—The ceremony of laying the first rail of the electric tramways is expected to take place on June 9th. The city engineer has reported on the subject of the overhead construction. A question had arisen, he said, whether the poles for carrying the trolley wires on the Holderness Road route should be placed on the north or the south side of the road. It was being arranged to place the poles on the right-hand side going out of the town on the Hessle Road, Anlaby Road, Spring Bank, and Beverley Road routes, and also on the right-hand side coming from Nelson Street on the Old Town route If it were not for the fact that through cars might be run from either the Hessle or Anlaby Road on to the Holderness Road (if Savile Street is carried straight through to St. John Street) the right-hand side going out of the town would no doubt be selected for the Holderness Road route; but in view of the possibility of through cars being run, he (the engineer) thought it desirable to adopt the left-hand, or north side, for the route. The only disadvantage which could arise by fixing the poles on the north side of the route appeared to be that unless the lines were arranged so that the cars would run straight through, by connecting St. John Street to Savile Street, or otherwise, a car could not, in case of emergency, be transferred to or from the Holderness Road route without turning it round; but if a double junction were provided at some suitable point on the system, the cars could be turned round if the necessity for doing so arose. It was resolved to adopt the engineer's suggestion with respect to the poles in Witham.

The Tramway Deputation Sub-Committee has been authorised to advertise for tenders for electric cars to run with those already ordered.

Italy.—It is reported that the Rete Adriatica Railway Authorities are considering the question of introducing electric traction on the railways between Lecco and Sondrio (79 kilometres) and between Colico and Chiavenna (26 kilometres). The water power of the River Adda would be utilised in generating the necessary electrical energy.

Kidderminster-Stourport. — This electric tramway scheme which was described in our last issue, was passed by the Board of Trade inspector on Wednesday, 18th inst. Sir F. Marindin and Major Cardew were the officials who inspected the line. In the matter of speed it was considered that 8 miles an hour would not be too great a pace in the streets, except Foundry Street, Stourport, and at certain narrow parts in Kidderminster, where 5 miles must be the maximum. On the open road between Kidderminster and Stourport a rate of 12 miles would be allowed. The inspectors were met by District Councillors, Mr. A. Dickinson, and representatives of the contractors. Sir Francis gave permission to commence running at once. He made suggestions with reference to the stopping places, but the permanent way and power plant were perfectly satisfactory.

Liverpool.—Notwithstanding that the Council at its last meeting declined to pass the recommendation of the Tramways Committee to accept the tender of Messrs. Willans & Robinson, to supply two compound engines and dynamos at the price of £6,530 each, and a triple expansion engine and dynamo at the price of £6,939, we learn from the *Liverpool Daily Post* that the committee at a special meeting on the 13th again passed the recommendation, which will, therefore, again come before the Council in its original form. An amendment was moved by Mr. Rutherford, and seconded by Mr. Beaver, "That in view of the fact that no engine of the type recommended has hitherto been used for power, this committee consult Dr. Hopkinson thereon prior to issuing the order." This was rejected by a large majority.

Llandudno.—At last week's Council meeting various small main extensions were authorised. The question of the application of the Llandudno and Colwyn Light Railway Syndicate, and the letters of the Simplex Company and Messrs. Kingsland and Edwards was discussed in a report by Mr. A. H. Preece. Mr. Preece said that it was to be regretted that the establishment of tramways in Llandudno could not be undertaken by the Council. However, as it had been necessary to arrange matters with the Light Railway Syndicate, the Council were only safeguarding their own interests by insisting upon the supply of energy remaining in their own hands. The question of the powers of the Council to supply the syndicate with energy in these outlying districts was a legal matter which he was unable to enter into. At the same time he saw no reason why it could not be suitably arranged temporarily with the chief parties concerned if a permanent arrangement were not possible. As regards the terms in the agreement for the supply of electrical energy, the following heads were suggested:—(1) The syndicate should guarantee the use of a minimum quantity of energy per annum. (2) The Council should agree to deliver the requisite electric current at constant pressure to a switchboard in the generating works, and all work, consisting of feeders, &c., beyond this board should be erected by the syndicate. (3) The syndicate to fix the maximum quantity required at any moment, and any increase to be subject to not less than nine months' notice. (4) The Council should agree to penalties in case of failure to supply energy, and fix fall in pressure below a fixed point, subject to causes beyond the Council's control. (5) The price to be mutually agreed upon subject to modification at the end of the second season, and every three years after. (6) The energy supplied to be measured by approved meters, and any difference to be settled by arbitration. (7) Payments to be made every month. The question of the prices to be charged was the only point which may present difficulties in settlement. He suggested that the Council should consider a scheme by which the payment should depend upon the interest, sinking fund, and depreciation of the cost of the extra plant required, and upon the actual working cost of the power generated. He anticipated that the extra capital expenditure in the generating works would not exceed £5,000. In reference to the overhead and underground system, Mr. Preece reported to the effect that there are four principal systems, viz., the overhead trolley system, the underground slot system, the closed conduit system, and the accumulator system. The overhead system was undoubtedly the cheapest system to instal and to maintain. The rest were all expensive both in first cost and in maintenance. The only possible objection to the overhead system was the æsthetic one. There was not the least doubt that a properly designed overhead system, with handsome poles erected in the centre of the main road upon which the public lamps could be placed, might be made sufficiently attractive to overcome the objection raised to the system. The Council adopted the recommendations.

Lord Jersey and Colonel Boughey held a light railway inquiry at Colwyn Bay on Friday last. The scheme was supported by Llandudno and Colwyn Bay District Council and the Conway Corporation, while Lord Mostyn and other private parties opposed. After two hours' evidence the promoters approached Lord Mostyn, and he withdrew his opposition upon terms. The Commissioners will recommend the scheme.

London.—Arrangements are being pushed forward with a view to providing the northern suburbs of London with increased facilities for getting cheaply and quickly into the central district. The scheme, says the *City Press*, is being prepared by the Metropolitan Tramways and Omnibus Company, and, if the authorities allow the programme to be carried out in its entirety, something like 30 miles of rails will be laid, at a cost of about £500,000. The new scheme is styled the "London, Barnet, Edgware, and Enfield Light Railways," and by means of electricity, on the overhead system, it intends to provide cheap and quick transit for passengers and parcels. A great part of the district affected is at present only served by the Great Eastern and Great Northern Railways, and the proposal has been warmly received in the localities that will be benefited. Owing to the fact that the London County Council are committed to a policy of developing the tramway system in their own borders, the new railways will have to commence at various points outside the county boundary. These will not be isolated points, but in most cases will practically be junctions with the main routes of the North Metropolitan Tramways Company. For instance, the latter runs cars to Wood Green, and from this point the new company will continue along the high road to Enfield, *viâ* New Southgate, Palmer's Green, Winchmore Hill, and Bush Hill. From Enfield a branch to the right will connect with Ponder's End, to which the North Metropolitan Company already convey passengers. From the base at Wood Green, also, a connection with Tottenham will be made, joining on to the existing tramway to Ponder's End. A third line from Wood Green will run *viâ* Friern Barnet and Whetstone to Chipping Barnet. From Whetstone it will be possible to get south-east through East Finchley and North End to Highgate; and south-west to Hampstead, Child's Hill, and Cricklewood; Finchley and Church End being served *en route*. Cricklewood is to be the centre of a connection between the Marble Arch and Edgware, the first part of the journey being in omnibuses run by the new company as feeders to the western branch of their system.

London United Tramways Bill. — The adjourned report of the Highways Committee of the London County Council in reference to the London United Tramways Bill, was again brought forward at last week's Council meeting. It will be remembered that the committee suggested that the Council should support its petition against the Bill by evidence before the Select Committee. Earl Russell had given notice of an amendment that the Council should offer no opposition to the use of overhead traction in the Uxbridge Road, but this was not proceeded with owing to the withdrawal of the recommendation by the chairman of the committee. Mr. J. W. Benn (chairman of the committee) asked permission of the Council to withdraw the paragraph, the committee being of opinion that they would be touching upon the scope of the Select Committee. The latter, he remarked, were proceeding on the lines of testing that clause of the Bill, the object of which was to deprive the Council of its power of veto in regard to mechanical traction. The question would, however, come up again, and hence he desired to withdraw the recommendation. The Council then consented to the withdrawal of the paragraph.

Norwich.—The Norwich Electric Tramways Bill came last week before the Standing Orders Committee of the House of Commons, on the petition of the promoters to be allowed to insert an additional provision giving them power to widen streets for the purpose of the tramways. The committee allowed the additional provision to proceed.

When the electric tramway Bill came before the Parliamentary Committee on 23rd inst., there was a strong opposition against running the trams along Surrey Street, and, in consequence, this portion of the scheme was struck out.

Redditch.—The District Council has given assent to a proposal made by Messrs. Coleman & Whiteley, solicitors, on behalf of a syndicate to lay down a light electric railway from the railway station, Redditch, through the populous districts of Headless Cross and Crabbs Cross to Astwood Bank, a distance of three miles.

Richmond.—The Duke of Cambridge, Lord Charles Beresford, the Earl of Dysart, Lord Perth, and others are opposed to the Kew and Hampton Court electric tramway scheme.

Richmond and Hampton Court.—At a meeting of the Kingston-on-Thames Town Council on Tuesday last week, it was agreed to dissent from the proposals to construct a light railway for passengers through the borough boundaries in connection with the scheme to connect the West End with the district by trams worked on the trolley system. The General Purposes Committee having framed a resolution to this effect, Councillor Lynes said there was undoubted need for better communication, seeing that Kingston was fast approaching the dimensions of a county borough, but he thought that a system of tramways under their own control would not only be a source of revenue, but would utilise the day load from the Corporation's electric lighting station. Alderman J. B. Walker, J.P., said that if the present light railway scheme were carried through, the Corporation would not have the option to purchase the undertaking, as under the Tramways Acts. He thought the Corporation ought not to lose control of their roads under any circumstances, and that the proposed alteration of the level of the road beneath the railway bridge in Richmond Road would make that place even more dangerous than it was already. Councillor Horsfield pointed out that Kingston had made a great mistake 30 years ago in refusing to allow the L. & S. W. R. Company to bring their main line into the town. He thought that the matter should be fully discussed at a special meeting, and said that he had seen on the Continent that wherever such railways had been made, the country round about them was in a very flourishing state. The Mayor (Councillor W. Hart), in putting the committee's recommendation, said that in the cases cited by Councillor Horsfield, the lines were worked either by the State or the municipal authorities. The resolution was carried *nem. con.*

Rowley Regis.—The District Council had a brief discussion last week regarding the scheme of electric light railways brought forward by a company, and it was resolved to support the scheme. It was stated that the Dudley Corporation was promoting a tramway scheme which it would like to run through Rowley Regis. The District Council of the latter place, however, thinks the matter would be more satisfactory if in the hands of a company.

Spen Valley.—It is extremely probable that within the course of a very short time some important developments will be made in the Spen Valley of Yorkshire in regard to the use of electricity as a motive power. An agitation has been proceeding sometime for placing the towns of this populous district more in touch with each other by means of trams. The matter is not only being discussed by people living in the towns, but by gentlemen connected with tramways in other towns. A director of a Midland electric tramways company visited the district, and after inspecting the various routes suggested promised to report to his company. He also stated that he would come over again and bring the company's engineer with him. The managing director and engineer of the British Electric Traction Company has also visited the district several times recently. The latter company are also prepared to lay down the line if there is a prospect of a reasonable return for the outlay, and providing that there is no opposition from local authorities. The scheme is an extensive one and would be about 11 miles in length. It is proposed that the line should proceed by way of Halifax Road, Berkdale Road, Starncliffe Road, White Lee Road, and then through Heckmondwike to Liversedge, and forward to Cleckheaton. The line should then proceed to Gomersal and effect a junction with the existing tramway from Dewsbury on which, however, steam power is used. The existing tramway from Gomersal, it is thought, could be purchased, and, in fact, some of the gentlemen connected with the tramway company have been approached and were not disinclined to sell out. By this circular route the trams would pass through a district with a population of over 100,000. It is stated that the corporations and district councils far from opposing the running of trams through these districts would do all they could to encourage.

St. Petersburg.—The Helios Company has offered to introduce electric traction on the St. Petersburg tramway on the following conditions:—The three existing lines to be converted into two lines of 4 5 and 7 3 kilometres in length. The cars to be worked with accumulators, and also to be lighted, heated, and braked by electricity. The fares for each line to be five and three kopeks. A three minute service to be run during the day, and a five minute service in the evening up to 12 o'clock. If the city should wish to work the line itself, the Helios Company asks to construct the line and the cars and also to supply the electric energy. After taking over the installation, the city will be asked, over and above the payment for the energy, to pay to the company 7 per cent. per annum on the installation capital for 40 years. But in case the city should not take over the undertaking, the Helios Company offers to work the undertaking for 40 years and pay the city on the net income annually: first, 7 per cent. on the installation capital; second, 1 per cent. of the capital for maintenance and the reserve fund. After subtracting the said 8 per cent., 30 per cent. of the remainder of the net income falls to the Helios Company, while the remaining 70 per cent. goes to the city, a minimum sum of 200,000 roubles yearly being guaranteed. Should the proposal be accepted without delay, electric traction could be introduced about September 1st. Further proposals are being made to take over the much more extensive network of the second horse tramway company.

Teeside.—We understand that the Middlesbrough, Thornaby, and Stockton electric tramway, which has been put down by the Imperial Tramway Company is now completed, a trial trip over the whole course from Norton to North Ormesby and Linthorpe being made by local pressmen and the officials of the company on Monday last. The run was not a formal opening, but merely a trial to see that the gauge was true, the points properly adjusted, and everything satisfactory.

Worksop to Newark.—It is stated that the Railway Corporation of Great Britain (the promoters of the above scheme) have decided to defer their application to the Light Railway Commissioners for powers to construct this proposed electric line until next November.

TELEGRAPH AND TELEPHONE NOTES.

The Gotland Cable.—The cable steamer, *H. C. Ørsted*, which left Henley's Telegraph Works at North Woolwich on the 21st inst., with the Gotland cable on board, arrived at Copenhagen on the 24th inst. and proceeded at once to Ahr, from which point she will start laying the cable. This is the second Gotland cable made and laid by Messrs. Henley—the first, laid many years ago, being still in good condition.

Interruptions of Cables to the Cape.—Since March 4th, the date of the repair to the cable between Aden and Zanzibar, on the East Coast of Africa, the interruptions of the cables to the Cape have been almost entirely confined to those on the West Coast. The record is as follows:—

	Down.		Repaired.
St. Thomé-Loanda ...	March 17th	...	March 19th.
Sierra Leone-Accra ...	April 9th	...	April 19th.
Cape Town-Mossamedes	„ 14th	...	May 5th.
Benguela-Mossamedes ...	„ 20th	...	May 5th.
Kotonou-San Thomé ...	„ 27th	...	Still interrupted.
St. Thomé-Loanda ...	May 4th	...	May 14th.

Thus from March 17th up to the present time, with the exception of 20 days, the West Coast route to the Cape has been totally interrupted; two of the main cables being down together during a portion of this time, and three of the main cables being simultaneously unavailable during another portion of the period mentioned. It is fortunate that during this period the only cable interrupted on the East Coast was that which runs from Delagoa Bay to Port Natal, which was useless on two occasions, during which, however, communication with the Cape was not entirely cut off, as telegrams for Cape Colony could still pass over the Transvaal landlines. As public confidence in Mr. Kruger's administration seems to be reviving, the fact that all telegrams for Cape Colony have occasionally to pass over the Transvaal landlines need not arouse such anxiety as would have been natural during the recent misunderstanding at Johannesburg.

Pacific Cable.—The *Critic* says that the events of the Spanish-American war, more especially the cable-cutting tactics of the opposing forces, have impressed upon Canadians the value of an open cable communication in time of war, and renewed interest has been aroused in favour of the Pacific Cable scheme. The general opinion is that Canada should take the initiative in the movement, especially as she contributes so little to the defence of the Empire. It is, therefore, being advocated by prominent Canadians and Imperialists, among others Doctor Parkin, that a joint resolution from both Houses of the Canadian Parliament be addressed to the Home authorities, asking that a Royal Commission should be at once appointed, with full powers to arrange for the construction and operation of a cable from Canada to Australia. It is also proposed that the Commission should assign the fair proportion of cost to be borne by the different parts of the Empire, the initial cost to be guaranteed by Canada. As Sir Sandford Fleming has proven, to his own satisfaction at least, the enterprise would pay from the start, and it would at least be an exhibition of our national pluck and patriotism.

Shallow Water Cables.—On many occasions we have pointed out the risks which attend telegraph cables lying in shallow water, even when no organised attempt is made to destroy them. This opinion is quite warranted by experience, but in time of peace the attention of the public is not drawn to such occurrences, as their interests are not sensibly affected. The extent of the damage to which we refer may be gauged from the following extract from the abridged report of the Great Northern Telegraph Company:—"The state of the cables in Europe has not been satisfactory during 1897, especially towards the end of the year. No fewer than 11 of the cables have been interrupted, the total number of interruptions being 32. These have nearly all been due to injury caused by the fishing vessels, especially by the steam trawlers, which are spreading more and more, not only over the North Sea, but also in the Skager Rack and Kattegat. Even the strongest cables cannot withstand the rough treatment to which they are exposed, and we are, therefore, now considering the advisability of making an alteration in the type of cable so as better to protect them against the attacks of the trawlers." This experience goes to prove the ease with which shallow water cable can be interrupted, as along the track of these cables in the North Sea, the depth of water is generally less than 50 fathoms. It is clearly against the interest of the trawlers to fall foul of a strong telegraph cable, as by so doing they run the risk of losing their trawl nets and lines, otherwise the interruptions referred to would be much more frequent. The lesson to be gathered from this is of especial interest to us now when the vital importance of unimpaired telegraph lines is so clearly illustrated in the case of the war between America and Spain. With this lesson before us we would again strongly insist on the danger to which the cables connecting England with Gibraltar, Malta, West Africa, the Cape, Zanzibar, Mauritius, Egypt, India, the Straits Settlements, China, Australia, and New Zealand are exposed. If we except Continental landlines, and also an impracticable route *viâ* America, the West Indies, the South American Republics and Brazil, we are utterly and entirely dependent for communication with the colonies above-named, on a single group of three cables, which, starting from Cornwall, run southwards to landing places in Spain and Portugal, all lying for a distance of about 150 miles from England in water which is not 100 fathoms in depth. These cables lie within easy reach of the French naval headquarters at Brest, and however efficiently the mouth of the Channel might be patrolled by English war vessels, the risk of interruption, and the disastrous consequences which such interruptions would entail, are much too serious to be any longer regarded with levity.

Telegraphic Interruptions and Repairs:—

CABLES.	Down.		Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1898	...	...
West Indies—			
St. Croix-Trinidad ...	Nov. 30th, 1896	...	...
Amazon Company's cable—			
Parintins-Itacatiara ...	May 5th, 1896	...	...
Obidos-Parintins ...	Dec. 7th, 1896	...	...
Cable beyond Gurupa ...	Nov. 4th, 1898	...	
Cyprus-Latakia	Feb. 10th, 1898	...	...
Bolama-Bissao	April 12th, 1898	...	...
Maranham-Para	„ 17th, 1898	...	...
Kotonou-San Thomé ...	„ 27th, 1898	...	May 25th, 1898
Hong Kong-Manila	May 3rd, 1898	...	...
Monte Video-Rio Grande ...	„ 5th, 1898	...	May 18th, 1898
Aden-Zanzibar	„ 24th, 1898	...	May 25th, 1898
LANDLINES.			
Trans-Continental line beyond Masol	March 12th, 1896	...	...
Cartagena-Barranquilla ...	July 4th, 1896	...	...
Saigon-Bangkok	May 20th, 1898	...	May 21st, 1898
Venezuela landlines	May 20th, 1898	...	May 23rd, 1898
Majunga-Tananarive... ...	May 23rd, 1898	...	...

Teneriffe-Cuba Cable.—A despatch dated April 4th, from H.M. Chargé d'Affaires at Madrid to our Foreign Office, says that the Minister of Colonies is authorised to announce a public auction for the concession for the construction and establishment of a submarine telegraph cable between Cadiz, Santa Cruz of Teneriffe, the Island of Vieques (near Puerto Rico) and Havana.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belfast.—June 6th. The Harbour Commissioners are inviting tenders for the supply of three belt-driven, continuous current, series wound dynamos, to give 15 amperes, 2,850 volts, at 800 revolutions per minute, for 18 hours' continuous running without undue heating. Harbour engineer, Mr. G. F. L. Giles, from whom particulars may be obtained. See our "Official Notices" for particulars.

Belgium.—June 10th. The Provincial Government Authorities in Brussels are inviting tenders for an installation of electric lighting in the Bibliotheque Royale, in the Place du Musée, Brussels. Tenders to be sent to Le Gouvernement Provincial, Rue des Augustins, 17, Brussels, from whence particulars may be obtained on payment of 4s. 6d.

Belgium.—May 31st. The Municipal Authorities of Ixelles, a suburb of Brussels, are inviting tenders until May 31st for the exclusive concession for the supply of electrical energy for lighting and power purposes during a period of 26 years, that is, to September 1st, 1924. Tenders to be sent to the Secretariat de la Commune d'Ixelles, Brussels, from whence particulars may be obtained.

Bournemouth.—June 20th. The Corporation is inviting tenders for the supply, &c., of cables, arc lamps, incandescent lamps, wiring, switchboards, fittings, &c.; also steam dynamo, &c. Particulars from the borough engineer, Mr. F. W. Lacey, also see our "Official Notices" this week.

Bury St. Edmunds.—June 13th. The Corporation invites tenders for the supply and erection of Lancashire boilers, three 60-kw. steam dynamos, transformer and booster, accumulators, street mains, and various other machinery and apparatus for the electricity undertaking. Consulting engineer, Mr. F. H. Medhurst, 13, Victoria Street, S.W. See our "Official Notices" May 13th.

Coventry.—June 7th. The Electric Lighting Committee invites tenders for electric mains, switchboards, arc lamps, posts and apparatus in connection therewith. For particulars of the several sections see our "Official Notices" May 13th. Mr. Gilbert S. Ram, city electrical engineer.

Hammersmith.—June 8th. The Vestry is inviting tenders for the supply and erection of a Ledward evaporative condenser and tanks, air pump, circulating pumps, and pipe work. Consulting engineer, Mr. A. H. Preece. See our "Official Notices" May 27th for particulars.

London.—June 21st. The London County Council is inviting tenders for engines, dynamos, accumulators, switchboards, feeders, distributors, and service mains and all accessories, to be fixed complete in buildings at the Crossness Outfall Works, near Erith, Kent. The L.C.C. also requires tenders for providing and fixing cables, wires, conductors, casing, pendants, brackets, and other fittings, columns, lanterns, lamps, switches, and switchboards, distributing boards, fuses, cut-outs, &c., necessary for the lighting by electricity of the Crossness pumping station and works, near Erith, Kent. Particulars of both contracts from the Engineer's Department, County Hall, Spring Gardens, S.W. See also our "Official Notices" May 27th.

Spain.—May 28th. Tenders are being invited by the Municipal Authorities of Plencia (province of Viscaya) for the concession for the electric lighting of the public streets of the town. Tenders to be sent to El Secretario del Ayuntamiento de Plencia (Viscaya) from whom particulars can be obtained.

St. Mary, Newington.—June 6th. The Vestry Electric Light Committee is inviting tenders for the supply and erection of engines, generators, and public lighting plant for the electric lighting scheme. Engineers, Messrs. Kincaid, Waller & Manville.

Sunderland.—May 27th. The Corporation invites tenders for the supply of steam and other piping, and water softener for the electricity works. Borough electrical engineer, Mr. J. F. C. Snell. See our "Official Notices" May 13th for particulars.

Taunton.—June 6th. The Corporation invites tenders for the supply and erection of engines and alternators in exchange for existing alternators and transformers, also alterations to switchboard, supply of rectifiers, &c. Messrs. Kincaid, Waller and Manville, engineers.

Victoria.—June 24th. The Council of the city of Hawthorne (Colony of Victoria, Australia) is inviting tenders for the supply and erection of buildings, boilers, engines, dynamos, transformers, mains, meters, arc lamps, poles; also running the plant for three years. See our "Official Notices" March 11th.

Watford.—June 8th. The District Council is inviting tenders for the erection of an electric light station adjoining the new sewerage works. Particulars from the architects, Messrs. Gordon, Lowther & Gunton, Finsbury House, Bloomfield Street, E.C.

CLOSED.

Aberdeen.—The Gas and Electric Lighting Committee recently authorised the electrical engineer to accept the offer of Siemens Bros. & Co., Limited, being the lowest, and amounting to £12,138, for the extension of the electric main cable to the harbour and the west end of the city. The committee recommended the borrowing of the further sum of £15,000 in connection with the electric lighting undertaking. The Council approved of these matters.

Chester.—The Council has accepted the tender of Messrs. Johnson & Phillips for the supply of 11 arc lamps at £136 odd.

FORTHCOMING EVENTS.

1898.

Friday, May 27th, at 5 p.m.—Physical Society, Burlington House. Agenda, "A Simple Interference Method of Reducing Prismatic Spectra," by Mr. E. Edser and Mr. Butler. "Some further Experiments on the Circulation of the Residual Gaseous Matter in Crookes Tubes," by Mr. Campbell Swinton.

At 9 p.m.—Conversazione at the Institution of Civil Engineers.

Thursday, June 2nd, at 8 p.m.—Chemical Society, Burlington House. Papers to be read:—"The Action of Ether on Organic Acids and on Carbo-hydrates in presence of Hydrogen Bromide," by H. J. H. Fenton, M.A., and Mildred Gostling, B.Sc.

Wednesday, Thursday, Friday, and Saturday, June 8th, 9th, 10th, and 11th.—Municipal Electrical Association Conference. See our "Notes" this week.

Thursday, June 16th, at 9 p.m.—Institution of Electrical Engineers' Conversazione at the National History Museum, South Kensington.

NOTES.

Electricity Direct from Water-power.—Herr Josef Popper describes in the *Electro-techniker*, May 15th, 1898, an ingenious method of obtaining electric currents directly from water-jets without the intervention of a hydraulic motor. He does not appear as yet to have reduced his invention to practical form, but it is just possible that there is something of practical value in it. It is a well-known principle that if a conductor moves so as to cut magnetic lines of force, that an E.M.F. is produced at right angles to the lines of force and to the direction of motion. If, now, a water-jet passes through a strong magnetic field—say between the poles of a strong electro-magnet—and the terminals of a circuit are brought in contact with the opposite sides of the jet, a current will flow through the circuit. Any number of jets may be used and connected up in series to obtain a useful electromotive force. The water of streams and waterfalls being by no means pure, will probably not have so high a resistance as to render the idea impracticable on that account—at least, so says the inventor. Popper thinks that steam and gas jets may be used in the same way, when currents of high tension and small quantity are required. This scheme, if practicable, would have the great advantage of reducing the cost and simplifying the construction of water-power installations. Popper states that he has been working at the idea since 1895.

"Scientific American" Naval Supplement.—The publishers of the *Scientific American* have very opportunely issued a "Special Navy Supplement," in which they include a brief history of the United States navy between the years 1883—1898 with the authorisations up to date. Any information respecting the fleet of either parties to the present war is of great interest, and the illustrations and general descriptive notes of the U.S. battleships, cruisers, monitors, gunboats, torpedo boats, &c., may be perused with profit. There are valuable tables of statistics, a coloured map of Cuba, and an explanation of the method of classifying the various types of war vessels. Messrs. Munn & Co., of 361, Broadway, New York, are the publishers.

Smoke Nuisance.—On Wednesday last week, at Bow Street, the Metropolitan Electric Supply Company were fined £5 5s. on one summons, and 6s. on each of 19 others, for having on 20 days between April 19th and May 11th allowed the chimneys at their Sardinia Street station to emit black smoke in such quantities as to cause a public nuisance. An order for the abatement of the nuisance was made by consent. The secretary of the company explained that, owing to the coal strike in South Wales, they were unable to get their usual smokeless coal.

Electric Railways in Europe. — Some interesting statistics showing development of electric railways in Europe within the last three years are published in the *Elektrotechnische Zeitschrift*, March 31st, p. 209. The statistics are arranged in two tables; one showing the extension in different countries, and the other the various systems in use. These tables are as follows:—

The Nature of an Oath.—It is said that a well-known counsel, a familiar figure in electrical lawsuits, was examining a youth the other day, and asked him if he knew the nature of an oath. "Don't I just!" replied the boy with evident glee. "Was'nt I your caddie for three days when you wos playin' golf a few weeks ago; and then you arst me, Do I know the nature of an oath!"

EXTENSION.

—	Total length of track in kilometres. January 1st.			Total output of the power stations in kilowatts.			Total number of motor cars.		
	1898	1897	1896	1898	1897	1896	1898	1897	1896
Germany	1,138 2	642·69	406 4	25,868	18,963	7,194	2,493	1,631	857
France	396 8	279 36	132 0	15,158	8,736	4,490	664	432	225
Great Britain	157 2	127·42	107 3	6,843	5,156	4,683	252	200	168
Switzerland	146 2	78 75	47 0	3,828	2,622	1,559	237	129	86
Italy	132·7	115 67	39 7	6,570	5,970	1,890	311	289	84
Austria-Hungary	106·5	83·89	71·0	3,404	2,389	1,949	243	194	157
Belgium	69 0	34 90	25 0	2,415	1,220	1,120	107	73	48
Spain	61 0	47 00	29 0	930	600	600	50	40	26
Russia	30 7	14 75	10·0	1,270	870	540	65	48	32
Sweden and Norway	24 0	7·50	7·5	875	225	225	43	15	15
Servia	10·0	10·00	10 0	200	200	200	11	11	11
Bosnia	5 6	5 60	5·6	75	75	75	6	6	6
Roumania	5·5	5·50	5 0	140	140	140	15	15	15
Holland	3·2	3 20	3 2	320	320	320	14	14	14
Portugal	2·8	2·80	2 8	110	110	110	3	3	3
Total	2,259·4	1,459·03	902 0	68,106	47,596	25,095	4,514	3,1[illegible]0	1 747

SYSTEMS.

—	Lines with overhead conductors. January 1st.			Lines with underground conductors.			Lines with middle rail.			Lines worked wholly by accumulators.			Lines on the mixed system (overhead wire and accumulators).			Total.		
	1898	1897	1886	1898	1897	1896	1898	1897	1896	1898	1897	1896	1898	1897	1896	1898	1897	1896
Germany	56	45	35	2	2	1	...	...	...	6	4		1	...	...	65	51	36
France	36	19	11	1	1	...	1	1	1	4	5	4	2	...	.	44	26	16
Great Britain ...	15	11	8	1	1	1	7	7	8	1	1	1	...	...	.	24	20	11
Switzerland ...	23	17	12		...	...	...	...	...	...	...	...	...	...	...	23	17	12
Italy	11	9	7	...	...	...	...	...	...	...	...	...	...	...	...	11	9	7
Austria-Hungary ...	11	7	6	2	2	1	...	...	...	1	1	2	...	...	...	13	10	9
Belgium	6	4	3	1	1	...	...	...	...	...	...	...	.	...	...	8	5	3
Spain	4	3	2	...	...	...	...	...	...	...	...	.	...	...	...	4	3	2
Russia	3	2	2	1	1	...	...	...	...		...	...	...	...	...	4	3	2
Sweden and Norway	3	1	1	...	...	...	...	...	...	..	...	...	...	...	...	3	1	1
Servia	1	1	1	...	...	...	...	...			...	...	...		...	1	1	1
Bosnia	1	1	1	...	...	...	...	...	...	..	...	...	...		...	1	1	1
Roumania	1	1	1	...	...	...	...	...	...	...	...	...	...	.	...	1	1	1
Holland	...	...	...	...	...		...	...	...	1	1	1	...	...	...	1	1	1
Portugal	1	1	1	...	...	...	...	...	...	...	...	...	...		.	1	1	1
Total ...	172	122	91	8	8	3	8	8	9	13	12	8	3	...	...	204	150	111

The First! The Best! The Last!—Hoult's original *electro-chemical* chimney and flue cleaner is a late discovery and invention for cleaning soot and scales out of stove pipes and ranges by a practical and scientific method. It more than does the work of a sweep, it requires but a few moments' time, it does its duty thoroughly, and all for *sixpence*. By burning an electro-chemical flue cleaner in a stove or furnace, it generates a gas *charged with electricity* that decomposes the soot, destroys all combustible matter, and causes it to pass out with the draught, leaving the pipe both free and clean. Here is a rare chance for an investigation by Lord Kelvin or Prof. J. J. Thomson into the electrification of electro-chemical stove pipe gases. "Mr. Hoult is indeed a very ingenious Yorkshireman," says the *Stationery World*. Just the sort of man, we would add, to keep the world, slowly as it moves, from absolute stagnation.

Appointment.—The Dewsbury Corporation has appointed Mr. O. M. Jonas, lately with Messrs. Ferranti, Limited, and the Newcastle Electric Supply Company, as borough electrical engineer at a salary of £250 per annum. There were 76 applications for the post.

The First Electric Automobile.—It is a fine thing for a modest man to have champions, and Mons. Raffard, the French engineer (whom we might fairly term "well known") finds his cause as inventor and designer ardently advocated by a friend in a journal called *Le Chauffeur*, a copy of which has just reached us. The article would appear to be written in defence of Mons. Raffard's title to the first practical designs for electric automotor vehicles actually carried out into operation on the road, and it recalls the original Faure accumulator patent of 1880 as a starting point. Some few months after this (in April, 1881, to be exact) Mons. Raffard made arrangements with the Paris Omnibus Company to take one of their vehicles for conversion to electric working, and at the same time completed an electric tricycle provided with 12 small Faure cells, the electric equipment weighing altogether about 160 lbs. The omnibus was completed, and ran on the streets in May and June, 1881, but was not shown at the Electrical Exhibition owing to an accident, which caused heavy repairs with a lawsuit to follow. This omnibus was one of the ordinary type, no alterations to the main structure or design being allowed, and was operated by means of a belt driving on to a differential pulley, which allowed for change of speed in either of the driving wheels. The differential pulley was mounted on a countershaft connected to the driving wheels by chain gear, with pinions and toothed discs on the driving wheels. The advocate of Mons. Raffard's claim to be the first in the field with an electric automobile, considers that this vehicle (which ran either on the tram rails or the ordinary road surface at will) took precedence not only of the small electric railway at the Electric Exhibition of that year, but should also be regarded as the first practical result achieved for real working, although the Berlin Exhibition of 1880 had a small electric line in operation. Probably Mons. Raffard may claim with justice the first electric motor car for street work; certainly he did more than many others to advance the automobile, for in 1883 he had a tramcar running in Paris both on the rails and the road for 30 miles at a time. This vehicle weighed complete, in working order and fully loaded, about 11 tons. Not contented with claiming precedence for Mons. Raffard in regard to self-contained electric omnibuses, and even tramcars, the contributor to *Le Chauffeur* also tries to show that he must be considered the originator of heavy electric locomotives. Certainly he patented in France, towards the end of 1883, the details of an electric locomotive which compares very favourably with those now so well known in connection with the Baltimore Belt Line railroad. Not the least ingenious or interesting feature of the Raffard locomotive may be considered the method of elastic coupling together of driving wheels, with the driving discs mounted on the multipolar motor armature shaft. It is perhaps hardly correct to call the latter a "shaft," as it is hollow, like a sleeve, and surrounds the main driving axle. Whether or no Mons. Raffard was actually the first to design a workable electric omnibus, and also an electric locomotive for heavy working, the fact remains that he can claim credit for some very ingenious details that perhaps even yet have not come into the extensive use which their value and good points deserve.

The Efficiency of Transformers.—In a recent number of the *Elektrotechnische Rundschau*, Herr Schlatter, in an article on transformer distribution (which is condensed in the *Practical Engineer*), draws attention to the fact that, notwithstanding the very high efficiency of transformers at full load, they nevertheless show but a very low all-day efficiency when permanently connected across the mains, and states, as the result of experience of central stations, that the total energy delivered by a transformer during 24 hours is approximately equal to the energy it would deliver in one-twelfth of the time if worked at full load, and on this assumption he gives the all-day efficiencies, together with other data, of transformers of various capacities, which we append in the form of a table below:—

Output of transformer in kilowatts ...	1	2·5	5	10
Useful energy in kilowatt-hours ...	2	5	10	20
Iron losses in kilowatt-hours	1·56	2·28	3·72	5·52
Copper losses in kilowatt-hours ...	0·04	0 09	0·17	0·31
Meter losses in kilowatt-hours ...	0·288	0·288	0·576	0 864
Total energy absorbed, kilowatt-hours	3·888	7·658	14·466	26·694
All-day efficiency	0 515	0·625	0 692	0 75

To check the value of the assumption, equal numbers of the four types of transformers given in the table were connected across the mains from a large central station, when the mean all-day efficiency worked out at 0·652, or practically a mean of the efficiencies of the four types. With the object of increasing the all-day efficiency, the house transformer system has been abandoned in favour of the transformer substation system, with which the number of transformers may be greatly reduced, with a corresponding increase in their size and efficiency. The distinct economy of such a change has been shown by the results obtain in a town in Massachusetts, where 57 small transformers were replaced by 18 of a larger size. In this instance the total core loss of the small transformers, supplying about 1,500 lights, was 5,870 watts, whereas the 18 larger ones substituted supply 1,624 lights with a total core loss of only 1,348 watts. In order to reduce the losses as much as possible, it is necessary to keep only so many transformers in circuit as will enable them to work at full load, or nearly full load.

Some Recent Tests of Materials, &c.—*Technology Quarterly* publishes from time to time tests made in engineering laboratories, which are of some interest. In a recent number are given results of tests on bolted joints, some 14 in number, with a view to finding the efficiency. All the best specimens were made from plate of a tensile strength of 68,000 lbs., and bolts of machine steel of 96,300 lbs. tensile strength, the bolt holes being drilled and rimmed to take the turned bolts an easy driving fit. Two joints, which showed an efficiency of 65·2 per cent., were made with plates 14·64 inches wide and ·45 inch thick. There were three bolts pitched 4⅞ inches centres; they were 1¼ inches diameter. The net plate section was 4·90 square inches after rimming, and the tension on this section was 59,600 lbs. per square inch. The shear on the bolts was 39,700 lbs. per square inch. The compression on the plate was 173,100 per square inch, and failure was by tearing of the plate through the bolt holes. The bolts were damaged only. In the next tests, with plates 11·55 inches wide of a net area of 3 96, with two 1⅜ inches bolts pitched 5¾ inches. The plate tension was 49,000 lbs., the bolt shear 32,700 lbs., the plate compression 156,700, and the joint efficiency only 55 per cent., the joint failing by shearing of the bolts; yet the maximum shear was less than that which failed to shear the bolts of the last test. A repetition test showed almost the same figures. After the test the bolt holes were about half an inch longer than their width. In a one-bolt joint, with plates about 5½ inches wide and 1⅜ bolts, which sheared at a unit stress of 32,600 lbs., the joint efficiency was 59 per cent. and the plate tension 53,200 lbs. Generally these and previous tests seem to show that the strongest joints were those which failed through the plate; that when joints failed at the bolts by shearing, the unit shear was less than the stress, which did not shear the bolts when the plates failed; also, that when the plates failed, the strength of both plates and bolts was better developed than when the bolts failed. The lesson seems to be that generally there should be an excess on the side of the bolts. Generally, with bolts from ¾ inch to 1⅜ inches at pitches of 2 inches to 5¾ inches the joint efficiency only varied between limits of 57 and 65 per cent., the best results being with 1¼-inch bolts. All the plates were ·43 inches to ·45 inches thick, but the maximum plate tension per unit net area was greatest with the more numerous small bolts. Tests of wrought-iron pipe columns about ¼ inch thick and from 2 inches to 6 inches inside diameter showed, for the 2 inches to 4 inches columns, when from 6 feet to 10 feet in length, a crushing strength between 21,000 lbs. and 27,000 lbs. per square inch of cross-section, while for the columns 4 inches to 6 inches diameter the strength varied from 27,000 lbs. to 32,500 lbs. for lengths of 8 feet to 15 feet. The first lot of smaller columns merely had ordinary screwed-on cast-iron flanges; the second lot of larger size had the ends turned off square, and supported on cast-iron caps. Well made pipe columns may thus be rated at a crushing stress of, say, 25,000 lbs. per square inch, a useful figure to know, as wrought-iron columns of short length are often very convenient and useful, and easily made, from readily procurable materials.

American Society of Mechanical Engineers.—The above society holds its conference from Tuesday next, May 31st, to June 3rd, at Niagara Falls. The opening address will be delivered by Hon. Arthur Hastings, Mayor of Niagara Falls, and the work and methods of the Cataract Construction Company will be afterwards described by Messrs. Coleman Sellers and W. A. Brackenbridge. On the Wednesday the power works will be visited. There will be a number of papers read on mechanical engineering and allied subjects.

The Bastian Meter.—It has been suggested in some quarters that when reading the paper on electrolytic meters before the Institution, Mr. Gibbings did not give due credit to Mr. Bastian, the inventor of the meter. We happen to know that it was the express wish of the inventor that his name should not be mentioned, and it was in carrying out this request that omission of Mr. Bastian's name was made.

Electrically Operated Dredgers.—We described some time ago an electrically worked dredge which was being used in Spain, and was driven from a shore plant. In the minutes of *Proceedings of the Institution of Civil Engineers* a year or two back will be found a description of a dredge, electrically operated, and in use on a New Zealand river for gold recovery from the river bed, the rivers of Southern New Zealand being full of gold, which is only recoverable by dredging. In Colorado, where there are large deposits of auriferous gravels, dry dredgers and excavators have been brought into use by the Bennett Amalgamator Manufacturing Company. The dredger is what in England would be called an excavator. It is of the ordinary steam navvy type, with scoop bucket as used on canal and railway work. It is carried on a car body 40 feet long by 12 feet wide, built up of 20-inch rolled girders, and supported on two four-wheel diamond trucks. The amalgamator is carried at one end of the frame, and serves to balance wholly or in part the dredger boom. This boom is like the jib of a crane, and with its appurtenances will swivel round a central pillar, the swivelling power being a 5 H.P. General Electric Company's motor through bevel and spur gears. A 25 H.P. motor, with double reduction spur gear, actuates the dredging scoop and derrick motion. There is a third motor of 5 H.P. to move the dipper handle up or down in the main jib. Three motors perform every movement necessary. The amalgamator is driven by its own motor of 25 H.P., which also travels the whole machine on its rails and also drives the tailings elevator. Water to the amount of 1,600 gallons per minute is furnished by a fifth motor, and a 15 H.P. motor receives this water and discharges it, after it has done its work, to beyond the crest of the tailings pile. A 150 kw. dynamo supplies all the current, and may be placed anywhere convenient for either fuel or water power. The voltage is 500. The capacity of the dredge is great—200 yards per hour. The dipper swings twice a minute, and cuts a 60-feet circle to a depth of 8 feet below the rail level. Electro-magnetic brakes are provided to the three dredger motors, which have rheostat reversing controllers all mounted in the cab within reach of one man. The brakes are not strap brakes, but magnetic clutches arranged to draw a large disc against a stationary face with a releasing spring to push the disc back when the brakes are off. The pumps and amalgamator run constantly, and so only require rheostat starters. One man on the machine, with two men for track laying and in the pit are sufficient to handle the whole machine satisfactorily, apart, of course, from the attendance at the boiler house if steam power is the original source of power. The company build also river dredgers for gold recovery, self-contained, as necessary.

Cleaning the Globes of Enclosed Arc Lamps.—In an article in the *Electrical World*, Mr. J. H. Hallberg remarks that the trimming and cleaning of the inner globes on enclosed arc lamps is of the utmost importance, as the efficiency and candle-power depend, to a large extent, on the transparency of the inner globes. It will be found that most of them are covered inside with a grey-white dust, or film, which comes off if the globe is washed in clean water; but some, even after they are washed in water, show a brown-black stain around the top of the globe which apparently will not come off, no matter how much it is washed; in fact, it appears as though it were a natural colour in the glass itself. This is due to several causes. The most common is the impurity of the carbons, which contain too much metallic material; another is too great a length of the lower carbon, which brings the arc too near the neck of the inner globe; or the cause may be too much current flowing across the arc, especially during the few minutes after trimming the lamp with new carbons, this causing an excessive flame, that gets in contact with the globe, and in that way stains it. The only way to clean a globe in this condition is by dipping the burned part in hydrofluoric acid. This acid is very dangerous to handle, and much care should be exercised when it is used. As this acid will eat through almost every material except lead and wax, it must be kept in a jar of either of those materials. Mr. Hallberg prefers lead, as the acid gets warm when it acts on the glass, and he has seen cases where the wax melted and let the acid run out.

The War and the Cables.—It is stated in official circles at Madrid that the Spanish Government has decided, if the cable from Cuba is cut by Americans, to send some auxiliary vessels to cut all the cables landing in the United States territory.

The *Times* Washington correspondent says that it is proposed to close without delay the three remaining cable exits from Santiago de Cuba to Jamaica and Hayti, whence there is a choice of six routes to Spain. Little danger, it is thought, will attend the cutting of these cables, and no doubt is entertained as to the right of the United States to cut them, although most of them belong to British companies. General Greely, the chief signal officer, advanced the principle that the right existed to destroy cables in waters within Spain's jurisdiction. This principle has been accepted, and the Government are acting upon it.

The *Times* New York correspondent says that the censorship on cable despatches which now exists is of a somewhat crude form. Each company seems to be acting as its own censor, and the feeling is that the Government itself should assume responsibility instead of the company's clerks.

The following communication on the general question of submarine cables in war time appeared in Tuesday's *Times* from the pen of Prof. T. E. Holland, of Oxford:—

I venture to think that the question which has been raised as to the legitimacy of cable cutting is not so insoluble as most of the allusions to it might lead one to suppose. It is true that no light is thrown upon it by the Convention of 1884, which relates exclusively to time of peace, and was indeed signed by Lord Lyons, on behalf of Great Britain, only with an express reservation to that effect. Nor are we helped by the case to which attention was called in your columns some time since by Messrs. Eyre & Spottiswoode. Their allusion was doubtless to the "International" (L.R., 3 A and E., 321), which is irrelevant to the present inquiry. The question is a new one; but though covered by no precedent, I cannot doubt that it is covered by certain well-established principles of international law, which, it is hardly necessary to remark, is no cut-and-dried system, but a body of rules founded upon, and moving with, the public opinion of nations.

That branch of international law which deals with the relations of neutrals and belligerents is, of course, a compromise between what Grotius calls the *belli rigor* and the *commerciorum libertas*. The terms of the compromise, originally suggested partly by equity partly by national interest, have been varied and re-defined, from time to time, with reference to the same considerations. It is perhaps reasonable that, in settling these terms, preponderant weight should have been given to the requirements of belligerents, engaged possibly in a life and death struggle. "*Jus commerciorum æquum est*," says Gentili; "*at hoc æquius, tuendæ salutis.*" There is accordingly no doubt that in land warfare a belligerent may not only interrupt communications by road, railway, post, or telegraph without giving any ground of complaint to neutrals who may be thereby inconvenienced, but may also lay hands on such neutral property—shipping, railway carriages, or telegraphic plant—as may be essential to the conduct of his operations, making use of and even destroying it, subject only to a duty to compensate the owners. This he does in pursuance of the well-known *droit d'angarie*, an extreme application of which occurred in 1871, when certain British colliers were sunk in the Seine by the Prussians in order to prevent the passage of French gunboats up the river. Count Bismarck undertook that the owners of the ships should be indemnified, and Lord Granville did not press for anything further. Such action, if it took place outside of belligerent territory, would not be tolerated for a moment.

The application of these principles to the case of submarine cables would appear to be, to a certain point at any rate, perfectly clear. Telegraphic communication with the outside world may well be as important to a State engaged in warfare as similar means of communication between one point and another within its own territory. Just as an invader would, without scruple, interrupt messages, and even destroy telegraphic plant, on land, so may he thus act within the enemy's territorial waters, or, perhaps, even so far from shore as he could reasonably place a blockading squadron. It may be objected that a belligerent has no right to prevent the access of neutral ships to unblockaded portions of the enemy's coast on the ground that by carrying diplomatic agents or despatches they are keeping up the communications of his enemy with neutral Governments. But this indulgence rests on the presumption that such official communications are "innocent," a presumption obviously inapplicable to telegraphic messages indiscriminately received in the course of business. It would seem, therefore, to be as reasonable as it is in accordance with analogy that a belligerent should be allowed, within the territorial waters of his enemy, to cut a cable, even though it may be neutral property, of which the *terminus ad quem* is enemy territory, subject only to a liability to indemnify the neutral owners.

The cutting, elsewhere than in the enemy's waters, of a cable connecting enemy with neutral territory, receives no countenance from international law. Still less permissible would be the cutting of a cable connecting two neutral ports, although messages may pass through it which, by previous and subsequent stages of transmission, may be useful to the enemy.

A brief note appeared in yesterday's *Times*, from Messrs. Eyre & Spottiswoode, in reply to the above.

A *Daily Chronicle* despatch, dated New York, Tuesday, says that "shortly after midnight much excitement was caused here by the discovery that the Western Union Telegraph and Telephone wires to Sandy Hook were interrupted. These wires connect the harbour fortifications and city. It is supposed that the interruption was effected by Spanish agents. The Postal Telegraph Company's wire is still working."

According to the *Financial News*, the New York *Sun* has received news from St. Thomas showing that the recent bombardments of Santiago de Cuba and Guantanamo arose from some cable-cutting exploits by the United States cruiser *St. Louis* and the gunboat *Wampatuck*. The *St. Louis*, while picking up a cable off Santiago, came within range of the Morro Fort there, and instantly became a target for its guns. The cable was severed, and the vessels left for Guantanamo, where similar incidents took place. They silenced the shore batteries and cut the cable.

Municipal Electrical Association Meeting.—The programme of the third annual convention of this association is to be held at the Royal United Service Institution, Whitehall, S.W., on June 8th, 9th, 10th, and 11th. The president of the year is Mr. A. H. Gibbings; the vice-presidents being Messrs. Faraday Proctor, and Wilmshurst. The presidential address will be delivered on Wednesday morning, and the papers down for discussion are as follow:—

"The Management of Electrical Undertakings," by Councillor Hesford, Southport Electricity Committee.

"Switchboard Apparatus," by J. R. Blaikie, Chief Assistant Electrical Engineer, Bristol.

"Steam - using Plant," by J. A. Jeckell, Borough Electrical Engineer, South Shields.

Visits will be paid to the Waterloo and City Railway, and to the Islington Electricity Works; and in the evening the Association Dinner will take place at the Holborn Restaurant. On Thursday papers will be discussed as follow:—

"Uniformity of Plant," by C. H. Wordingham, Manchester.

"Appropriation of Profits and Repayment of Loans," by Bailie W. Maclay, convener of the Glasgow Electricity Committee.

"Single *v.* Multiple Generating Stations," by J. F. C. Snell, Sunderland Borough Electrical Engineer.

Visits will be paid to the works of Messrs. Willans & Robinson, Limited, at Rugby, Croydon electricity works, and the General Electric Company's lamp works. On the Friday papers are to be discussed as follow:—

"Electric Traction," by R. C. Quin, Blackpool borough electrical engineer, and J. E. Stewart, Derby borough electrical engineer.

"Accumulators in Connection with Lighting and Traction," by J. H. Rider, Plymouth borough electrical engineer.

"Stand-by Supply," by R. C. Quin, Blackpool.

Visits will be paid to Messrs. Siemens Bros. & Co.'s works at Woolwich, and the Shoreditch electricity works. The business meeting will be held on Saturday, June 11th, and in the afternoon visits will be paid to the Portsmouth and Dover electricity works.

Death by Electricity.—Our New York namesake, having reprinted from our columns Dr. Hedley's recent article on "Death by Electricity," Dr. J. Mount Bleyer writes to that journal criticising the article, saying:—

I carefully looked over the article, and must say that I failed to learn therefrom anything original, either from investigations or suggestions on the part of the author. The whole matter contains nothing but a rehash of what others have done. I therefore cannot find a single peg or plea—to hang it upon—for his having written this article except for reviewing some of the already known works of others. As father and one of the first experimenters on electrocution, a few words in answer to this review will be acceptable to your readers, &c., &c.

As a matter of fact, Dr. Hedley's article was what it was intended to be—a judicial summary of all that is worth knowing on the subject of death by electricity. It was not written to proclaim his own praises, nor to claim anything for himself—not even the title of "Father of Electrocution," or foster-father of the high-sounding phrase "dynamic apoplexy" (a term used by Dr. Bleyer in his letter), which, in the present connection, means about as much as Mesopotamia.

The New German Cable.—We understand two officials of the German Government have arrived in London to discuss the question of the proposed new German cable from the Azores across the Atlantic.

Copper.—The *Engineer* asks, "Is there to be a copper famine?" In the reply to this question, says our contemporary, the boilermaking and general engineering trades are vitally interested. And certainly the way in which the copper market has been jumping lately makes such a query not at all unreasonable. During last year this metal has been higher than the year before by an average of £2 per ton, and this advance has recently been greatly accentuated by the war. The production and consumption of copper was on a greater scale in 1897 than in any previous year in the history of the trade, no less than 396,723 tons having been produced, against 373,368 tons in 1896. Yet notwithstanding this great increase of 23,000 tons, the present visible supply in this latter part of May is at least 5,000 tons less than it was 12 months ago. The general increase in the consumption of copper for electrical engineering services and for marine engineering purposes is chiefly responsible for this diminution. European consumers are depending to a greater extent than ever before upon American supplies. The trans-Atlantic production has been, and still continues to be, on a very large scale. The price of copper to-day is altogether out of proportion to the quantity available for use, it being £2 per ton cheaper than at the same date in 1891, although the visible supply—or quantity in stock—is less than half what it was in 1891. In fact, the present stock is only sufficient for five weeks' consumption, and if the war between the United States and Spain is prolonged—for they, of course, are the two chief producing countries—there is no knowing to what extent the supply may be diminished; so that a copper famine is quite within the bounds of possibility, and those who have much to do with this useful metal in any capacity will act wisely if they regulate their operations in accordance with that possibility. Any real scarcity would, however, be only temporary, for new sources of supply are not infrequent—the latest copper discovery being just announced from Russia, where extensive copper ore beds have been found at Potar, only 10 miles from a point on the Samarkand-Andidsban railway.

Obituary.—The death is announced of Mr. R. Stuart Hampson, of Mayfield, Withington, at the early age of 37 years. At the time of his death Mr. Hampson was the electrical engineer of the Great Central Railway Company, and also of the Manchester and South Junction Railway. He joined the service of the Great Central about 11 years ago as telegraph engineer and superintendent, and since then he has carried out many important engineering works. Previously, as an assistant of the late Mr. E. C. Warburton, telegraph superintendent of the Lancashire and Yorkshire Railway Company, Mr. Hampson erected the electric light installation—one of the first in the country—at the grain silo at Fleetwood, in the early eighties. Mr. Hampson was a member of the Institution of Electrical Engineers, and was president of the Association of Railway Telegraph Engineers and Superintendents of Great Britain for the years 1896-7-8. He was a frequent contributor to scientific and electrical journals, and his professional advice was frequently sought.

Personal.—We are glad to be able to inform the many friends of Mr. H. Hirst, of the General Electric Company, of London, that he is now recovering from the serious operation which was quite successfully performed on Tuesday last.

Queensland Electrical Association.—On the initiative of Mr. John Hesketh, the Government electrical engineer, an electrical association is being formed for Queensland. The association would have for its objects the promotion of the general advancement of electrical and telegraphic science and its applications, the facilitating of the exchange of information and ideas on these subjects amongst its members and the general public, and would hold meetings, publish papers, &c. The *British Australasian* says that at a recent meeting at Brisbane a committee was formed for the purpose of drafting rules for the approval of a subsequent meeting. The committee consists of Messrs. J. S. Badger, E. G. Barton, C. H. Caspersonn, J. H. Durant, and J. Hesketh. Mr. J. Power, Post and Telegraph Department, Brisbane, is secretary to the committee.

Röntgen Rays in Warfare.—Before the Royal United Service Institution on Friday last, Surgeon-Major Beevor, M.B., Army Medical Staff, lectured on the "Working of the Röntgen Ray in Warfare." The lecturer said, according to the *Times* report, that his object was to give his experience in the working of the X ray in military surgery, and through the kindness of many official friends he would be able to give the audience the results of its employment on the recent frontier expedition in India, and then to lay before them some modifications in the construction of the appliances for generating the X ray which had suggested themselves to him after working among the wounded on the field of battle and its adjacent hospitals. He then exhibited, by means of the magic lantern, photographs of cases from the Frontier War, which showed with the utmost clearness the importance of the use of the X ray in the treatment of wounded men. The positions of bullets in various parts of the body were made perfectly evident in cases where it was quite impossible to localise the bullets by ordinary surgical methods. The lecturer said that it was not only possible, but quite easy to have an X ray apparatus working at the front. The cases exhibited contained indisputable proof that even in savage warfare, where the Geneva Convention was unknown, the X ray could be brought under control, and an immensity of human suffering obviated; it was not necessary that every field hospital or bearer company should be supplied with an apparatus, as it could be readily transported from one part to another of the field of operations. He felt sure they would see what an advantage it was to be able to localise bullets, and other foreign bodies, without the painful process of searching with probes, and that a threefold advantage was gained in the treatment of patients by this means—first, the absence of any pain or physical injury, from which arose the second advantage, that in cases where there had been much loss of blood or injury to bone, they were enabled to ascertain the exact condition of affairs, without the risk of increasing the depression of the patient by operation, and they thus gave him the best chance of reaction, upon which depended his recovery. He maintained that it was now the duty of every civilised nation to supply its wounded in war with an X ray apparatus, among other surgical aids, not only at base hospitals, but close at hand, wherever they might be fighting and exposing themselves to injury in the performance of their hazardous duty. The rest of the lecture was devoted to the consideration of technical questions in connection with the appliances required for generating the X ray.

Electric Light Wires as Telephonic Circuits.—In a letter to *Nature*, Mr. F. J. Jervis-Smith, of Oxford, describes a method of using electric lighting wires as telephonic circuits. He was requested some time ago to try to localise a fault in an electric light main, by means of a certain form of inductor used in conjunction with a telephone but not connected to the main. While using it, it occurred to him that probably the main might be used instead of a telephone wire. His first experiments were not productive of good results, as a small fraction of the company's current passed continuously through the telephone. In October, 1897, he placed $\frac{1}{2}$ microfarad condensers in his telephone circuit at each end; these stopped the current, but in no way reduced the telephonic effects. If the note given out by virtue of the rotation of the armature of the dynamo is great, it can be very greatly reduced by placing an inductively-wound resistance in the circuit. The resistance, he writes, does not appear to modify the telephonic effects in any marked degree. This probably arises from the fact that the E.M.F. due to the secondary coil of the telephone transmitter is high. The experiment was successfully made over two miles of a main which was carrying the full load used in lighting the town.

The Royal Society.—The following were among the papers down for reading yesterday afternoon:—Prof. Roberts-Austen, F.R.S., "On Surfusion in Metals and Alloys." Dr. J. Larmor, F.R.S., "Note on the Complete Scheme of Electro-dynamic Equations of a Moving Material Medium, and on Electrostriction." E. Wilson, "Aluminium as an Electrode in Cells for Direct and Alternate Currents." Dr. Capstick, "On the Kathode Fall in Gases."

Fatal Shock Accident at Chelmsford.—On Saturday, 21st inst., Edward Fell, the outdoor foreman of the Chelmsford Electric Lighting Company, went to a small transformer pit to switch off the transformer with a view to removing some secondary leads. He switched off the transformer, and afterwards, whilst removing some high pressure leads with his ungloved left hand, touched another high pressure lead with his right hand, and was immediately killed. The inquest was opened on Monday, 23rd inst., but was adjourned until yesterday (Thursday). Major Cardew held an official inquiry into the matter on Tuesday.

Erratum.—In the evidence given before the Select Telephone Committee, on page 722 of this issue, *Mr. F. T. Lamb* should, of course, read as Mr. J. C. Lamb, C.B.

NEW COMPANIES REGISTERED.

Cowans, Limited (57,378).—Registered May 16th, with capital £30,000 in £5 shares (2,000 7½ per cent. cumulative preference), to carry on the business of electricians, suppliers of electricity, mechanical and general engineers, contractors, machinists, &c. The subscribers (with one share each) are:—T. S. Cowan, 4, Marlborough Road, Ealing, solicitor; C. C. Smith, Bengeo, Hertford, gentleman; A. E. Hale, 18, Austin Friars, E.C., clerk; H. J. Wells, 5, Victoria Grove, Stoke Newington, clerk; E. W. Cowan, Hart Hill, Bowden, Cheshire, civil engineer; E. J. Cowan, 26, Kenilworth Road, Ealing, gentleman; A. J. Wells, 5, Victoria Grove, Stoke Newington, clerk. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first; qualification, £250; remuneration, £50 each per annum. Registered by E. W. Cowan, Hart Hill, Bowden, Cheshire.

Leyland and Birmingham Rubber Company, Ltd. (57,410).—Registered May 18th, with capital £300,000 in £1 shares, to adopt agreements (1) with the Leyland Rubber Company, Ltd.; (2) W. Stanley Morrison & Company, Limited; and (3) with "The Birmingham India-Rubber Company," and to carry on the business of manufacturers and dealers in India-rubber, gutta-percha, flax-hose, flax and cotton belting, &c., electricians, telegraph and electrical engineers and contractors, cable and telegraph instrument manufacturers, pneumatic and other tyre manufacturers, cycle manufacturers and dealers, motor car builders, engineers, machinists, &c. The subscribers (with one share each) are:—J. E. Baxter, Highfield, Leyland, Lancashire, manufacturer; J. W. Brown, Beech Mount, Bolton, cotton waste dealer; S. Whitehead, Sunnyside, Leyland, manager; J. W. Kenyon, The Hollies, Bury, gentlemen; J. A. Fallows, 14, New Brown Street, Manchester, salesman; E. T. Everett, 3, Stevenson Square, Manchester, merchant; R. T. Byrne, 124, New Street, Birmingham, manufacturer. The number of directors is not to be less than three nor more than seven; the first are: J. E. Baxter, A. S. Morrison, R. T. Byrne, J. W. Brown, and S. Whitehead; qualification, £2,500; remuneration, £52 10s. each per annum. Registered by Jordan & Sons, Limited, 120, Chancery Lane, W.C. Registered office, Golden Hill Works, Leyland, Lancashire.

The Caledonian Wire Rope Company, Limited (3,875).—Registered at Edinburgh, May 17th, with capital £20,000 in £10 shares, to carry on in the United Kingdom or abroad the business of manufacturers of wire ropes, electric cables, telegraph wires and lightning conductors and wire fencing of every description. The subscribers (with one share each) are:—J. Wilson, Airdrie House, Airdrie, M.P.; R. Moore, 156, St. Vincent Street, Glasgow, C.C.; R. Wilson, 75, Bothwell Street, Glasgow, coal master; J. Dixon, 127, St. Vincent Street, Glasgow, coal master; J. Mitchell, Airdrie, banker; W. Hugh, Thornhill, Blantyre, wire rope maker; J. Hugh, Thornhill, Blantyre, wire rope maker. The first directors are J. Wilson, R. Wilson, J. Mitchell, W. Hugh and J. Hugh. Qualification, £100. Registered by Oswald & Son, Edinburgh.

Werner Cadmium Electric Accumulator Syndicate, Limited (57,417).—Registered May 19th, with capital £6,000 in £1 shares, (2,250 preference), to adopt an agreement with Alexis Werner, and to carry on the business of an electric accumulator and electric supply company, also electricians, mechanical engineers, and electrical apparatus manufacturers. The subscribers (with one share each) are:—H. Simmons, 5, Sydenham Park, S.E., engineer; R. S. Keary, 1, Lea Hall Road, Leyton, E., clerk; T. L. W. Ginger, 39, Roseman Road, S.W., traveller; L. Sternberg, 22, Little Alie Street, Aldgate, E., clerk; G. Goodman, 21, St. Helen's Place, E.C., solicitor; M. Goodman, 21, St. Helen's Place, E.C., clerk; W. G. Richardson, 88, Dempsey Street, Stepney, clerk. Registered without articles of association. Registered office, Devonshire Chambers, Bishopsgate Street Without, E.C.

Electric Theatre, Limited (57,446).—Registered May 20th, with capital £5,000 in £1 shares, to erect, produce, construct, organise, exploit and show an electric theatre or music hall, and to carry on the business of electricians, mechanical engineers, suppliers of electricity, &c. The subscribers (with one share each) are:—J. H. Harrison, 31, Bow Street, W.C., costumier; A. J. Thomas, 30, Regent Street, S.W., gentleman; S. Jonsiffe, Grosvenor House, Kensington Park, wine merchant; J. L. Camp, 1, Spridgdale Road, Stoke Newington, artist; A. R. Kelly, 5, Camden Square, N.W., surveyor; E. Tremearne, 34, Gresham Street, E.C., accountant; M. W. Taylor, 34 and 36, Gresham Street, E.C., solicitor. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first; qualification, £250; remuneration as fixed by the company. Registered by Stanley & Co., 45, Ludgate Hill, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Barcelona Tramways Company, Limited (6,544).—This company's return was filed on March 24th, when 23,000 shares were taken up and paid for in full out of a capital of £300,000 in £10 shares.

Anglo-Portuguese Telephone Company, Limited (24,545).—This company's return was filed on April 15th, when 50,000 shares were taken up out of a capital of £75,000 in £1 shares, all of which are considered as fully paid.

Edmondson Electricity Meter Syndicate, Limited (41,756).—This company's annual return was filed on April 26th, when 175 shares were taken up out of a capital of £2,000 in £1 shares; 168 are considered as paid, and £7 has been received.

Eastbourne Electric Light Company, Limited (16,422).—This company's annual return was filed on May 3rd, when 1,949 shares were taken up out of a capital of £50,000 in £10 shares, and paid for in full.

Edison-Gower Bell Telephone Company, Limited (16,010).—This company's return was filed on April 15th, when 385,009 shares were taken up out of a capital of £500,000 in £1 shares. 370,000 have been considered as paid, £15,005 has been received, and £4 is in arrears.

CITY NOTES.

The Worcester Accounts.

The result of the year's working is that the gross profit amounts to £2,195, the net deficiency, after setting aside amounts for sinking fund, being £1,474. The works' costs are slightly higher than those of last year, and the reasons given by Mr. Ruthven Murray in his very excellent report to the municipality are as follow:—

"The greater consumption of fuel during last year is mainly responsible for the higher works' cost, and it at first sight appears paradoxical that while so many more units were generated by water-power, the coal account should have increased. The following is the explanation:—By reason of an increased private day load and public lighting load, extending daily over many hours, it was possible to use more water-power when the supply was plentiful, but it necessitated more steaming on low loads when the limits of the water-power were exceeded, or when no water could be obtained. During the fall of year, when the flow of water was exceptionally small, the percentage of steaming hours and steam generated units became very high. Owing to the engineers' strike and the stoppage of work, we were unable to get any of the extension plant which was ordered last year. The day load engine, which was more than ever required, has only just been delivered. Consequent upon the increase of the mean load, and the small flow of water, the steaming hours increased from the previous year's 33 per cent. to 45 per cent. of the total, and the cost of coal, per sold steam unit generated, from 1.06d. to 1.32d. With the new small engine at work, I look forward with confidence to a reduction in this figure for the present year.

The following table gives the cost per unit:—

	1897.	1896.
Total capital expended	£67,298	£60,718
Number of units sold	429,270	333,644
Number of lamps connected	—	—
Revenue from sale of current	£5,948	—
Net revenue	£2,195	—
Average price obtained per unit ...	8·14d.	—

Cost of Production.	£		Per unit.	1896.
Coal	1,328		·74d.	—
Oil, waste, water, and engine room stores	144		·08d.	—
Salaries and wages at generating station	1,176		·66d.*	—
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	744	Works' cost 1·90d.	·42d.*	—
Rent, rates and taxes	87		·05d.	—
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges and insurance	485		·27d.	—
Depreciation of buildings and plant account	—		—	—
Renewal fund account	—		—	—
Total	£3,964		2·22d.	—

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	5,948	0	0	3·14d.
Meter rents, &c.	192	0	0	—
Supply of steam		—		—
Transfer fees		—		—
Other items	151	0	0	—
Total	£6,291	0	0	3·14d.

Total cost per unit (exclusive of depreciation and renewal accounts), 2·22d.; works' cost, 1·90d.

* Including charges for public lamps.

The Shoreditch Electric Lighting Accounts.

The lighting accounts of the Shoreditch Vestry for the nine months ending March 25th, while presenting some interesting features, are nevertheless incomplete, because they do not include any statement setting forth the financial results of the dust destructor. Though dust destruction and electric lighting go hand in hand in the parish of Shoreditch, we understand that it is impossible to do otherwise than present separate accounts. Before an extended criticism were offered it would be necessary to have complete figures relating to both departments of the undertaking, and we shall therefore wait until the publication of the dust destructor accounts.

The form of the accounts is by no means a model of perspicuity, and it is to be regretted that the Board of Trade form is not adhered to. The net result of the undertaking is, that after providing for redemption of capital and payment of interest, there is a profit of £2,072. Of this sum £1,255 goes to pay off previous calls on the rates, which leaves a round sum of £700 to be carried forward. No provision has been made for depreciation. The least satisfactory feature in the report is the statement relating to electricity generated, and we reproduce the table as it stands:—

STATEMENT OF ELECTRICITY GENERATED, SOLD, &c.

Quantity generated in B.T. units.	Quantity sold. Public lamps.	Quantity sold. By contract.	Quantity sold. Private consumers by meter.	Quantity sold. Total sold.	Quantity used on works.	Total quantity accounted for.	Quantity not accounted for.	Number of public lamps.	Total maximum supply demanded.
491,107	80,791	...	203,504	284,295	156,725 including that quantity used by lift and fan motors, also loss in distribution.	441,020	50,087	57 arcs, 114 incandescents (32 C.P.)	408 kw.

"As the works have been taken to the water, fuel has also to follow, and at a moderate estimate the extra cost for increased railway dues and cartage on the 1,702 tons of coal used was £127, which should, of course, be deducted from the revenue derived from the water-power. It may also be noted that the above sum represents 6 per cent. on £2,100."

If we add to the amount of electricity used in works and lost in distribution, the quantity unaccounted for, we arrive at 206,812 units, which is not far off half the total quantity generated, and is in excess of the total current sold to private consumers.

An analysis of the cost of production shows the following:—

	1897.	1896.
Total capital expended	£87,802	—
Number of units sold	284,295	—
Number of lamps connected ...	—	—
Revenue from sale of current ...	£6,118	—
Net revenue	£3,730	—
Average price obtained per unit ...	5·14d.	—

Cost of Production.	£		Per unit.	1896.
Coal	279		·23d.	—
Oil, waste, water, and engine room stores	226		·19d.	—
Salaries and wages at generating station	774		·65d.	—
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	276	Works' cost 1·30d.	·23d.	—
Rent, rates and taxes	19		·02d.	—
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	412		·35d.	—
Depreciation of buildings and plant account	—		—	—
Renewal fund account	—		—	—
Total	£1.9:6		1·67d.	—

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	6,118	0	0	5·14d.
Meter rents, &c.	—			—
Supply of steam	—			—
Transfer fees	—			—
Other items	3,643	0	0	—
Total	£9,761	0	0	5·14d.

Total cost per unit (exclusive of depreciation and renewal accounts), 1·67d.; works' cost, 1·30d.

The Electric Railway and Tramway Carriage Works, Limited.

The prospectus of this company has been before the public this week, the list of subscriptions closing on Wednesday. The nominal capital is £150,000 in £5 shares, and the present is an issue of 22,000 shares, of which the vendors, who are the promoters of the company, have agreed to take 3,000 in part payment of the purchase money. The company has been formed to manufacture all classes of cars and railway carriages, but especially tramway cars for horse, electric, and cable roads, and vehicles for light railways. The production of electric motor trucks and steel underframes for Indian and Colonial railways, will also be a feature of the undertaking. The company has also been formed to acquire valuable property and works in West Strand Road, Preston, Lancashire, having an area of nearly 12½ acres, about 9½ acres, of which will be used by the company for the above purposes.

The present is considered the right moment to bring out the company, in view of the extensive movement all over the country in the adoption of mechanical traction.

The vendors will furnish and equip the works with machinery of the most modern character, and lay down plant for driving the principal machinery by electric motors. They will also construct an overhead electric tramway system through the works and grounds, so that all cars manufactured can be properly tested before leaving the works.

It does not appear that the company is to acquire any business reputation or connection, or to take over any orders, but it is expected that the works, *when completed*, will be capable of an output of 600 cars per annum at least, although, as we presume the works cannot get into full working order for some little time, profits may have to be waited for. The company will sell cars and other rolling stock on the hire-purchase system as required.

Mr. Wm. Wilson has reported upon the value of the works and property, and *when completed* they will, in his estimation, work out at £59,465. Mr. Stephen Sellon has reported upon the contract for the equipment of the works, and both his and Mr. Wilson's statements are included in the prospectus.

The vendors are to receive £80,000, payable as to £65,000 in cash and £15,000 in fully paid shares, leaving £30,000 available for working capital. The directors are: George Richardson, Esq., chairman North Metropolitan Tramways Company, chairman; George F. Fry, Esq., J.P., director Brisbane Electric Tramways Company, Limited; Richard H. Prestwich, Esq., deputy-chairman Blackpool and Fleetwood Tramroad Company; John Kerr, Esq., director Edinburgh and District Tramways Company, Limited; George Flett, Esq., director Newcastle and Gosforth Tramways Company, Limited. The secretary (*pro. tem.*) is Mr. Frederick Crimes, 13, Spring Gardens, Manchester.

The West African Telegraph Company, Limited.

The report and accounts of the directors for the year ended December 31st, 1897, presented to the thirteenth ordinary general meeting, held at Winchester House, 50, Old Broad Street, London, E.C., yesterday, states that the company's revenue for that period amounted to £64,722 15s. 2d., against which £21,212 9s. 2d. is charged for ordinary expenses, and £18,780 4s. 4d. for expenditure relating to repairs of cables, &c. After providing £860 2s. 3d. for income-tax, and £225 1s. 3d for re-valuation of currency assets, there remains a balance of £23,644 18s. 2d, to which is added £459 10s. brought from the preceding year, making a total available balance of £24,104 8s. 2d. From this balance there has been deducted £10,098 9s. for interest on debentures, and £13,633 6s. 8d. for sinking fund, leaving a balance of £372 12s. 6d., which it is proposed to carry forward to next year. The director who retires by rotation is Robert Kaye Gray, Esq., who, being eligible, offers himself for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths & Co., also retire, and offer themselves for re-election.

The Marquis of Tweeddale presided at the ordinary meeting of the company.

The Chairman said the gross revenue for 1897 was £64,723, a decrease of £6,266 compared with 1896; this was accounted for by the falling off in the Cape joint-purse traffic, which amounted to £1,693, the increased loss in exchange of £2,699, which could not possibly have been foreseen, and to increase under the head of rent of cable, £1,074. The last increase was explained by the interruption of cable between Bathurst and St. Vincent, which occurred simultaneously with interruption to communication by the East Coast, compelling them to divert traffic on to lines not belonging to the company, and for which they had to pay rent. The total working expenses for the year amounted to £21,212, or an increase of £3,314. Repairs of cables was £18,780, or a decrease of £1,915. Although this was a decrease, the figures were still exceptionally high. The French Government still continued to withhold subsidies, the action of the Government being due to difference of opinion, based on certain clauses of their concession. They were anxious to maintain good relations with the French Government, and they submitted a proposal for the settlement of the differences, conceived in a very liberal spirit, and they had reason to think it was acceptable. It had not yet received the confirmation of the Chamber, which was probably accounted for by the election nearly concluded. They hoped before long to come to an arrangement satisfactory to all parties.

The report and accounts were then adopted. Mr. Robert K. Gray, the retiring director, and the auditors, were then re-elected.

British Aluminium Company, Limited.—This company has, during the past week, been inviting applications for an issue of £100,000 5 per cent. debentures, of which £18,000 has already been applied for and allotted to shareholders. The list closed on Wednesday, 25th inst. The money is required to provide for a larger output at the different factories, the necessary additional works being now in course of construction.

Brazilian Submarine Telegraph Company, Limited.—The directors have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income-tax, for the quarter ended March 31st, 1898, and payable on June 24th. The transfer books of this company will be closed from June 17th to the 23rd, both days inclusive.

Detroit Telephone Company.—The directors have declared a quarterly dividend of 2 per cent., being at the rate of 8 per cent. per annum, payable on and after 16th inst., to all holders on the register on April 30th.

TRAFFIC RECEIPTS.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending May 20th, 1898, were £2,696 13s. 9d.; corresponding period 1897, £2,483 19s. 1d.; increase, £212 14s. 8d.

The City and South London Railway Company.—The receipts for the week ending May 22nd, 1898, were £987; week ending May 23rd, 1897, £958; increase, £29; total receipts for half-year, 1898, £21,666; corresponding period, 1897, £21,461; increase, £205.

The Dover Corporation Electric Tramways.—The receipts for the week ending May 14th, 1898, £135 5s. 11d.; total receipts to May 14th, 1898, £2,217 8s. 7d. Week ending May 21st, 1898, £127 16s. 5d.; total receipts to May, 1898, £2,209 19s. 1d.

The Dublin Southern District (Electric) Tramways Company.—The receipts for week ending Friday, May 20th, 1898, were £563 3s. 4d.; corresponding week last year, £669 17s. 10d.; decrease, £106 14s. 6d.; passengers carried, 88,163; corresponding week last year, 95,616; aggregate to date, £8,921 1s. 1d; aggregate to date last year, £9,367 15s. 9d.; decrease to date, £446 14s. 8d.; mileage open, 8 miles.

The Liverpool Overhead Railway Company.—The receipts for the week ending May 22nd, 1898, amounted to £1,416; corresponding week last year, £1,386; increase, £30.

The Western and Brazilian Telegraph Company, Limited.—The receipts for the week ending May 20th, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,259.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, May 18th.	Closing Quotation, May 25th.	Business done during week ended May 25th, 1898. Highest.	Lowest.
137,400l	African Direct Telegraph, 4 % Deb.	100	4 %	...	...	100 —104	100 —104	...	...
25,000	Amazon Telegraph, shares	10	...	...	...	7 — 8	7 — 8	...	...
125,000	Do. do. 5 % Debs. Red.	100	...	...	...	93 — 96	93 — 96	...	...
923,960l	Anglo-American Telegraph	Stock	£2 9s	£2 13s	3 %	63 — 66	64 — 67	64	63
3,038,020l	Do. do. 6 % Pref.	Stock	£4 18s	£5 6s	6 %	112½—113½	114 —115	114½	113
3,038,020l	Do. do. Deferred	Stock	...	...	...	14¾— 15¼	15¼— 15¾	15½	14 15/16
130,000	Brazilian Submarine Telegraph	10	7 %	7 %	7 %	15¼— 15¾	15¼— 15¾	15⅝	15½
75,000l	Do. do. 5 % Debs. 2nd series, 1906	100	5 %	...	...	112 —116	112 —116	...	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	4 %	...	3 — 3½	3 — 3½	...	...
10,000,000$	Commercial Cable	$100	7 %	8 %	8 %	175 —185	170 —185	...	...
918,297l	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	104 —106	104 —106	105½	104¼
224,850	Consolidated Telephone Construction and Manufacturing	10/-	1½%	2 %	...	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Telegraph	10	8 %	8 %	7 %	7 — 8	6½— 7½	7	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	14½— 15½	14½— 15½	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 11	10 — 11	...	...
30,000l	Do. do. 4½ % Debs., Nos. 1 to 6,000	50	4½%	4½%	4½%	103 —106%	103 —106%	...	...
60,710l	Direct United States Cable	20	2¼%	2½%	...	10¼— 10¾	10¼— 10¾	10 9/16	10½
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	99 —102	99 —102	...	...
400,000	Eastern Telegraph, Nos. 1 to 400,000	10	6½%	6½%	...	16¾— 17¼	16¾— 17¼	17 1/16	16 13/16
70,000	Do. 6 % Cum. Pref.	10	6	6 %	...	18 — 19	17½— 18½	18	17¾
89,900	Do. 5 % Debs., repayable August, 1899	100	5 %	5 %	...	100 —103	100 —103	...	...
1,302,615l	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	123 —127	123 —127	...	...
250,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	7 %	17½— 18	17½— 18	17¾	17½
25,200l	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	5 %	5 %	100 —104	100 —104	...	...
100,500l	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	5 %	...	101 —104	101 —104	...	...
320,000l	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	127 —130	126 —129	...	...
35,100l	Eastern and South African Telegraph, 5 % Mort. Deb., 1900 red. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	...	100 —104	100 —104	...	...
46,500l	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	...	101 —104	101 —104	...	...
300,000l	Do. 4 % Mort. Debs., Nos. 1 to 3,000, red. 1909	100	4 %	4 %	...	101 —104	101 —104	102¼	...
200,000l	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1 –8,000	25	4 %	4 %	...	105 —108	105 —108%	105	...
180,227	Globe Telegraph and Trust	10	4⅛%	4½%	4½%	11¼— 11¾	11½— 12	11⅞	11¼
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6 %	16½— 17	16¾— 17¼	16 13/16	16½
150,000	Great Northern Telegraph, of Copenhagen	10	10 %	10 %	10 %	28 — 29	28½— 29½	28 9/16	28½
160,000l	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	100 —103	100 —103	...	...
97,000	Halifax and Bermuda Cable, 4½ % 1st. Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	97 —102	97 —102	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	50 — 53	50 — 53	52	50⅛
100,000l	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	6 %	6 %	107 —110	107 —110	...	...
28,000	Montevideo Telephone, 6 % Pref., Nos. 1 to 28,000	5	4 %	4 %	4 %	2 — 2½	2¼— 2¾	...	...
484,597	National Telephone, 1 to 484,597	5	5½%	5½%	6 %	5⅝— 5⅞	5½— 5¾	5¾	5⅝
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	15 — 17	14 — 16	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5⅜— 5⅝	5⅜— 5⅝	5⅝	5 9/16
1,329,471l	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	99 —104	99 —104	102½	100
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	⅝— ¾	⅝— ¾	¾	11/16
100,000l	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	4 %	4 %	4 %	105 —108	105 —108	...	...
11,839	Reuter's	8	5 %	5 %	5 %	8 — 9	8 — 9	8 11/16	...
3,381	Submarine Cables Trust	Cert.	...	...	...	136 —141	136 —141	...	...
58,000	United River Plate Telephone	5	4 %	5 %	...	4 — 4½	4 — 4½	...	...
146,733l	Do. do. 5 % Debs.	Stock	5 %	...	...	105 —108	104 —107	...	...
15,609	West African Telegraph, 7,501 to 23,109	10	4 %	*nil*	*nil*	3½— 4½	3½— 4½	...	...
213,400l	Do. do. 5 % Debs.	100	5 %	5 %	5 %	99 —102	99 —102	...	...
64,269	Western and Brazilian Telegraph	15	3 %	2 %	3¼%	11¾— 12¼	11½— 12	...	...
33,129	Do. do. do. 5 % Pref. Ord.	7½	5 %	5 %	5 %	7½— 8	7½— 8	7⅝	...
33,129	Do. do. do. Def. Ord.	7½	1 %	*nil*	½%	4 — 4½	4 — 4½	...	...
389,521	Do. do. do. 4 % Deb. Stock Red.	Stock	...	...	...	105 —108	104 —107	106½	...
88,321	West India and Panama Telegraph	10	⅞%	1 %	¾%	½— ¾	½— ¾	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	7¼— 7¾	7¼— 7¾	7 11/16	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	5 — 7	5 — 7	...	...
80,000l	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	5 %	105 —108	105 —108	...	...
1,163,000$	Western Union of U.S. Telegraph, 7 % 1st Mort. Bonds	$1000	7 %	7 %	7 %	103 —108	103 —108	...	...
160,100l	Do. do. do. 6 % Ster. Bonds	100	6 %	6 %	6 %	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

Present Issue.	NAME.	Stock or Share.	1895.	1896.	1897.	Closing Quotation, May 18th.	Closing Quotation, May 25th.	Highest.	Lowest.
30,000	Charing Cross and Strand Electricity Supply	5	5 %	6 %	7 %	13 — 14	12 — 13	12¾	12 9/16
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	...	...
26,000	*Chelsea Electricity Supply, Ord., Nos. 1 to 10,277	5	5 %	5 %	6 %	9 — 10	8½— 9½	9⅛	8⅝
60,000	Do. do. 4½ % Deb. Stock Red.	Stock	4½%	4½%	4½%	115 —117	115 —117	...	...
50,000	City of London Electric Lighting, Ord. 40,001—90,000	10	5 %	7 %	10 %	23½— 24½	24½— 25½	25⅛	23½
10,000	Do. Prov. Certs. Nos. 90,001 to 100,000 £5	10	...	...	...	16 — 17	16½— 17½	16¾	16
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16½— 17½	16½— 17½	...	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	129 —134	129 — 134	...	...
30,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—30,000	10	*nil*	*nil*	*nil*	12 — 13	13 — 14	13¾	12½
10,000	Do. do. do. Nos. 30,001 to 40,000 £4 paid.	10	...	...	...	6 — 7	6½— 7½	7	6 1/16
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	15 — 16	15 — 16	15	14¾
17,400	Edmundsons Elec. Corp., Ord. Shares 1—17,400 £4 paid	5	...	...	...	3½— 4½	3½— 4½	4½	...
10,000	House-to-House Electric Light Supply, Ord., 101 to 10,100	5	...	...	4 %	9 — 10	9 — 10	...	...
10,000	Do. do. 7 % Cum. Pref.	5	7 %	7 %	7 %	11 — 12	11 — 12	...	...
62,400	*Metropolitan Electric Supply, 101 to 62,500	10	4 %	5 %	6 %	17 — 18	16½— 17½	17¼	16½
220,000l	Do. 4½ % First Mortgage Debenture Stock	...	4½%	4½%	4½%	117 —121	117 —121	...	...
6,452	Notting Hill Electric Lighting	10	2 %	4 %	6 %	19 — 20	18½— 19½	...	...
31,980	*St. James's and Pall Mall Electric Light, Ord.	5	7¼%	10½%	14½%	16½— 17½	16 — 17	16⅞	16½
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	10 — 11	10 — 11	...	...
50,000	Do. do. 4 % Deb. Stock Red.	Stock	...	...	4 %	107 —110	107 —110	...	...
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	1¾— 2¼	2 — 2½	2 3/16	2⅛
79,900	Westminster Electric Supply, Ord., 101 to 80,000	5	7 %	9 %	12 %	15 — 16	15½— 16½	16 5/16	15 7/16

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation May 18th.	Closing Quotation May 25th.	Business done during week ended May 25th, 1898. Highest.	Lowest.
30,000	British Electric Traction	10	...	...	...	15½— 16	15½— 16	...	...
10,000	Do. do. 6 % Cum. Pref. 30,001—40,000 £4 pd. (issued at £2 10s. prem. all pd.)	10	...	...	...	7 — 8	7 — 8	7¼	7
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	3	2½%	*nil*	*nil*	1¾— 2	1¾— 2	1⅞	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	*nil*	4 %	2¼— 2½	2¼— 2½	$2\frac{5}{16}$	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	110 —114	110 —114	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red. ...	Stock	...	...	...	101 —104	101 —104	103½	101¾
19,894	Central London Railway, Ord. Shares	10	...	...	...	10 — 10½	10 — 10½	10⅜	10¼
129,179	Do. do. do. £6 paid	10	...	...	...	6 — 6½	6 — 6½	6¼	$6\frac{1}{16}$
59,254	Do. do. Pref. half-shares £1 paid ...	...	...	...	...	1¼— 1¾	1¼— 1¾	...	...
67,680	Do. do. Def. do. £5 paid ...	...	...	...	...	4¼— 4¾	4¼— 4¾	...	...
630,000*l*	City and South London Railway	Stock	$1\frac{3}{16}$%	$1\frac{9}{16}$%	1⅞%	67 — 70	67 — 70	...	...
28,180	Crompton & Co., 7 % Cum. Pref. Shares, 1 to 28,180 ...	5	*nil*	...	...	2 — 2½	2 — 2½	...	...
99,261	Edison & Swan United Elec. Lgt., "A" shares, £3 pd. 1 to 99,261	5	5 %	5½%	...	2¼— 2¾	2¼— 2¾	2⅝	...
17,139	Do. do. do. "A" Shares, 01—017,139	5	5 %	5½%	...	4 — 5	4 — 5	...	...
194,023	Do. do. do. 4 % Deb. Stock Red. ...	100	...	...	...	103 —105	103 —105	103	...
110,000	Electric Construction, 1 to 110,000	2	5 %	6 %	...	2⅝— 2⅞	2⅝— 2⅞	2⅝	...
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 ...	2	7 %	7 %	...	3⅛— 3⅜	3⅛— 3⅜	3¼	...
111,100	Do. do. 4% Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	106 —108	106 —108	...	...
91,196	Elmore's Patent Copper Depositing, 1 to 70,000	2	...	...	...	½— ¾	½— ¾	...	...
67,275	Elmore's Wire Manufacturing, 1 to 69,385, issued at 1 pm.	2	...	...	...	⅜— ⅝	⅜— ⅝	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	10½%	7 %	7 %	9 — 11	9 — 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ord.	10	8 %	12 %	10 %	21½— 22½	21½— 22½	...	...
3,000	Do. do. do. 7 % Pref.	10	7 %	7 %	7 %	18½— 19½	18½— 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½%	4½%	4½%	110 —115	110 —115	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	10 %	21 — 22	21 — 22	21½	...
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	102 —106	102 —106	106	...
37,500	†Liverpool Overhead Railway, Ord.	10	2⅞%	2⅞%	3¼%	10⅝— 10¾	10⅝— 10¾	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15¾— 16¼	15¾— 16¼	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	35 — 38	34 — 37	36	35¼
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	...	...	133 —136	133 —136	134	133½

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 10½.

House-to-House, 4½% Debentures of £100, 107—110.

Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 15—16; 1st Preference Cumulative 6%, £5 (fully paid), 8—8½. Debentures, 107—110. Dividend, 1897, on Ordinary Shares 10%.

* From Birmingham Share List.

London Electric Supply Corporation, £5 Ordinary, 3¼—3¾.

*T. Parker, £10 (fully paid), 15½.

Yorkshire House-to-House Electricity, £5 Ordinary Shares fully paid, 8—8½. Dividend for 1896—6 %.

Bank rate of discount 4 per cent. (April 7th, 1898).

PHYSICAL SOCIETY.

ORDINARY MEETING, May 13th, 1898.

MR. SHELFORD BIDWELL, President, in the Chair.

A PAPER by Prof. W. E. AYRTON and Mr. J. MATHER, on GALVANOMETERS, was read by Prof. AYRTON.

It is a sequel to *Proc. Physical Soc.*, Vol. x., p. 393, and to *Phil. Mag.*, Vol. xxx., p. 58. The authors suggest that in future the comparative sensitiveness of galvanometers should be expressed in terms of the number of millimetre scale-divisions per micro-ampere, when the observed image or "spot" is one metre from the mirror. Unit angular deflection is, therefore, one two-thousandth of a radian. Further, for the periodic time, *i.e.*, the time between two transits of the "spot" across some fixed point on the scale, in the *same* direction, the standard should be 10 seconds. It is also proposed to reduce the factor of sensitiveness, as regards resistance, to the common basis of one ohm. The assumption is that, for a given galvanometer, the deflection per micro-ampere is proportional to the two-fifth power of the resistance of the windings. Tables accompanying the paper give complete data for a large number of galvanometers constructed during the past ten years, and it is possible to trace the improvements in sensitiveness throughout that time. The most sensitive galvanometers are the oscillographs, they have very short periods; the moving parts are small; the controlling fields very strong. They are designed to indicate the character of rapidly-varying currents. An oscillograph, as improved by Mr. Duddell, was exhibited; its period is 0·0001 per second, and its factor of sensitiveness, according to the authors' classification, is greater than any yet obtained. A distinction is drawn as to the use of the term "dead-beat." Maxwell applies it to galvanometers in which the motion is "aperiodic," *i.e.*, to those in which the suspended system, before coming to rest, passes only *once* through the position of equilibrium. This meaning is retained; it is not to be confused with "quick-moving" or "short-period." A pendulum illustrating these distinctions was exhibited. As regards insulation of galvanometers and shunt-boxes, the authors now apply the "guard-wire" principle of Mr. W. A. Price. The instrument to be insulated is enclosed in a metal case, provided with a terminal to which one end of the windings is connected. The second end of the windings passes out through an ebonite bush piece. This arrangement is said to nullify leakage and to prevent electrostatic disturbance of the suspended system. In the second section of the paper the authors calculate the limiting sensitiveness of galvanometers of the "Thomson" type. The investigation is based upon Prof. Schuster's B.A. 1894 paper, it takes into account the period of the suspended system, and the specific magnetisation of the needle. Lastly, the authors discuss the relative merits of long and short periods, *i.e.*, the best "control," for galvanometers intended to indicate zero points in potentiometer operations. They conclude that if the control can be readily altered, and if the sensitiveness can be adjusted for the test, then, for rapidity of working, the "control" should be so adjusted that the sensitiveness is approximately two or three times greater than is absolutely needed for the desired accuracy.

Prof. THRELFALL thought the author's method of comparing galvanometers very misleading. The results obtained in their comparison of the oscillograph (3,310,000), and the suspended-coil galvanometer (27) might be regarded as the *reductio ad absurdum* of the proposed system. The absurdity arose from the dissimilarity of the two instruments. Moreover, the proposed system ignored the fact that sensitiveness may be obtained by optical as well as by electro-magnetic means. Optical sensitiveness, owing to its greater stability was to be preferred to electro-magnetic sensitiveness. The fundamental problem in the construction of galvanometers is an optical one, it is necessary to decide the mass and dimensions of the suspended parts so as to ensure (1) optical accuracy, and (2) electro-magnetic sensitiveness. Thus, to some extent the weight of the mirror determines the thickness of the suspension. As an instance of what might be done by optical methods, Prof. Threlfall referred to work done by himself and Mr. Brearley (*Phil. Mag.*, 1896), in which it was possible to measure to $1·48 \times 10^{-13}$ amperes, and, with special refinements, to 3×10^{-14} amperes. He had found that the best diameter for glass mirrors was 1·1 cms., with a weight just under 0·5 grammes. These were used with a scale at 276 cms., read by a microscope to 0·04 mm. The course of the light was: lamp, large lens, small scale, mirror, eye-piece. The period was 25 secs., and the resistance 10,000 ohms. Even better results could be obtained by using mirrors of quartz or of bloodstone. Quartz is incomparably to be preferred to glass. Such figures indicated what could be done by optical sensitiveness, the sensitiveness that the authors ignored. It was pointed out by Prof. Threlfall that the controlling field for galvanometers of the "Thomson" type should be straight and uniform. This was best secured by using two magnets, one above and one below the needles.

Prof. PERRY said the authors had not asserted that a galvanometer with higher figure of merit, according to their classification, was *superior* to another of lower figure. It must be agreed that the figure they obtain is a very valuable datum for the comparison of instruments designed for similar purposes; for instance, in classifying those used by Prof Threlfall, Mr. Duddell was to be congratulated on the extreme sensitiveness and small period of his oscillograph.

Prof. AYRTON, referring to Prof. Threlfall's *reductio ad absurdum*, admitted that the criticism would carry some conviction if the two instruments were of different kinds; if, for instance, one possessed a suspended needle and the other a suspended coil. But the argument failed, because both instruments were of the suspended coil type. In one of them Mr. Duddell had developed the advantages to be gained by reducing the air-gap. To form an opinion of electro-magnetic improvements in galvanometers, it was necessary to reduce the results of all instruments to some system of classification. There was no objection, after that, to adding a good mirror and reading by a good microscope.

The PRESIDENT proposed votes of thanks to the authors, and the meeting adjourned until May 27th.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

THE PREVENTION OF INTERRUPTIONS TO ELECTRICITY SUPPLY. By LEONARD ANDREWS, Associate. Read May 5th, 1898.

(*Concluded from page* 708.)

Fig. 5 is a sectional elevation of a similar cut-out modified for use in connection with high-tension currents. In this arrangement the contacts are screwed and sweated into metal pots, and immersed in water. This serves effectually to quench any tendency to arcing

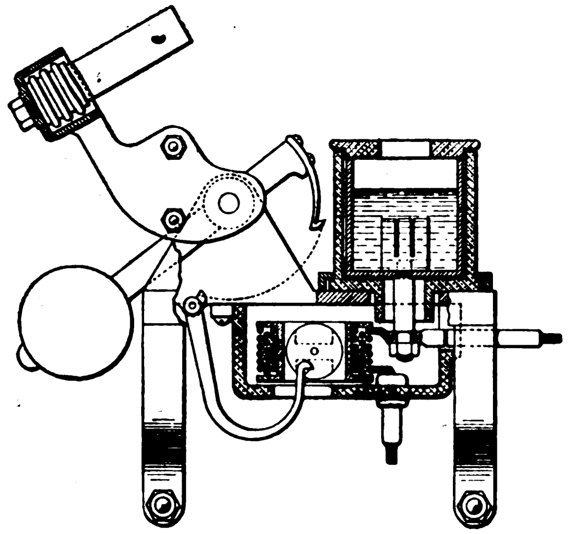


FIG. 5.

when large high-tension currents are interrupted. All the high-tension parts in this cut-out are entirely covered with porcelain or other insulating material. The releasing mechanism is practically the same as in the low-tension cut-out.

Fig. 6 is a diagram of the Hastings switch gear. We have found this arrangement entirely satisfactory in every respect. It has not only enabled us to cope with several breakdowns to machinery without interruptions to the supply, but it has also effected a saving in coal, &c., during the past 18 months of over £400. This has been saved by the arrangement referred to enabling us to work safely without running a spare plant.

All the machines are arranged to feed into a common pair of inner and outer 'bus bars. The inner 'bus bar, however, is divided at A by a change-over switch, C, into two separate branches. One of these, A_1, is permanently connected to A, but the other branch, A_2, may be connected either to the main 'bus bar or to a spare 'bus bar, B. Normally, it is connected to the former. Each machine and circuit is equipped with a two-way switch, T, by means of which any machine or any circuit may be connected either to the inner 'bus bar or to its auxiliary branch. In the diagram only three circuits and three machines are shown. The maximum output of the machines is 60 amperes, and the total load of the three circuits is assumed to be 120 amperes—namely, 60 on No. 1, 40 on No. 2, and 20 on No. 3. By setting the circuit two-way switches, T_2 and T_3, over to the left, circuits 2 and 3 are connected directly on to the A_1 branch of the inner 'bus bar; whereas, T_1 being set over to the right, circuit 1 is connected on to the A_2 branch. The machines Nos. 2 and 3 are connected in parallel by their two-way switches directly on to the inner 'bus bar, A. And the machine No. 1 is kept turning as a spare, with its two-way switch over to the right, thereby connecting it on to the spare 'bus bar, B. The change-over switch, C, is constructed to

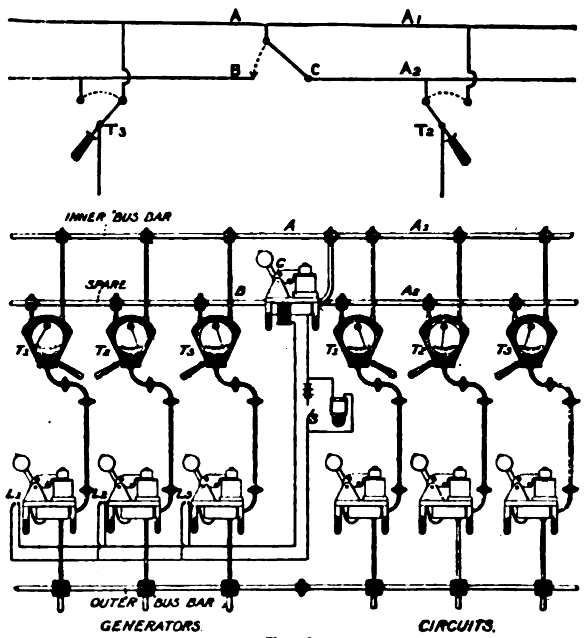
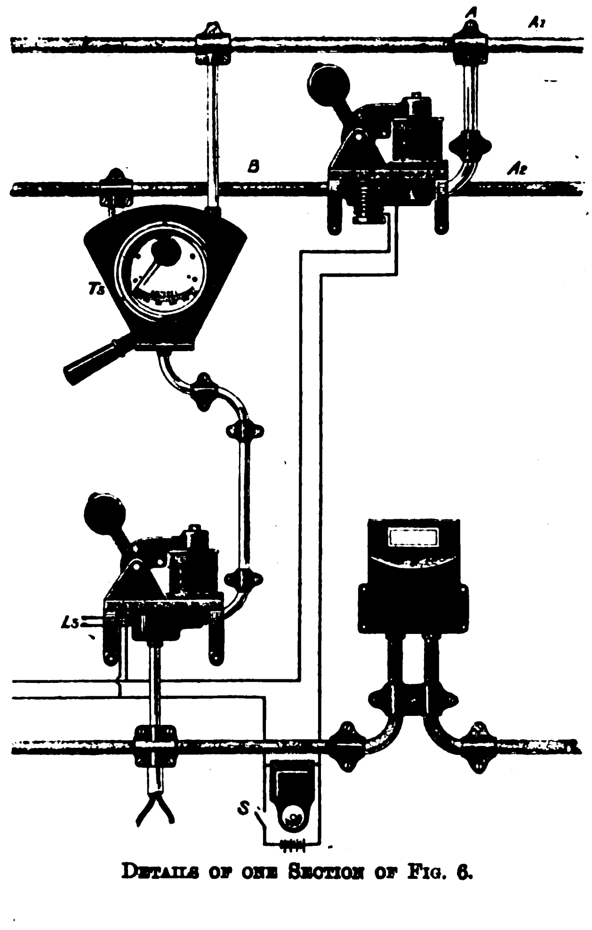


FIG. 6.

be released by a solenoid excited off any convenient source, E. Inserted in series with it are two switches, S and L_1, L_2, or L_3. Both the S and one of the L switches must be closed together to excite the



DETAILS OF ONE SECTION OF FIG. 6.

solenoid. When S only is closed it completes a circuit through an electric bell, which can be heard anywhere in the station. The driver has instructions that whenever that bell rings he must immediately run the spare plant up to speed. Now if either of the running plants break down, the switchboard attendant merely has to close switch S, and then as soon as the volts on the spare machine have risen to normal, or before if necessary, he releases the cut-out switch of the faulty machine. The weight of this on falling closes switch L, and so completes the circuit through the solenoid of the releasing change-over switch C. This disconnects the 'bus bar A_2 with its load of 60 amperes from the inner 'bus bar A, and transfers it to the spare 'bus bar B at precisely the same moment as the generator supplying 60 amperes is disconnected from the inner 'bus bar. Thus the lights on the circuits Nos. 2 and 3 are not affected as they would be if the change-over were not done simultaneously with switching out the faulty machine; and the lights on No. 1 circuit only give a momentary flicker, which, as a rule, is not even noticed by the consumers.

Of course the use of a spare 'bus bar is not original, but we believe that the simultaneous method of change-over is.

In the discussion on a paper read before the Northern Society of Engineers on switch gear last year, it appeared to be the general opinion of engineers present that all high-tension connections should be absolutely enclosed. But it was objected that it did not appear possible to do so without having exposed connections at the back of the board, and boards with backs to them increased rather than decreased the risk of accidents. A suggestion was also made in this same paper that a full sized diagram of connections painted on the walls above the switch gear would often prove useful, but other engineers thought that the switch gear should be its own diagram. We venture to think that in the switch gear shown in fig. 6 we have succeeded in complying with both of these specifications. The leads from the machines are carried in porcelain or other insulating pipes directly up to their respective cut-outs, from these to the two-way switches *viâ* their ammeters, and so on to the 'bus bars. All the high tension connections, both in the cut-out switches and the two-way switches, are entirely enclosed; and, as these switches and the conductors are bolted and clipped to the surface of a brick wall, all the connections are diagrammatically shown at a glance.

Some form of excess current cut-out should certainly be used on the feeders. We prefer magnetic cut-outs to fuses, as we find them more reliable. They can also be used as switches if necessary, which is a distinct advantage. At any rate, whatever form of cut-outs is used, their operation should on no account be permitted to interrupt the supply to any consumers.

It is curious that engineers have not paid more attention to the duplication of electrical mains. It is the custom to spend thousands of pounds on duplicating boilers, engines, dynamos, and other plant which is directly under the engineer's control; but no steps are taken efficiently to duplicate that part of the system over which he has no direct control, and which is always at the mercy of such external forces as gas explosions, burst water mains, fires, pick-holes, &c.

It is true many engineers arrange their mains on some ring system, so that any portion of it may be made dead for repairs, extensions,

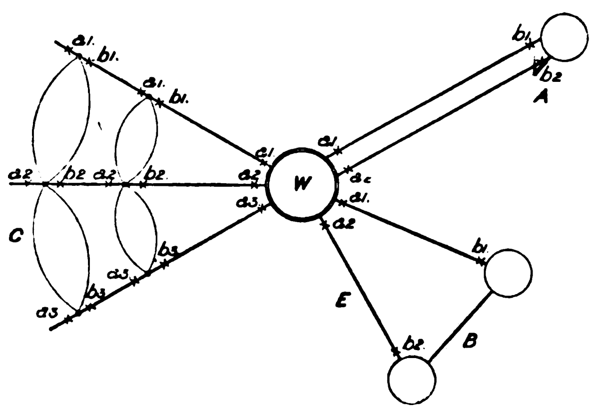


Fig. 7.

&c.; and some go even further, and fix fuses at intervals round the ring, so proportioned that a fault will only cut out a certain section of the lights. But that is not sufficient. We ought not to be satisfied until we are able to guarantee an absolutely constant supply to everyone. The problem of how to do this has been troubling us at Hastings for years. But we now feel satisfied that we have solved it. Our method of doing so is shown in fig. 7.

Each sub-station or feeding point is supplied from the works, W, by two feeders, either by running to each two distinct mains, each sufficiently heavy to carry without excessive fall of pressure half the load of the sub-station, as shown at A, or by connecting together two sub-stations, each supplied by separate feeders, as at B; or, in the case of low tension distribution, by running radial feeders from the generating station, and connecting the several feeding points on these to corresponding feeding points on an adjacent feeder by the distributing mains, as shown at C. If a fault occurs on either of these feeders, the current will be supplied to it both directly from the generating station and also *viâ* the adjacent feeder and connecting mains. To prevent this fault from short-circuiting the whole of the system, fuses have previously been inserted in the feeders at a_1, a_2, b_1, and b_2. A little consideration will show, however, that this arrangement can never be satisfactory, for it is obvious that either one of these feeders may at any time have to carry as heavy a current as the others; consequently, they must all be equally fused. Now, if a short-circuit occurs at, say, E, fuse a_2 will blow. The current will then be supplied *viâ* a_1, b_1, and b_2. Now fuse b_2 should, of course, blow, and so cut out the faulty main, leaving both sub-stations to be supplied *viâ* feeder 1. But this will not happen, because a_1 and b_1 would have to carry sufficient current to blow b_2, in addition to the useful current taken by the sub-stations. The result will naturally be that a_1 or b_1 will invariably blow before b_2, thus cutting off the lights supplied by both feeders. Now, if fuses b_1 and b_2 are replaced by discriminating cut-outs, no amount of current flowing in its normal direction will cause them to operate, but a comparatively small return current will immediately release them. As the only conditions that can possibly cause the current to flow back from the sub-stations to the generating station is a fault on the feeder between these points, this form of cut-out can be relied upon to operate only when it is required to do so.

It is, of course, very essential that the cut-outs used for this purpose should be made not to operate if either the series or shunt current is interrupted separately or simultaneously, as it would cause a great deal of trouble if the supply from the works was ever interrupted for a few seconds and all the cut-outs on the mains were thereby caused to operate.

Cut-outs that are opened with a spring or springs should also be avoided, as it is impossible to make them sensitive and reliable, owing to the fact that the catch has to be released against the maximum tension of the springs; and, further, these springs must be very stiff, as in addition to overcoming the friction of the contacts when they are clean, a large margin must be allowed to overcome the increased friction that will certainly be caused by corrosion of the contacts after they have been in, say, a few months. A falling weight seems much better suited for the purpose than a spring, for the pressure on the releasing catch is comparatively small, and the sharp blow upon the contact arm is just what is required to overcome with certainty any tendency to sticking due to corrosion.

Cut-outs should have no screws about them liable to work loose and so release the catch and open the circuit.

For burying under the pavements they should be as compact as possible, as the space is then very limited.

They should also be unaffected by rust, dust, damp, or corrosion, and precaution should be taken to prevent any possibility of their being caused to operate by external vibration. They should be made to cut out with as small a current as possible, to prevent excessive arcing when the circuit is interrupted.

The cut-out illustrated in fig. 5 has been designed to comply with these and other requirements.

Another very frequent cause of local interruptions is the failure of primary fuses of transformers. It certainly appears to be advisable to use some form of excess-current cut-out between the primary winding of transformers and the mains supplying them. But the object of this cut-out should be, not to prevent the transformers from being overloaded, but to protect the mains from being short-circuited by a faulty transformer. Where two or three transformers are coupled together no good can come of cutting one of them out of circuit because it is overloaded, for if one is cut out the extra load is thrown upon the others, thus invariably blowing their fuses as well and cutting off the supply to the whole district.

We consider that a transformer fuse should not blow unless the excess current exceeds the normal current by about 300 per cent.

Fuses between the secondaries of transformers and secondary 'bus bars are invariably worse than useless. Take, for instance, the case of three transformers of equal size feeding a common 'bus bar. If one of these fails, the current will rush back into it from the other two; but, as these have to supply the useful current to the mains, in addition to that required to blow the faulty transformer's fuse, they will blow their own fuses before that of the faulty transformer. Obviously these fuses should be replaced by discriminating cut-outs

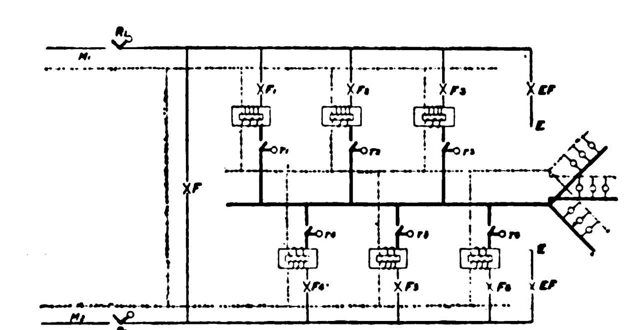


Fig. 8.

Fig. 8 is a diagram showing the equipment of a sub-station we now have in hand. The two high-tension feeders from the generating station, M_1, M_2, terminate in two return-current cut-outs, B_1 and B_2. Beyond the cut-outs they are connected together by the fuse F. Fuses F_1 and F_2, &c., are inserted in series with the primaries of each transformer. Return-current cut-outs, r^1, r^2, r^3, &c., are inserted in series with the secondaries of each transformer. The primary connections of the sub-station are divided into two distinct halves; the inner 'bus bar of each half is equipped with an earthing fuse, E F. Any man found working on the primary connections of either side without the earth fuse inserted will be instantly dismissed. Either half sub-station can, of course, be made dead by opening the return-current cut-out of the feeder to which it is directly connected, fuse F, and the secondary return-current cut-outs of that side.

There are no high-tension connections exposed in this sub-station. The primary cut-outs are of the type illustrated in fig. 5. The fuses are also of an enclosed type, and are screwed to two cast-iron frames

—one frame for each half of the station. A section of these frames is shown at G, fig. 9. The 'bus bar, B, to which the transformer fuses are connected, is supported on insulators inside this frame. These frames are hung on hinges, H, so that they can be lifted to enable the connections to the fuses to be periodically examined. High tension

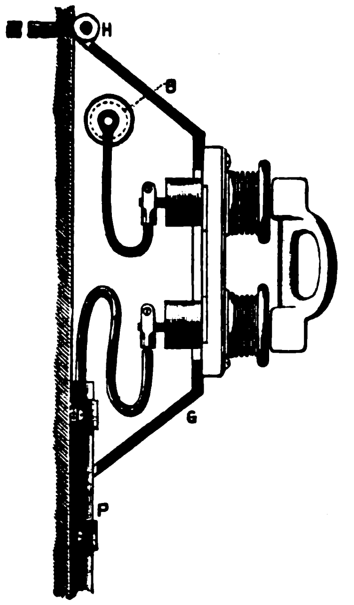


FIG. 9.

cables are run down to the transformers in porcelain tubes, P, clipped to the walls. The high tension apparatus for one half of the station is on the north wall, and that for the other is on the east wall. The low tension return current cut-outs, which also serve as secondary switches, are on the south wall, and the distributing 'bus bars and instruments are on the west wall. This sub-station is a building 12 feet long by 8 feet wide by 7 feet 6 inches high. It is built above ground in a back garden in the centre of the district it supplies. We pay £10 per annum for the rent of the ground it stands upon.

Several of our existing sub-stations are placed under the pavement. These have been such a source of trouble to us that we are now abandoning them entirely.

Arrangements are made to cut off all the transformers except one small one during the hours of light load, not only for the purpose of saving the current wasted in exciting them, but also to allow them to cool down between each heavy shift. We expect by so doing to greatly increase the life of our transformers.

Whether it is advisable to equip the low tension distributors with cut-outs or not, is a question upon which we should be glad to hear the opinion of other engineers. We are inclined to think that, if a 200-volt short-circuit occurred on a cable not exceeding 1 square inch sectional area, it would in most cases burn itself out before it damaged other parts of the cable. If we could be sure of this, we should endeavour to loop all of our distributors and insert in series with each main a magnetic cut-out adjusted to operate when the current exceeded five times the normal. If the main burnt asunder before the cut-outs operated, the supply would not then be interrupted to any consumers.

Presumably everyone will admit that excess-current cut-outs are necessary on electric light services where they enter consumers' premises, but we think the majority of central station engineers will agree with Mr. Sayers when he says that they should not operate until the normal current has been exceeded by at least 300 per cent. Is it not possible that the number of branch cut-outs at present used to comply with the fire insurance regulations might be reduced? It appears to us to be rather a question whether or no so many of these cut-outs do tend to reduce the risk of fires. Consumers who are repeatedly troubled by these branch fuses melting are apt to discover that a fuse replaced by a stout piece of copper wire gives them far less trouble. Now, if the connection to one of these short-circuited fuses should work loose, it gets hot, the heat is transmitted to the cable, and a smell of burning is the result. Of course, if no branch fuses were used, it would be advisable entirely to enclose the house wiring in some form of fireproof conduit instead of in wood casing; but we are inclined to think this would be a preferable arrangement both for the prevention of interruptions to the supply, and for the reduction of fire risks.

FAILURE OF COPPER PIPES.

It is one of the commonest experiences of engineers that materials and processes which for years give satisfaction, suddenly begin to be associated with disaster. One such instance is the brazed copper steam pipe so common in marine practice. For years satisfactory, the brazed pipe has begun to cause disaster.

Undoubtedly the use of copper pipe has come about because good copper is a tough material. It can be worked to fit the requirements of a steamer, and it can be made thin, and will follow the springing of a vessel without risk of fracture. But copper pipe has one unsound part—its brazed joint. These brazed joints have, since steam pressures became so high, commenced to give way, and the disaster on the Elbe, among many others, served to call more particular attention to the subject. At Deptford, at the electrical station, Mr. S. Z. de Ferranti adopted a novel method of pipe construction. He clustered a set of small pipes, aiming to reduce the bursting stress, and to reduce, perhaps, also the outburst of steam in case of any rupture. To give the cross-sectional area of steam, say, equal to that of a 12-inch pipe, will, however, require 16 pipes of 3 inches diameter. Each of these 3-inch pipes must be one-fourth as thick as the 12-inch pipe they replace. The mean circumference of 16 3-inch pipes is fully four times that of the 12-inch pipe, and as the fourth of the thickness of a 12-inch pipe will scarcely be sufficient for brazing purposes, it is probable that there will be a good deal more copper in a Ferranti pipe than in a single pipe of equal capacity, and the thought suggests itself why not use more material in a large pipe, and so increase its factor of safety, just as makers of shell boilers have made good work, where makers of water-tube boilers have sheltered themselves behind small diameters. But if we are to accept recent findings, the fault of copper pipes is in the brazing of them, and no amount of thickness and original excellence can be proof against a brazing which changes its nature, and becomes as brittle as a flower-pot. Various remedies are proposed, such as frequent hoops to confine a rupture within short limits, wire wrapping to take the bursting stress, and that ever dangerous hydraulic test to be applied occasionally, under the false assumption that a hydraulic test to-day will make a pipe safe for a year or two, whereas, in fact, a common result of such test is to put the pipe into a condition to burst when the next pressure of steam comes upon it. The chief engineer of Lloyd's Register of Shipping has reported upon the steam-pipe of the ss. *Pradano*, which exploded in June, 1897, and portions of which have been tested and examined by Prof. Arnold, of Sheffield.

The chief engineer and Mr. Walliker, of Cardiff, came to the conclusion that the failure was due to brazing, *originally sound*, but deteriorated by some cause. The pipe which burst had been made straight, and bent cold, proving the original excellence of the brazing. The Court which sat under the Boiler Explosions Acts of 1882, 1890, came to the conclusion that the brazing had been originally unsound, and they further considered it ought to have been hydraulically tested. They also recommend lap-welded iron or seamless steel as superior to either brazed or seamless copper. The hydraulic test is recommended to be made on pipes above 3½ inches diameter every four years—a rather useless expedient.

There was very little brazing material to be obtained from the burst pipe, but Mr. Walliker found another ship, the pipes of which showed a similar appearance, and had a considerable amount of the solder at the joints. This was submitted to Prof. Arnold, who made microscopic and other inspection, and showed that the brazing had lost a good deal of its constituent zinc, which had been dissolved out by fatty acids of oil or tallow introduced for lubrication either intentionally or as an adulterant. The zinc having disappeared left the copper as a more or less cellular mass with the pores containing the above acids. The percentage of copper was raised considerably, proving the disappearance of the zinc, and there seems no room to doubt this latter had been removed.

If this be so, it points to the absolute necessity of entirely discarding brazed pipe or of ignoring the bursting resistance, and trusting entirely to the wire serving on the outside to withstand all bursting stress. Now that copper pipes are made electrolytically without seam, there ought to be no difficulty in avoiding this very serious difficulty of brazing.

It is not that brazing is weak when made. A brazed pipe when new will test well, and give a sense of security in brazing; but now that brazing is proved so likely to fail under the influence of fatty acids generated by high temperatures it ought to be abolished. We have heard it said that electrolytically deposited copper is not particularly strong. We have no figures before us as we write, but should be glad to publish any reliable figures sent to us. In our opinion, the crux of the matter is not so much in the original tenacity of the material of a pipe as in the continuance of such original tenacity as it may possess. The tenacity being known may be suitably arranged for in the proper thickness of pipe, and if no deterioration takes place, the pipe will be as strong in 20 years as it is when new. The writer has used a good deal of electrically deposited pipe, but not under pressure, and has found it good, sound, and tough material. There appears ample reason to expect that it will remain good. Turnings cut from it were tough, like wire, and had no appearance whatever of any discontinuity of substance as might be feared from the mode of manufacture in their lamina.

Prof. Arnold's analysis of a sample of deteriorated brazing showed as follows:—

Metallic copper	76·8
Zinc oxide	22·5
Fatty acid in terms of oleic acid ...	1·4
	100·7

Yet new brazing solder by the makers of the pipe is supposed to be mixed of half zinc and half copper. A melted up sample showed only 54 per cent. of copper.

Heated to 400 C., pounded in a mortar, and fused with borax so as follow through all the operations of pipe brazing and solder preparation, there was still only 62 per cent. of copper. Yet the deteriorated brazing showed 76 8 of copper, and such zinc as there was was in the form of oxide, whence we find the true percentage of copper must have been much greater—something like 81 per cent.—proving the disappearance of zinc since brazing. The failure of copper pipes is probably hastened by improper design and fixing, insufficient attention being given to expansion. A brazed pipe does not in any case appeal to an engineer's sense of the fitness of things in these days of high pressures, good materials, and facilities for securing solid-drawn or otherwise seamless tubes.

NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

Electric Elevators, with Special Reference to their Starting and Stopping. Abstract of paper read by W. C. C. Hawtayne, May 16th.

The first electrically-driven elevator to be put to any practical use was, of course, the belt-driven machine. This consists of a winding drum on which the lifting cable coils or uncoils, and which is rotated in either direction by straight and crossed belts. These belts run on loose pulleys when the car is at rest, and are shifted over to an intermediate tight pulley, when motion is required, by means of shifting or shipping gear operated by a rope passing through the car and controlled by the car attendant. A number of these machines can be seen in our workshops and factories, the countershaft from which they are driven in some cases taking power from the works countershaft, and in some cases from a countershaft driven direct by electric motors or other available power.

When you consider that it is only about 15 years since the electric motor was really brought out, and that within a few months it was actually being used for this class of work, you will acknowledge that practical engineers saw at once how eminently suitable the electric motor was for this class of work and that they lost no time in getting it to work.

A number of these machines are still being erected, and though, of course, they differ materially in design from those first constructed, and are greatly superior both as regards safety and efficiency to the pioneer machine, yet the principle underlying them is practically the same.

It was, of course, apparent that one of the first things to do was to produce a suitable starting and stopping arrangement for the motor, for all the first machines had motors that ran continuously.

It was necessary to insert a resistance in the armature circuit of the motor to guard against a sudden rush of current at starting, and in order to control the cutting in and out of this resistance and to operate the main switch, an independent hand rope was provided, operated from the car or from the various landings.

In some cases the armature resistance was cut out by the direct pull of the rope, in others by gravity, the hand rope releasing by means of a cam, an arm which in falling cut out the different sections, the too rapid travel of the arm being impeded by a dash pot.

By the time we had got thus far, it was of course seen that there was a great future for the electric elevator as a passenger conveyer, but before it could be put to this use a decided advance had to be made—what would do for factory use would not do for passenger service.

To begin with, the loss of a few seconds in starting and stopping would be fatal to the usefulness of an elevator in a business office, the jerky motion of starting and stopping by means of a shifting belt would not be tolerated, and the safety devices were crude in the extreme.

An elevator motor must be able to work instantly with a fully loaded car, otherwise no one will be bothered with it. In the early days of motors there were objections made to starting them under load; when they were so started it was considered necessary to transmit their power by means of a belt in order to give elasticity to the system, and one thing that had to be done by the elevator engineer was to obtain a motor with a sufficiently good starting torque, and gear the armature direct to the winding drum, providing fixed brushes, and causing it to rotate in either direction without sparking. With such a machine a single-hand rope was all that was necessary to do the work originally performed by two independent ropes, and this, of course, was an advantage not to be lost sight of, as it at once relieved the car attendant of a lot of responsibility and considerably reduced the risk of a mishap.

I will now pass on to describe the modern passenger elevator as it has come under my own observation, and I think it may prove interesting if I describe at length the Otis machine, this being the one I am naturally best acquainted with.

Here Mr. Hawtayne described the Otis elevator, full particulars of which can be seen by referring to the Electrical Review for February 24th, 1896.

The latest system of electric control used by the Otis Company is one in which a small pilot motor is also used, but I regret I am not yet at liberty to describe it fully. It consists of push buttons in connection with a small pilot motor, actuating a series of contacts. There are two forms of this arrangement, in one of which two buttons are used, one for the *up* motion, the other for the *down* motion and the car stops automatically at any required floor. In the second arrangement only a single push is used. No relays are required with either form.

In addition to the push buttons there are also stops in the car corresponding to the various floors. In the one button arrangement, the stop corresponding to the floor required is pressed, and then the main push is pressed, when the car commences to move towards the floor desired, no matter whether it be above or below the car at that moment. A single push button is also placed on each landing, which, when pressed, will call the car to that floor, automatically stopping it when it reaches the landing. Whenever the car is in use the pushes on the various landings are thrown out of action, so that it is impossible to interfere with anyone who may at the time be using the elevator.

Automatic door contacts and locks are also used with this arrangement, which is one that is especially suitable to private houses, accidents being practically impossible and the general arrangement being so simple that a child can use it with impunity.

I have only had an opportunity of seeing one of the machines made by Messrs. Waygood & Co., but I believe they now make some of similar type to the Otis. In the one in question the motor and gear are at the top of the shaft. A two-rope grip sheave is used instead of a winding drum. The car is counter-balanced, and the car ropes pass over the grip sheave direct to the counter-balance weights—an arrangement I do not care so much about as the drum wind. The grip sheave is geared through a worm shaft coupled direct to the armature of the motor, and the coupling between worm shaft and armature shaft is also used as the brake pulley.

The motor is of the ordinary two-pole kind.

The starting and stopping is affected by a hand rope working over a sheave keyed to a shaft connected with the switch box. Midway on this shaft is a cam, which raises by means of a bar the brake band on the coupling referred to above.

In the switch box is a main switch and a reversing drum operated by the shipper shaft. At the end of this shaft is a small cam holding up a rack and pinion device. When the hand rope is pulled, depressing the cam, the rack falls by gravity, and as the pinion is turned a pair of brushes work round a "resistance commutator" cutting out the coils. I am not aware that there is any means of re-inserting the resistance in case of an accident to the lift attendant, or should the hand rope break. Switches are provided at the top and bottom of the lift shaft to cut off current if the lift should overrun, but unless the brake is also applied the momentum of the car or balance weights might well cause an accident, and if the car should stick, and the hand rope should break, the motor might receive far more current than would be good for it.

Perhaps in the discussion a fuller description of the machine may be given, but from what I remember of some correspondence that appeared in the Electrical Review* a year or so ago, the above description is practically correct, and I think the arrangement might be considerably improved upon.

The United Ordnance and Engineering Company, better known as Messrs. Easton, Anderson and Goolden, have recently taken a large number of orders for electric elevators. The principal feature in their machine is the winding mechanism, by which the disadvantages of a many grooved drum are done away with.

The gear may, as in the case of all drum machines, be placed either at the top or bottom of the lift shaft or even remote from it. It consists of a motor of either multipolar or two-pole type driving a sheave, usually provided with eight grooves, through the medium of a worm gear. A slightly smaller sheave, having four grooves, is placed either above, below, or to the side of the winding sheave according to circumstances and has its axle slightly skewed with respect to that of the main sheave.

Usually four wire ropes are employed, and they are led from the cage, either direct or over guide pulleys, first round four grooves of the winding sheave, then round the four grooves of the smaller or cross-over sheave and finally round the remaining four grooves of the winding sheave and away (over guide pulleys if required) to the balance weight.

The advantages claimed for this arrangement are:—

(1) Saving in the space occupied by the gearing, the length of travel of the car not affecting the size of the winding sheaves.

(2) Any number of ropes may be used to suspend the cage and the balance weight, without greatly affecting the size of the apparatus.

(3) The ropes always lead off in the same position and do not require space for lateral travel as when a drum is used.

(4) The car and counter-balance weights being all in one, less rope is required than with the ordinary drum.

A magnetic brake is used connected as usual in parallel with the shunt circuit of the motor.

The control of the armature resistance in the machine used to be, and I believe still is, effected by a centrifugal governor, driven off the armature shaft and cutting resistance in and out as the speed of the armature decreases or increases.

I have tried this arrangement on small service elevators, but always found it troublesome.

An emergency switch is generally fitted arranged to break the main circuit, and so cause the car to stop if by any chance its motion should not be arrested at the end of its travel by the usual stop on the hand rope.

As the company have the contract for the elevators at the New Brighton Tower, which is in the immediate neighbourhood, I hope we may hear something more of their machine in the discussion. I should like, for instance, to know what would happen to the winding ropes and counter-balance weights if the hand rope were to break and the car be brought to a standstill through any hitch occurring.

So much has been written of late about the screw and nut machine of Mr. F. J. Sprague that, although it is a distinct type in itself, I will leave it out of consideration in this paper.

The New Central London Railway some time ago entered into a contract with the Sprague Electric Company for two experimental elevators to be placed in the shaft of their Notting Hill Station, and these have done so well that I believe the firm have now obtained the contract for all the other elevators on the line.

These cars are to carry from 12,000 to 17,000 lbs. at full load at a speed of from 150 feet to 180 feet per minute.

* See our "Correspondence" columns for February 28th, March 6th, 13th, 20th, 27th, and April 3rd, 1896.—Eds. Elec. Rev.

The general arrangement is on the lines of the Sprague ordinary drum-type machine, and is somewhat similar to that of the Otis Company already described. The motor is iron-clad and shunt wound, having its armature coupled direct to a double worm shaft; the two driven gear wheels do not intermesh, but are bolted to two other gears which do intermesh and turn the winding drum.

The starting and stopping is effected by a pilot motor worked from a circular switch in the car; the brake is magnetic, and the car attendant can vary the speed of the car by the operation of the switch. The handle of the switch works against a spring action, so that if the attendant lets go or is pushed away from his post, the handle flies back, and the circuit being thus broken, the car comes to rest at once.

The duty of the pilot motor is to complete the armature circuit, and, by means of a revolving arm passing over faced contact pieces, to cut out the armature resistance.

The car attendant, by moving his switch to contact No. 1, lifts the brake and gives the machine full field; on the second contact he starts the pilot motor, which cuts out the armature resistance till he considers the car has attained the right speed; he then comes back to contact 1, or else moves on to other contacts connected with a resistance in the field circuit of the driving motor. When the handle of the car switch is returned to the normal point the revolving arm in connection with the armature resistance is returned to its normal position.

The machine is provided with a slack cable device, and a switch in connection with this device opens the brake magnet circuit and applies the brake directly anything goes wrong with the ropes.

I had hoped to give a description of the Central London Railway machines, together with some figures showing their efficiency at various loads, but I understand this is to appear shortly from the pen of Mr. Sprague himself. It will, however, give you food for thought when I say that at full load the actual efficiency of the Notting Hill machines from motor terminals to lifting ropes is as high as 70 per cent., and at one-third load 50 per cent.

I append results of tests made on two typical Otis machines, one of which was erected nearly four years ago in an office at Glasgow, the other about 18 months ago in a private house in London:—

Sun Insurance Company, Glasgow.

Rise of Car, 74 feet 9 inches. Speed, 170 feet. Volts, 220.
Car designed to carry 1,000 lbs.

Load.	Weight.	Time in seconds.	Amps.	Cost at 1d. per B.T.U.	Total.	Cost at 5d. per B.T.U.
1 Man	149 lbs.	up 24 secs.	1 5	·0022		
		down 26 „	26·	·0416	04682	·2341
2 Men	289 lbs.	up 25 „	4·	·C061		
		down 28 „	19·	·0324	·0385	·1925
3 „	457 lbs.	up 26 „	7·	0118		
		down 28 „	15·	·0258	·0376	·1880
4 „	597 lbs.	up 26 „	10·	0157		
		down 28 „	10·	·0169	·0326	·1630
5 „	757 lbs.	up 26 „	15·	·0231		
		down 27 „	7·	·0115	0346	·1730
6 „	911 lbs.	up 26 „	19·	·0302		
		down 27 „	5·	·0082	·0384	·1920
7 „	1,051 lbs.	up 26 „	25·	0412		
		down 27 „	2·	·0031	0444	·2220
8 „	1,225 lbs	up 29 „	29·	·05		
		down 26 „	1·	·0015	0515	·2575

Tests of Otis Electric Lift at 12, Hill Street, W., November 27th, 1896.

No. of Test.	1	2	3	4	5	12	7	8	9	14	15	18
Direction	Up	Down	Up	Down	Up	Down	Up	Down	Up	Down	Up	Down
Load ... ... lbs.	648	648	506	506	336	336	171	171	0	0	336	336
Travel ... ... feet	36·5	36·5	36·5	36·5	36·5	36·5	36·5	36·5	36·5	36·5	24·75	24·75
Time per trip ... ... seconds	23·0	22·0	25·0	21·0	22·0	23·0	22·0	22·4	22·0	24·0	16·4	16·0
Maximum current ... ... amps.	13·0	11·0	12·0	12·0	11·0	12·0	10·0	11·0	12·0	12·0	12·0	12·0
Average „ ... ... „	11·5	3·0	8·5	4·0	6·5	6·5	4·25	7·5	2·5	9·5	6·5	5·5
Duration of current ... seconds	28·6	23·2	27·2	23·2	25·2	24·0	24·0	24·2	23·4	25·8	17·6	16·4
Energy per trip ... ... watt-hours	19·8	5·6	15·6	7·08	11·2	9·27	7·8	12·68	5·37	16·35	8·3	6·83
Cost per single trip at 4d. per unit ...	0·079	0·0225	0·0624	0·0283	0·0448	0·037	0·0312	0·0509	0·0214	0·0655	0·0334	0·0273
„ „ double trip	0·1015		0·0907		0·08.8		0·0521		0·0869		0·0·05	
Average current from meter reading amps.	12·2	4·25	10·2	5·4	7·9	6·9	5·75	9·20	4·0	11·2	8·3	7·4
Average speed ... feet per minute	78·0	99·5	87·5	104·0	99·5	95·0	99·5	98·0	99·5	91·0	90·0	92·7

In conclusion, gentlemen, I would draw your attention to the tremendous strides that are being made in the elevator business. I have seen it boldly stated, and I have no doubt it is true, that in the States more people are carried vertically in elevators than horizontally by street cars. When the electric elevator was introduced here makers of hydraulic lifts went about trying to prove how expensive they were to buy and to maintain, but most of them have since been converted, and now that they have mastered the principles of the machinery, and have seen the immense advantages to be obtained by the use of electric power, they have started into the field themselves. Some of the machines produced are very good, some are marvels of how not to do it. I was called to one a few weeks ago in London—it was a case where the lowest tender was accepted, —which absolutely had not a good point about it, and on which I refused to travel. A specification had been prepared by the manufacturers duly setting forth that the machine was equal to any of the more expensive machines, and would be provided with switches and all the latest improvements, including resistance in the armature circuit to be cut out as the machine acquired speed. The consulting engineer was satisfied and the contract made. The resistance in the armature circuit turned out to be a hand arrangement, and the motor now has to run continuously, being thrown on by a wonderful friction gear; it is only brought into use on the "up" motion, and the car drops by gravity on the "down" motion, acquiring speed at such a pace that the shock of stopping nearly throws the passengers off their legs, and brings in the safety device nearly every time. You can hear the noise of the gear wheels (not worm gearing) out in the street, and the whole construction of the machine is bad. A great deal of experience and thought is required to design a first-class elevator, and I hope many of you will take the subject up. At present, there is no alternate current motor that I know of that can be used in this connection. This is an enormous drawback, for many of our largest towns are supplied, as you know, on the alternating system, and I have personal knowledge that many orders could be obtained for electric elevators in these places if the machinery was forthcoming. Perhaps during the discussion someone may be able to show us how to do it.

I had hoped to give you more data with regard to loads and efficiencies, but manufacturers are still averse to letting others know too much, and so I have only been able to give you generalities. Data that I have been promised has not yet come to hand; when it does I may find a means of communicating it to you, if the subject is of sufficient interest.

THE TELEPHONE SERVICE.—CONFERENCE AT SPRING GARDENS.

At the County Hall, Spring Gardens, on Monday, Mr. McKinnon Wood (chairman of the London County Council) presided over a Conference between the London County Council and Municipal Corporations, representatives being present from Belfast, Brighton, Salford, Bedford, Liverpool, Huddersfield, Leeds, Halifax, the City of London, Blackburn, Gateshead, Leicester, Newcastle-on-Tyne, Norwich, Oldham, Plymouth, Portsmouth, Sheffield, Cardiff, Tunbridge Wells, and Bradford.

The Chairman, in opening the Conference, said that the matter of the Telephone Company was one upon which great disadvantages would arise from isolated action. They had had to call that Conference upon short notice, because the Select Committee which had been appointed had begun to take evidence. The evidence given was of a very interesting character, showing that the position of the National Telephone Company throughout the country was an exceedingly strong one, and one which behoved them, as representatives of the towns of the country, to consider with a good deal of care. A practical monopoly had been conferred upon the Telephone Company, he thought he might say, without the safeguards which were usually attached to such a monopoly. They had to consider how far the telephone service was likely to prove of general benefit, and how far there was a possibility of its further extension, if it could be perfected and reduced in cost. He thought it was obvious that municipal authorities would not go in for a telephone system if a license was only granted to them to 1911. The L.C.C. had passed no resolution for submission to the meeting.

Mr. J. W. Benn (L.C.C.) moved: "That in the opinion of this Conference the telephone service is calculated to become of great general benefit, and is so much in the nature of a monopoly, that it ought not to be left permanently in the hands of private undertakers." He said that it would be a great advantage to the State if it decided to take the telephone system over, to have a municipal system working beside a private company.

The Town Clerk of Salford seconded the resolution, which was carried.

Mr. Thornton (L.C.C.) compared the cost of the telephone system in Stockholm and Douglas with that of London, and said it was reserved to the greatest city in the world to be charged eight times as much for their service as the people of Stockholm. He moved: "That the evidence afforded by foreign towns and cities shows that similar places in this country—especially London—do not utilise the telephone for business and private purposes to nearly the same extent as abroad, and that such non-user arises mainly from excessive charges and inefficient service."

The Town Clerk of Liverpool, in seconding the motion, said that the inefficiency of the service was in a great measure due to the short-sighted policy of the Government, who might have acquired the whole system for £100,000 years ago, whereas now it would cost millions. He suggested the addition of the following words: "And the failure of the Post Office Department to provide an adequate number of trunk lines to connect the local exchanges."

The addition was accepted, and the resolution, as amended, agreed to.

The Lord Mayor of Belfast next moved: "That in the event of the Post Office being unable to take over the whole telephone service of the country, it is practicable and advisable that municipal authorities should be empowered to provide such service in their respective localities, on the understanding that every facility will be afforded for close co-operation between the local authorities and the Post Office."

The Town Clerk of Leeds seconded.

The Town Clerk of Huddersfield moved the following amendment: "That in the opinion of the Conference, it is expedient that municipal and other local authorities should undertake the telephone service within the area composed of their own districts or a combination of such districts."

Mr. Boyle (Bedford) seconded the amendment, and said that he had worked out the cost, and found that in Bedford, with 500 subscribers, they could work an exchange for £2 5s. a year, and after five years make a profit of something like £5,000.

Mr. Morton (City) observed that the Post Office officials seemed completely captured by the private company.

The Town Clerk of Liverpool said it was no good talking about having a £3 municipal service if they could not get communication with other places. It was a national question, and they wanted the great commercial houses of the country to be in a position to have a good service. It was playing with the question to say that a few isolated corporations would start a system of their own.

The amendment was lost and the resolution carried.

Mr. Dickinson (L.C.C.) moved: "That as the National Telephone Company obtained its powers and raised its money upon the basis of being subject to actual effective competition, it is just and expedient that steps should be taken to protect the public against the practical monopoly that the company has obtained for itself, and against the inordinate charges that are only leviable by the company by reason of such monopoly."

Mr. Green (Norwich) seconded the motion, and it was carried.

Mr. Baker (L.C.C.) proposed: "That, as one of the causes of the excessive charges is the fact that the company's capital, upon which dividend is paid, has been swelled by the expenditure of large sums of money not represented by any works, it is inequitable that the public should be forced into the position of either having to submit to such charges permanently, or having to buy out the company on the basis of such charges."

This was carried without discussion.

Mr. Benn (L.C.C.) moved: "That seeing that the license of the National Telephone Company will expire in 1911, it is expedient (a) that Parliament should decide that no extension of the license should be granted to the company; (b) that in order that the public may be provided with a telephone service by 1911, the various municipal authorities be granted licenses to establish and work local telephone services prior to that date, and that such licenses shall only be terminable on the payment by the State of the outlay of the undertakings."

Recommendation (a) was agreed to without dissent, but considerable discussion took place on the second recommendation, which was eventually amended so as to provide that any license granted to a municipal authority should give leave to speak over the trunk lines.

On the motion of Mr. Benn, the following resolution was agreed to without discussion:—"That the power of the breaking up of the streets which is claimed on behalf of the National Telephone Company—acting through the Postmaster-General—is a grave interference with the rights of municipal authorities."

It was resolved that the views of the Conference be placed before the Select Committee.

ELECTRIC LIGHTING IN ST. PANCRAS DURING 1897-1898.

An epitome of the work of the Electricity and Public Lighting Committee of St. Pancras Vestry during the year 1897-98 has been prepared and presented to the Vestry by Mr. H. J. Menzies, chairman of the committee. The report is accompanied by a diagram showing both the expenditure and income since 1892, and that for the first time the private lighting income (for 1897) has exceeded the total expenditure by nearly £3,000. The following figures indicate the selling and cost price per unit each year from 1892:—

Year.	Average price realised.	Average cost of production.	Total cost.
	d.	d.	d.
1892	6	4·6	6·88
1893	6	3·5	5·3
1894	5·6	3·2	5
1895	5·3	3·5	5·1
1896	5·4	3·8	5·8
1897	5·2	2·9	4·2

It will be seen from this that last year, whilst by far the most prosperous of the series, realised the lowest average in price, which is, with one exception, the lowest also of any of the Metropolitan supply companies. The alteration in the method of charging, recommended to the Vestry in January, and now further modified, together with the reduction in the charge for public lighting, will probably make the St. Pancras rate the cheapest in London.

Another satisfactory feature is the great diminution in cost. It is interesting to note that in the revised original estimates, on which the Vestry commenced operations, the price per unit was fixed at 2·45 pence works' cost, and ·75 pence for interest and repayment charges. The former figure might have been realised but for the heavy repairs, and probably will be reached immediately; the latter seems altogether too low. Either more was expected of a limited area than it has been found to yield, or money was sunk in unproductive mains: in any case the capital expenditure has involved a heavier burden than ¾d. per unit. It is possible, however, that when the full benefits of the chief engineer's invention of the 220 volts system are obtained, the original figure may not be far exceeded.

Analysis of Costs in Pence per Unit.

—	Coal.	Oil, waste, &c.	Wages.	Maintenance and repairs, including carbon.	Rates.	Management, insurance, law, &c.	Total.
	d.	d.	d.	d.	d.	d.	d.
1892	1·63	·24	1·30	·34	—	1·08	4·60
1893	1·26	·17	·72	·92	—	·43	3·50
1894	·93	·15	·71	·80	·10	·46	3·21
1895	·95	·10	·67	1·18	·10	·49	3·49
1896	·99	·17	·72	1·07	·12	·73	3·80
1897	·84	·09	·63	·92	·09	·33	2·89

The report points out that the coal consumption shows much improvement, but the expenses for maintenance and repairs continue abnormally heavy. The fact is, Mr. Menzies states, that the system is being reconstructed out of revenue, but it is to be hoped the most of the early faults are now removed.

The business, which has more particularly engaged the attention of the Electricity and Public Lighting Committee, has been that of extending the Stanhope Street station. This important step was forced upon the committee by the increasing demand for current, which has so grown that at Christmas much anxiety was felt by Mr. Baynes lest the requirements should be more than the plant could supply. Consumers have come on very fast, especially during the past three years; and as the committee have to anticipate their wants by at least 18 months, their action was not taken a moment too soon, for both stations are already almost fully loaded. The plans of the engineer were of a very comprehensive character, both doubling the capacity of Stanhope Street station and adding greatly to its efficiency; and although some opinion was expressed that a third station should be built elsewhere, the advantages of enlarging the existing one on a site quite ready for use weighed down every other consideration. The new work will probably cost £45,000, but no one who has studied the business can doubt that it will prove a most remunerative outlay. The bulk of the contracts are now placed, and it is much to be hoped such progress may be made that some of the new machinery will be in position for next winter's work.

In addition to the increase of generative power, the decision to carry the mains to Highgate almost completes the arterial system of distribution, all the boundaries of the parish having thus been reached. The extension to Queen's Crescent, Malden Road, and Prince of Wales Road takes up all the remaining important thoroughfares as yet unsupplied with current.

The work of public lighting goes on slowly, but, owing to the precautions imposed last year on the engineer, its early stages are of a difficult and complicated nature. The Gray's Inn Road extension has come into operation, and the Kentish Town Road section is nearing completion. When the Highgate and Malden Road arcs are installed there will be 222 lamps in operation, and it will be the duty to consider by what further action the Vestry can entirely supply itself with the means of street illumination.

Naturally with an increasing revenue and the prospect of a favourable balance, claims have been made for reduction in price. After much consideration the committee adopted the maximum demand indicator as the first step towards fairly effecting this object. There is no doubt that Dr. Hopkinson's method, favoured by the engineer, is theoretically the right one, that every lamp in use should pay a fixed sum towards the standing expenses of the station after which current could be supplied at a slight advance over the cost of coal, labour, and wear and tear of machinery required in its production. But this has many practical difficulties, and to adapt it to a business built up on different lines was a hopeless endeavour. Next in scientific value is the so-called Brighton system, the success of which is shown by its general use for municipal charges. This achieves the same result as is sought by Dr. Hopkinson, and when its application becomes general in St. Pancras on the basis now accepted, it will not only give considerable relief to consumers, but stimulate as well a large extra demand. The vestry is rapidly approaching in its tariff a point when electricity becomes as cheap as gas, and there seems no reason, why in the near future customers whose use of it can average four hours a day during the winter half of the year will be actually paying less.

By direction of the Vestry the committee have had to consider the question of lighting Somers Town, but pressure of business has prevented the engineer preparing his report in sufficient time for decision. This, however, must come up for judgment shortly, either as a special case or as part of a large and general scheme for covering the parish with electrical illumination.

A matter that must not escape notice is the decision of the Home Secretary that the generating stations fall under the operation of the new Workmen's Compensation for Injuries Act coming into operation on July 1st of this year. It will be necessary to make some provision to meet the obligations of this Act, and early action is desirable.

The closing month of the committee's term of office has seen the partial realisation of a hope which originally connected the King's Road station with the dust destructor, that the latter could supply the engines with steam. It cannot be said as yet what is the practical value of this supply, and the investigation Mr. Baynes has been authorised to make must determine to what extent it can be turned to use.

ELECTRICAL ENGINEERS (R.E.) VOLUNTEERS.

It will be seen from the annexed rules that the War Office have made an important change in the regulations for efficiency of the Electrical Engineers Volunteers. By the regulations originally proposed, recruits were required, in addition to military drills and eight days' training in camp, to attend 78 technical drills. By the modified regulations the 78 technical drills are reduced to 12. Whilst this will make the work of recruits living in London much easier, it will also make it quite practicable for men residing at a distance from London to join the corps, they will obtain their purely military training with any volunteer corps in their own neighbourhood, and will complete their technical training by attending in camp two additional days, making, with the eight days' training required from all, a total of 10 days. No doubt these altered conditions will conduce very materially to the greater success of the corps. The rules are now as follows:—

The headquarters of the corps are at 13, Victoria Street, Westminster.

The uniform will be the same as that worn by other Royal Engineer Volunteers, with such modifications as the War Office approve. Uniform will be supplied free to members.

The corps will be armed with the Lee-Metford rifle.

The training is divided into two kinds—military and technical.

The military work consists of infantry drills, musketry, &c.

The technical work includes every application of electricity to war, with the exception of telegraphy, and such other work as will be useful to an electrician or engine-driver in carrying out his duties, such as signalling; fitting, loading, priming, and connecting up submarine mines; a certain amount of boat work, and knotting, splicing, &c.

This work will be carried out partly in London, but mainly at defended ports.

In order to become efficient, each member must attend a continuous training at a defended port for at least eight days each year. In addition, 12 hours' technical work must be done each year. For this purpose, each working day—after the first eight—of the continuous training counts as six hours; each half-day four hours. Or, these drills may be done in periods of 1, 1½, 2, 2½, 3, and 3½ hours.

The capitation allowance is £4.

For each of the eight days of the continuous training, an allowance of 5s. per member in camp is paid to the corps. The allowance will be primarily devoted to the maintenance in camp.

Drills—both military and technical—are being carried out in London and Woolwich at present.

Members from other districts will only be permitted to join on undertaking to make private arrangements to learn their infantry drill.

Intending members are requested to study the conditions of efficiency.

Below will be found an extract from the rules of the corps:—

5. Every enrolled member who is non-efficient in any year shall pay to the funds of the corps, on or before November 10th in that year, a sum equal to the Government capitation allowance which he failed to earn. . . . . The commanding officer shall have power to remit payment, wholly or in part, in special cases.

8. No person shall be admitted as member or honorary member unless proposed by one or more members of the corps, and approved by the commanding officer.

24. Any member wishing to leave the corps may do so on November 2nd, providing he shall have given notice of his intention not later than the 30th of the preceding September. Failure to comply with this rule shall render him liable for half the amount of the succeeding year's capitation grant.

Note.—Age limit 17 to 47 years.

Intending members should write to the adjutant, Captain Brady, R.E., 13, Victoria Street, S.W., who will supply all information. They should give their full name, address, occupation, and electrical qualifications. If they wish to join as engine drivers, they should state their qualifications for that work.

Every application must be accompanied by a reference to a member of the corps or to some other person well known to the commanding officer.

Before enrolment, each candidate must be passed as fit by a medical officer.

Every member shall be enrolled for three years at least. A member leaving before completing three trainings shall be liable to a penalty of £2 10s.

Note.—The headquarters are open on week days from 10 to 4, Saturdays from 10 to 12. On Mondays and Thursdays at 8 p.m. in addition.

J. Hopkinson, F.R.S., Major,
Commanding the Electrical Engineers, R.E. (Volunteers).

REVIEWS.

A Treatise on Magnetism and Electricity. By Andrew Gray, LL.D., F.R.S. London: Macmillan & Co., Limited.

Messrs. Macmillan have sent to us the first volume of this work by Prof. A. Gray. It is pleasant to recognise the learning and scholarship of the author in such a handsome material form. The matter of the book, so far as this volume goes, is arranged in the logical order suggested by modern conceptions of magnetism, and though possessing no originality in matter or treatment, is the most philosophical connected statement of these conceptions we have seen. The production of this work is creditable to the author, and to the distinguished school of physicists that trained him. The book is beautifully printed and got up, and will no doubt find a place on the shelves of all mathematical physicists. We could wish the author had the courage of his convictions in the matter of the Heavisidal units. The magnetic pole is now to everyone the source of magnetic flux, only secondarily the centre of magnetic force, and we do not believe the adoption of the corresponding definition would cause any confusion through our use in practice of the ampere and the ohm. Probably 19 out of 20 electricians are more or less agreed about this, and not 1 in 20 will act on the consensus. Prof. Gray's preface shows that he is, as every teacher must be, alive to the philosophical value of a change. The defect of the book, if it is a defect, is its very close following of Lord Kelvin in subject and mode of demonstration, but it seems that the time cannot be distant when a satisfactory hypothesis for the conditions of the ether will be devised, and all electrical phenomena will be deducible from the laws of these conditions. Then the books can be re-written on an exact basis, and the work of the great physicists built into a perfect structure. May we be there to see!

The Standard Electrical Dictionary. By T. O'Conor Sloane, A.M., E.M., Ph.D. London: Crosby Lockwood and Son.

This dictionary of electrical terms is not only a useful work for present reference, but promises to be of great interest in the future. Electricity is the mother of a great family of new ideas, new terms, and new inventions. Many of these are already obsolete, and others continually become so, and a book which condenses into a small space short statements and illustrations of all the terms in use at any given date is of great value: and this small volume contains all sorts of electrical terms, some scientific, some slang, that one ever meets. It is not very serious lexicography, nor are the definitions too precise, and except in a few cases of conspicuous difficulty, *e.g.*, induction, and resistance, the treatment is very terse; but for the object of the book this is undoubtedly a merit. To a non-expert electrician the book would be useful and interesting; for a professional man the matter is hardly exact enough to be very valuable.

Practical Telephony. By JAMES BELL, A.I.E.E., and S. WILSON. London: *Electricity*, 11, Ludgate Hill, E.C.

This is a republication in book form (with additions) of a series of articles which appeared in the pages of our contemporary *Electricity*. It describes—much after the manner of earlier works—various types of telephonic instruments. It is perhaps chiefly valuable for its description of the apparatus now used by the Post Office, and also for domestic apparatus. Exchange working generally is somewhat beyond its scope. The authors believe that "there is room for a simple telephone manual at a moderate price," and two shillings and sixpence will doubtless be considered as coming within the lines of moderation.

A Popular Guide to Commercial and Domestic Telephony. By M. BYNG, M.I.E.E., and F. G. BELL. London: The General Electric Co., and Whittaker & Co., 2, White Hart Street, Paternoster Square.

This work mainly deals with apparatus furnished by the firm whose name is given as joint publishers. Its object is "to assist the fitter to obtain some knowledge of the telephone, both theoretically and practically," and, being written from the standpoint of the non-expert, it covers much elementary ground. Some of its statements may be open to question, as for example, the origin suggested for the discovery of the microphone on page 16, but the main object of the work is descriptive of apparatus which is, on the whole, well done. It may perhaps be doubted if the non-expert, for whom the work is intended, will make much of the instructions for discovering faults on page 142. The work is well printed and furnished with good blocks and clear diagrams.

First Stage Magnetism and Electricity. By R. H. JUDE, M.A., D.Sc. University Correspondence College Press. London: W. B. Clive, 13, Booksellers' Row, Strand, W.C.

The book is intended primarily to cover the syllabus of the elementary stage of the Science and Art Department. The author admits that there are already a number of books in existence written for the same subject, but he argues that none of them present the subject of *electrical potential* clearly to the student. Whether the failure to make this particular point clear is a sufficient justification for the issue of a new book dealing with the whole general subjects of electricity and magnetism, may be doubted. We cannot, however, find fault with Mr. Jude's production nor his attempt to compete with others who may have written books equally good and of equal utility with his own. With the exception of the particular point (certainly an important one) with reference to electric potential there is but little originality in the work; it is, however, perfectly sound and can, therefore, be safely and profitably used for the purpose intended.

NEW PATENTS.—1898.

Compiled expressly for this journal by*. W. P. THOMPSON & Co., *Electrical Patent Agents*, 322, *High Holborn, London, W.C., to whom all inquiries should be addressed.

10,535. "Improved method of winding armatures of dynamo-electric generators or motors." W. R. V. MARSHALL and PATERSON, COOPER & Co. Dated May 9th.

10,557. "Improvements in and relating to electric furnaces." T. JACKSON. Dated May 9th. (*Complete.*)

10,585. "Improvements in electric resistances." W. P. THOMPSON. (The Chemisch Elektrische Fabrik "Prometheus" Gesellschaft mit beschrankter Haftung, Germany.) Dated May 9th. (*Complete.*)

10,599. "Improvements in electrical devices for igniting liquid burners." THE REFORM PETROLEUM BELEUCHTUNG, GESELLSCHAFT M. B. HAFTUNG and E. WEINHAGEN. Dated May 9th. (*Complete.*)

10,606. "An electric signal bell for cycles." S. KRAUS. Dated May 9th. (*Complete.*)

10,608. "Improvements in electrically illuminated buoys." H. H. LAKE. (P. C. F. Hoffman, Germany.) Dated May 9th.

10,611. "Improvements in electric primers for firing guns." C. A. MCEVOY. Dated May 9th.

10,615. "Improvements in automatic apparatus for receiving the charges for telephone conversations and telegrams." L. M. ERICSSON and S. RITTER. Dated May 9th. (*Complete.*)

10,616. "Improvements in enclosed arc lamps." G. T. DAVIES. Dated May 9th.

10,617. "A controlling switch for large numbers of electric circuits." H. K. SMITH and J. ECK. Dated May 9th.

10,618. "An improved indicating and recording apparatus for use in connection with electric meters." G. C. PILLINGER. Dated May 10th.

10,647. "Improvements in electric incandescent lamps." W. J. PHELPS. Dated May 10th. (*Complete.*)

10,650. "Improvements in and relating to electric arc lamps." F. A. GILBERT and E. O. LUNDIN. Dated May 10th. (*Complete.*)

10,652. "Improvements in electric condensers." C. S. BRADLEY. Dated May 10th. (*Complete.*)

10,690. "Improvements in starting devices for single-phase alternating electric current motors." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (J. P. Stone and S. E. Doone, United States.) Dated May 10th. (*Complete.*)

10,705. "Improvements in electric motors and meters adapted for use with alternating currents." H. P. DAVIS and F. CONRAD. Dated May 10th. (Date applied for under Patents, &c., Act, 1883, Sec. 103, October 22nd, 1897, being date of application in United States.)

10,805. "Improvements in primary batteries." F. H. PERRY. Dated May 11th.

10,808. "Improvements in Morse telegraph apparatus." SIEMENS BROS. & Co., LIMITED. (A. Tribelhorn, Argentine Republic.) Dated May 11th. (*Complete.*)

10,816. "An electrical two-way pear or pressel switch." J. W HINTZL. Dated May 11th.

10,818. "Improvements in electricity meters." G. HOOKHAM. Dated May 11th.

10,821. "Improvements in the manufacture of electro-plate." S. COWPER COLES. Dated May 12th.

10,848. "Improvements in dynamo-electric machines and motors." S. G. BROWN. Dated May 12th.

10,869. "Improvements in electrical clocks." A. GRIFFITHS. Dated May 12th.

10,883. "Apparatus for transmitting motion to a distance by means of electrical energy." SIEMENS BROS. & Co., LIMITED. (Siemens & Halske, Acktien-Gesellschaft, Germany.) Dated May 12th. (*Complete.*)

10,900. "Improvements in electric arc lamps." W. L. WISE. (J. H. Hubbell, United States.) Dated May 12th. (*Complete.*)

10,901. "Improved system of vacuum tube lighting and apparatus for use therein." W. L. WISE. (The Moore Electrical Company, United States.) Dated May 12th. (*Complete.*)

10,922. "An improved switch for electric motors." A. E. TANNER and F. A. C. LEIGH. Dated May 13th.

10,941. "Improvements in conduits for electric railway and tramway traction." E. C. HORGERSTAEDT. Dated May 13th.

10,942. "Improvements in electro-magnetically operated switches for strong electric currents." E. C. HORGERSTAEDT. Dated May 13th.

10,960. "Improvements in electrical storage batteries or accumulators." J. B. SCAMMELL. Dated May 13th.

10,979. "Improvements in and in the production of glass globes, chimneys, lenses, and such like, for electrical, gas, and oil illumination." H. CRUDGINGTON, W. CRUDGINGTON, and W. R. RIDINGS. Dated May 18th.

11,044. "Process and apparatus for covering metallic wires with asbestos for insulating and other purposes." E. ALBASINI. Dated May 14th. (Date applied for under Patents, &c., Act, 1883, Sec. 103, December 3rd, 1897, being date of application in Italy.) (*Complete.*)

11,051. "Improvements in apparatus for use in the electro-deposition of zinc or other metals." THE COWPER-COLES GALVANISING SYNDICATE, LIMITED, and S. O. COWPER-COLES. Dated May 14th.

11,068. "Improvements in the production of zinc and sulphate of copper by electrolysis." H. H. LAKE. (A. Lotti, Italy.) Dated May 14th.

11,075. "Improvements in apparatus for vacuum tube lighting." W. L. WISE. (The Moore Electrical Company, United States). Dated May 14th. (*Complete.*)

11,076. "Improvements in and relating to telephone installations." E. BAIVY. Dated May 14th.

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LOAD FACTOR.

THE question of what is the best definition of the term load factor has recently been brought into prominence as the result of the divergence of opinion shown to exist amongst speakers in the discussion on Mr. Hammond's paper "On the Cost of Generation and Distribution of Electrical Energy;" and, in consequence of this want of accord amongst electrical engineers, Mr. Hammond, in a letter which appeared recently in the columns of a contemporary, has explained his own views more fully than he was able to do when replying to the discussion on his paper, and has invited discussion with a view of settling once for all the definition of the term "load factor." In this letter Mr. Hammond claims that a complete agreement was come to as to the definition of this term in the discussion on Mr. Crompton's paper, which was read in 1891 at the Institution of Civil Engineers, and in which the term load factor was first employed; and although we must confess that the discussion itself did not evidence a complete agreement, yet the final definition given by the author of the paper in his reply to the discussion is the one which has been almost universally adopted; and, when any one has spoken of the load factor, it has been understood to mean the ratio of the actual units generated during the year to the product of the maximum output in kilowatts at any time during the year into the total number of hours in the year.

Although the above definition is, we believe, the generally accepted one, yet the term is often used, sometimes with and sometimes without qualification, to express other ratios than the one named above; the reason being that there are a number of factors all of the nature of load factors which influence the total cost of a unit of electricity, and that sometimes one and sometimes another of these factors is the most important in its effect according to the particular point which is being examined. Take, for instance, the load factor to which Mr. Hammond takes objection, and which is based on plant capacity, we can find three different definitions, each of which has its special utility. If the denominator of the ratio is the maximum plant capacity multiplied by the number of hours, we have a factor which has a decided effect on the financial results; since, if the plant is of greater capacity than is necessary, capital is lying idle, and interest has to be paid on plant which has no earning power. Again, if the maximum capacity of the plant in use at the time of greatest demand appears in the denominator, the factor so obtained has a great effect on the coal consumption and evaporative efficiency of the boilers, and also on the labour bill; and this factor is extremely useful in comparing the results of one week with another, or one month with another. The third factor is one in which the denominator expresses the sum of the products of maximum output of each engine and dynamo into the number of hours it has been in service, and this factor, which gives the ratio of the actual average output of each steam plant during running hours to its maximum output, is the one which affects the steam consumption per unit.

Another factor which affects the financial results may be termed the lamp-hour load factor, and is obtained by making the denominator equal to the product of the output required for the total lamps connected into the number of hours, and this is useful as a basis of comparison of the earning power of the distributing plant. Although all these factors have their utility, we do not think that any of them have a claim to be called "the load factor," as compared with the one based on maximum output, unless it be the factor based on the maximum capacity of the plant in use at the time of greatest demand. This latter factor, we consider, gives a truer basis of comparison for works' cost than any other, if the load factor for the year is calculated by taking the average of the daily or weekly load factors. For example, the load factor each day will be the ratio of the number of units generated to the capacity in kilowatts of the plant in use at the time of greatest demand multiplied by 24, or for each week the similar ratio with a multiplier of 168 instead of 24; and the load factor for the year will be the average of the 365 daily or the 52 weekly load factors.

This averaging of daily or weekly load factors, whether they are based on maximum units generated or maximum plant capacity in use at the time of greatest demand, gives a factor for the year which is much more useful than one based on the absolute maximum at any time during the year; and of the two ways of calculating the daily or weekly load factor, we consider that the one which depends on plant capacity is the more useful. This averaging is advantageous, not only for the reason given by Mr. Hammond that it takes into account the fact that the lamp connections are continually increasing in number, but because it takes into account the variations of the daily load curve at the different seasons of the year; and these variations are equally important, whether the number of lamps connected has doubled in the 12 months, or has remained stationary. For example, if we take two districts, in one of which the demand is very largely for the lighting of residential and other buildings which require to be fully lighted for a certain time every evening throughout the year, whilst in the other the demand is chiefly for the lighting of shops which close early enough not to require any artificial light during the summer months; we may get equal load factors if we calculate on the absolute maximum demand or capacity of plant in service; and yet the shop district, which would give the higher load factor calculated by averaging the daily or weekly factors, would be the cheaper district to supply as far as generating costs are concerned, because in the summer months a smaller number of boilers would have to be lighted and fewer engines run than for the residential district.

In conclusion, we would remind our readers that, whatever definition is adopted for "the load factor," it will at best be a sort of compromise, as no one factor can be found which will form an accurate basis of comparison between two supply undertakings; and, that if it be desired to compare the conditions of working of two undertakings, all the other factors that we have mentioned, and possibly others that have not been referred to, must be taken into account, whether they be called load factors or by any other name.

The Inconveniences of Acetylene.—We have frequently argued that whatever results are obtained on a small scale in laboratory working with such a thing as an illuminant should not be given to the world as absolute, or as illustrative of that which will attain in practice, and we are interested to notice that our position is fully confirmed in the case of acetylene by the numerous experiments which have been made since this gas came into prominence. In Hungary, at the town of Veszprim, Josef Vértess has been studying the use of acetylene on a large scale at the central station there, and we should like to suggest that it is desirable, for those who are endeavouring to bring this gas into general use, to consider carefully the experiences recorded by Vértess in a paper which may be found in the *Chemiker Zeitung*, Vol. 21, page 174. The paper does not betray any bias, and, indeed, does not go nearly so far as might have been expected, considering the opportunities which exist at Veszprim for an exhaustive examination of the whole subject. However, Vértess has succeeded in recognising a number of inconveniences at present attaching to the use of acetylene in practice, and these may be summed up in the following abstract of his paper:—"The carbide generally contains uncombined carbon, which is carried in the form of fine dust into the pipes, and with the water of condensation forms obstructions in them. In theory, 1,000 grammes of carbide should yield 360 litres of acetylene; the Continental works guarantee only 300, and practice shows that 280—290 is the general yield. Besides free carbon, the carbide contains metallic compounds of sulphur, phosphorous, and nitrogen, and consequently the acetylene evolved contains H_2S, phosphuretted hydrogen and ammonia, the impurities reaching 3—4 per cent. Acetylene ought to be purified in the same way as coal gas, and until that is realised it cannot make much progress as an illuminating agent. The burning of unpurified acetylene in closed rooms is dangerous to health, the most dangerous impurity being phosphuretted hydrogen. There is no doubt that some of the so-called spontaneous explosions have been caused by the ignition of this gas at the temperature existing in the generator. The worst inconvenience of acetylene is the 'smoking of the flame.' The best burners are those with 10—12 small flames, as each flame has a separate atmosphere; even with these, smoking sets in after 200—300 hours' burning. The cause is the decomposition of the acetylene by the heat of the burner; the carbon deposits in the narrow opening of the burner and the flame begins to smoke. Sometimes an oily liquid is formed in the burner, probably a hydrocarbon formed by polymerisation of the acetylene." In conclusion, Vértess says that a very great deal more work must be done before the defects specified in lighting by acetylene can be overcome, and he contents himself by the opinion that it is *absurd* to attempt to produce acetylene for general lighting purposes until the problem of properly purifying it has been overcome.

The Magnetic Properties of Nickel Steel.—Numerous researches have been made on this subject and a good deal of knowledge accumulated, but there is still much to do in checking the results and a great deal more to be done in obtaining further information. Recently E. Dumont has contributed a paper to the Paris Academy of Sciences on this subject (*vide Comptes Rendus*, Vol. 126, pages 741—744.) Dumont has determined the magnetic permeability for fields lying between 14 and 50 C.G.S. units, and for temperatures between — 78° and 250° C., of reversible nickel steels, containing from 27 to 44 per cent. of nickel. The variations of permeability with temperature in the maximum field are continuous, and the curves representing them are roughly parallel to each other, so that at equal distances (of temperature) from the point of total loss of magnetism, all the alloys have the same permeability. At a temperature of 20°, all the alloys show similar changes of permeability, with variations in the magnetising field, rising slowly as the field is strengthened from 14 to 25 units, then rapidly increasing to a maximum in a field of 35 units, and slowly diminishing as the strength of the field is further increased. Under the same circumstances of temperature and strength of field, the permeability increases with the content of nickel.

VIBRATING CABLE RELAY.

By K. GULSTAD.

What to be done in order to produce a suitable cable "relay" is a question which no doubt has troubled the minds of many telegraph people. It is certainly not less interesting at the present time, when the demand for increasing the working speed of submarine cables to their utmost capacity has necessitated the introduction of automatic transmitters on the busiest lines.

With the exception of some ingenious proposals by Mr. Ch. Cuttriss and others—*vide* the Review, July, 1892—in reference to the reversal system, I am, however, not aware that anything worth mentioning has been published about cable relays since the appearance of the Brown & Allan relay, an instrument which is probably still looked upon as the only veritable cable relay, and which deserves this name, from its being able to act under the influence of varying current strengths, independent of the direction of the current.

It is at the same time hardly necessary to point out that the Brown & Allan relay does not possess all the qualities required for working at high speed, and as an essential point, I may mention that it is unable to give reliable contacts unless its sensibility be sacrificed.

A cable relay, like the Brown and Allan instrument adapted for Morse code signalling, and more especially for automatic working, may, however, be made in quite another way, as described hereafter, which I trust will not prove uninteresting to some of the readers of the Review. The cable relay I refer to is not in principle of any particular construction. Any polarised double current relay may, generally speaking, be used and made into a cable relay, not by way of altered construction, but simply through a special arrangement.

The failure of the polarised relay, when employed as a cable relay in the usual manner, is partly due to want of sensitiveness, but principally to its being unable to respond to variation of currents in one direction only. It is understood that the want of sensitiveness *à priori* is caused by the magnetic attraction between the armature and the nearest pole-piece, a circumstance that gives to the relay its most sensitive state when the pole-pieces are removed to some distance from the armature, although the action of the current through the relay is considerably diminished thereby.

Now this attraction can be done away with, or rather converted into a repulsion independent of the relative position of the pole-pieces. Of course, a relay freed from the attraction would be very sensitive, and it would also respond better to variation of the current than before. In figs. 1, 2, 3, a cable signal through a relay is represented. Let a be the zero line, and let further the dotted lines m and n, fig. 1, signify the current requisite to overcome the said attraction. As indicated by Morse signals on the sketch, the relay would record the received signal in different ways, according to whether the attraction is neutralised or not, as in fig. 2 and fig. 1 respectively, the effect of distortion in the former case being at least somewhat less.

Fig 1 Fig 2 Fig 3

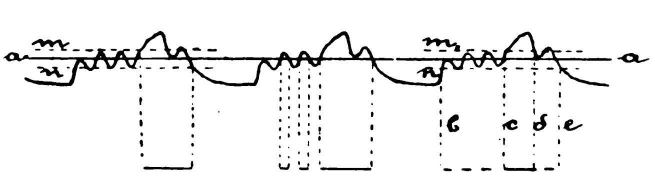


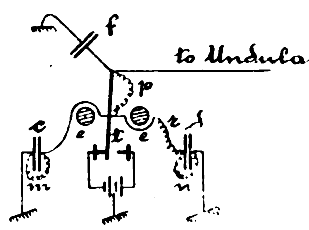
Fig. 3 shows a still better result, and refers to a case of repulsion, or to that particular point which I am going to deal with here. This repulsion of the armature is achieved by arranging the relay as an interrupter in some particular manner, which will make the armature vibrate at a certain rate between the contacts, if the interrupting current be made sufficiently strong. In fig. 3 this rate is supposed to be equal to that of dots sent into the cable; if m_1 and n_1 here represent the current required to stop the vibrations, the relay will accordingly record 3 dots between b c and 1 dot between d e—*i.e.*, the Morse signal as shown.

By thus employing a vibrating relay the effect of distortion is reduced—a most valuable achievement—and all the energy required to move the armature is supplied by the relay current itself, the work left for the cable current being to stop the motion when wanted. This work can be made very small indeed, and means in reality that the relay becomes exceedingly sensitive. One thing is, however, needed, namely, that the vibrations of the tongue can be "tuned," and this being a matter of importance, I propose to treat of it more particularly.

Experiment will show that the plain arrangement of an interrupter will not do when a polarised relay is to be altered into a double current interrupter of required qualities, as the relay might not vibrate at all, or at too high a rate, and too irregularly to be of any use—see fig. 4, where the relay is shown, t being the tongue, e the electro-magnets.

This occurs because the attraction cannot be converted into a repulsion of sufficient strength to make the armature or torque vibrate between the contacts, unless the current be made so strong, that the rate of vibrations at the same time becomes disproportionately high. If the current be reduced by increasing the resistance, p, in order to get vibrations of a lower rate, the armature may be moved, but only very little indeed, until the contact is broken and the interrupting current ceases to flow; the attraction will then again predominate, viz., the vibrations take place very close to one of the contacts, but not from the one to the other.

Fig 6



In order to overcome this difficulty, I retard the propagation of the interrupting current by applying an inductive capacity, c. Fig. 5, for instance, at point o, in connection with the resistance, r, a little time will pass before the potential at o is raised sufficiently to enable the current to overcome the attraction, but when this is accomplished and the contact broken, the armature will not fall back, but continue its motion from one contact to the other with appreciable energy, due to the fact that the condenser, c, is now partly discharged through the windings and r.

By utilising this principle it is possible to make a relay vibrate at a slow rate, but some alterations of, and additions to, the arrangement will nevertheless be found advantageous or necessary to enable the rate to be varied at pleasure.

Fig 4

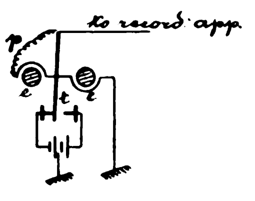
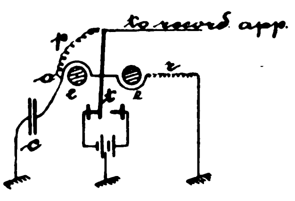


Fig 5



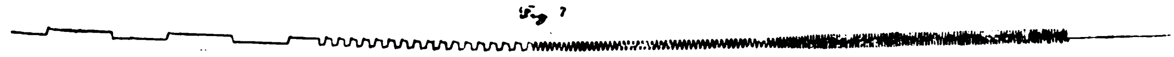
An appropriate arrangement is sketched out in fig. 6. c, d, f are condensers; n, p resistances; m a large and r a rather small resistance. The relay is differentially wound in the usual manner.

The resistance, p, is put between the tongue and some other point of the circuit than before, say, at the middle of the convolutions. By charging the conductor, c, the tongue is at first pressed against one of the contacts, whence it is removed shortly after. Good contacts are thus fully ensured.

One particular object of the condenser, d, will be evident from the following:—Suffice it here to say that the reversals for high speeds are produced by the difference in charges of c and d, that d increases the rate of vibrations, at the same time somewhat mitigating the rattle of the apparatus, and that d must be shunted by a resistance n, for otherwise the tongue will not vibrate, or, at least, not steadily. The condenser, f, is inserted to avoid or make up for other causes of trouble, viz., the sparking between the contact points, minute mechanical vibrations, &c., in virtue of the condenser maintaining the electrical potential of the tongue for a little while, when it moves from one of the contacts.

With suitable condensers the relay, arranged as described, can be made to vibrate practically at any pitch—by varying the resistances, &c.—with beautiful regularity, as will be observed from the relay records, fig. 7, on the slip of an "undulator," a recording instrument described in the REVIEW, January 29th, 1892, page 130.

Fig 7



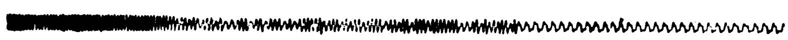


Fig 8

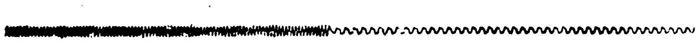


Fig 9

Such vibrations give an interesting illustration of the retarding effect accompanying the charge of condensers combined with resistances and effect, which for large condensers, *c*, and cables can be extended to such a degree that the armature only is reversed once every half second or more. Under certain conditions irregular vibrations can also be had—see record fig. 8—for instance, when the direct action of the resistance, *n*, is about to be overpowered by the action of the condenser, *d*, or *vice versâ*.

In some instances the different action of the condenser and resistance can be produced instantly, without any period of transition—see record fig. 9—causing the rate of vibrations to be changed suddenly.

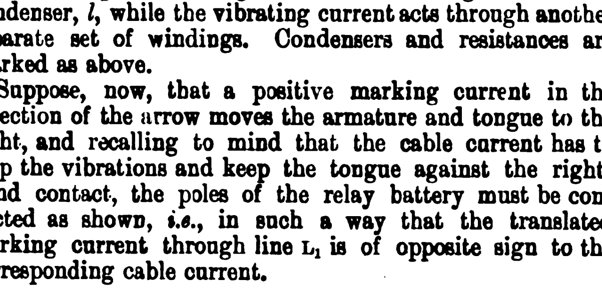
A curious thing can be observed in connection herewith, namely, that the tongue is able to vibrate at two different rates under the same conditions, although the vibrations are stable for one rate only.

This shows that the vibrations or the condenser oscillations keep their pitch at any moment with a persistence that can only be overcome by a certain force. In fig. 9 the different rate of vibrations is not produced by altering the connections, but by slightly tapping the base of the apparatus.

In the regulations to be described later on, one must, of course, not make any connections, which tend to cause such irregular vibrations.

The application of the vibrating relay for working can be effected as shown in fig. 10, L being line or cable, whence

Fig 10



the current passes through one set of windings to the cable condenser, *l*, while the vibrating current acts through another separate set of windings. Condensers and resistances are marked as above.

Suppose, now, that a positive marking current in the direction of the arrow moves the armature and tongue to the right, and recalling to mind that the cable current has to stop the vibrations and keep the tongue against the right-hand contact, the poles of the relay battery must be connected as shown, *i.e.*, in such a way that the translated marking current through line L_1 is of opposite sign to the corresponding cable current.

(*To be continued.*)

CATHODE RAYS IN AN OSCILLATING ELECTRIC FIELD.

THE theory of the cathode rays most in favour among physicists in this country is that which assumes that the rays consist of a stream of particles charged with electricity. This theory has not been generally accepted in Germany, though recently it has made a few converts.

One apparently fatal objection urged against the view that the cathode rays consist of charged particles, is that they are not deflected by an electrostatic force. If these rays consist of electrified particles, one would expect *primâ facie* that they would be more susceptible to an electrostatic force than to a magnetic force. The reverse, however, is the case. They can be readily deflected by a comparatively weak magnet; but Hertz found that no deflection was produced when the rays passed between two plates connected to a battery.

Prof. J. J. Thomson makes an ingenious attempt to explain away this anomaly in the charged particle theory. He says: * "We must remember, however, that the cathode rays, when they pass through a gas, make it a conductor, so that the gas acting like a conductor, screens off the electric force from the charged particle, and when the plates are immersed in the gas, and a definite potential difference established between the plates, the conductivity of the gas close to the cathode rays is probably enormously greater than the average conductivity of the gas between the plates, and the potential gradient on the cathode rays is probably very small compared with the average potential gradient" He also describes an experiment in which a deflection can be produced when the electrostatic field is caused to act on the dark space next the cathode, and this he explains by the hypothesis that the gas in the dark space is either not a conductor at all, or, if a conductor, a poor one, compared with the gas in the main body of the tube.

An interesting experiment is described by J. J. Thomson, which illustrates this curious resistance of the dark space to the passage of the cathode rays. Two spherical bulbs were connected together by a glass tube; one of these bulbs was small, the other large; they each contained a cathode, and the pressure of the gas was such that the dark space round the cathode in the small bulb completely filled the bulb, while that round the one in the larger bulb did not extend to the walls of the bulb. The two bulbs were wound with a wire which connected the outsides of two Leyden jars; the insides of these jars were connected with the terminals of a Wimshurst machine. When sparks passed between these terminals, currents passed through the wires and induced currents in the bulbs, which caused a ring discharge to pass through them. Things were so arranged that the ring was faint in the larger bulb and bright in the smaller one. On making, however, the wires in these bulbs cathodes, the discharge in the small bulb, which was filled by the dark space, was completely stopped, while that in the larger one became brighter. Prof. Ebert has also shown that a cathode stream is deflected out of its straight path by creating a dark space in its way.

The charged particle theory gives no satisfactory explanation of this curious property of the dark space; and though some ingenious experiments, similar to that of Perrin, have been devised by J. J. Thomson to show that the cathode rays discharge negative electricity on anticathode conductors, yet, while so many important phenomena remain inexplicable by this theory, it appears advisable, for the present, to suspend our judgment.

Jauman also obtained a deflection of the cathode rays by placing a conductor close to the side of the tube just in front of the cathode. But this has been shown by Schmidt and Wiedemann † to be due to a displacement of the starting point of the cathode rays owing to the change produced in the electric field by the presence of the charged conductor, and not to a deflecting influence exerted on the cathode rays by the electrostatic field. The deflection obtained by J. J. Thomson may be explicable in the same way, since the conditions of his experiment were very similar to those of Jauman.

Though it is still doubtful whether the stationary electric

* Royal Institution Lecture, April 30th, 1897, p. 10.

† E. Wiedemann & G. C. Schmidt, *Wied. Ann.*, 60, p. 510, 1897.

field produces any deflection of the cathode stream, it has been recently shown by Schmidt * that unmistakable deflections are produced by an oscillating electric field. The conditions of the experiments made by Schmidt exclude the possibility of the deflections being due to a displacement of the starting place of the cathode rays.

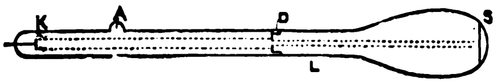


Fig. 1.

Schmidt's experiments were made with a special vacuum tube designed by Braun.† In this tube, illustrated in fig. 1, K is the cathode disc, and A is the anode. At D is an aluminium diaphragm with a central aperture about 2 mm. in diameter; S is a disc of mica coated with phosphorescent material, on which the phosphorescent spot can be seen through the glass when looking at the end of the tube.

If an insulated metal plate is brought near the tube in the neighbourhood of L, the phosphorescent spot widens out a little. This phenomenon is intensified if the plate or, in its place, a brass ball is connected to the cathode pole of the induction coil. Under these circumstances a comet-like tail is thrown out from the side of the spot opposite to the inducing body. The appearance of some of these comet tails is shown in fig. 2.

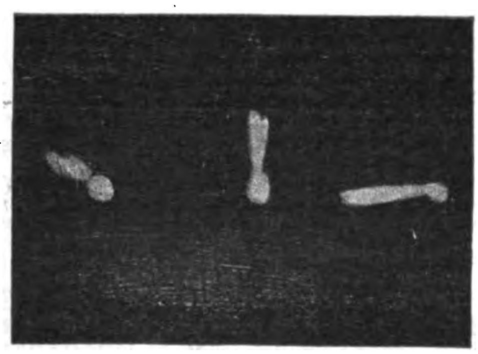


Fig. 2.

Since the publication of Schmidt's experiments, this subject has been taken up and thoroughly investigated by Prof. Ebert, of Kiel.‡ Instead of the induction coil, Ebert used a small alternating dynamo driven at the highest possible speed by an electro-motor. This machine generated an alternating current with a frequency of 60,000 per minute. The E.M.F. of this current was raised by a Siemens spark inductor with the condenser removed to 1,500 volts. The terminals of the secondary of this coil were connected to a pair of condenser plates placed at opposite sides of the Braun tube close behind the diaphragm. The cathode rays in the tube were produced by an influence machine. Ebert's arrangement, therefore, differs from Schmidt's in several features. (1) With Ebert's apparatus the oscillating electric field is persistent and regular, while in the Schmidt arrangement it is irregular and quickly damped, owing to the oscillations being derived from the ordinary induction coil. (2) The source of the oscillating field is independent of the source of the cathode rays in Ebert's arrangement, while in Schmidt's they are both derived from the same source, viz., the secondary of an induction coil.

Ebert satisfied himself, by experiment, that the time changes of the electric field between the condenser plates were almost perfectly sinusoidal, and followed one another without a break. With this apparatus were obtained not only comet-tail extensions of the nucleus spot on the phosphorescent screen, but well defined deflected rays could be seen, which, in the rotating mirror, were drawn out into oscillation curves of the greatest regularity.

* K. E. F. Schmidt, *Abhandl der Naturforsch-Gesellschaft zu Halle*, 21, p. 163 and 173, 1897.

† *Wied. Ann.*, Vol. 60, p. 552.

‡ *Wied. Ann.* 64, p. 240, 1898.

The two metal plates, P_1 P_2, fig. 3, having each a surface of 8·7 × 6·8 cm., were formed into a small condenser by fixing them at one end to a block of vulcanite, S_2, 2·5 cm. thick. These plates projected far enough over the vulcanite to embrace the tube, B. When the machine was started, the spot on the phosphorescent screen was drawn out into a thick vertical band of about 3 cm. in length. This experiment, therefore, proves that in the oscillating electric field cathode rays are distinctly deflected, and always in the direction of the lines of force, the latter assertion being easily demonstrated by turning round the condenser. The deflection in this case cannot be explained on the theory of the displacement of the starting point of the cathode rays, since that was 30 cm. distant from the condenser plates, and it was found that these plates lost their deflecting power if they were moved away from the tube even a few centimetres. The deflection is greater the greater the surface of the plates, and it also increases if the condenser is moved towards the end of the tube, as if the amplitude depended on the leverage at which the condenser acted. The deflection also increases with the potential difference between the plates.

Ebert suggests three different theories to explain this deflection effect of the oscillating electric field, and then proceeds to examine these theories by crucial experiments to determine which gives the correct explanation. He considers it possible that the deflection may be due to :—

I.—The magnetic effect of the displacement currents in the dielectric.

II.—The electrostatic charges on the walls of the vacuum tube.

III.—The deflection effects of secondary cathode phenomena.

I.—The Influence of the Displacement Currents.

The displacement currents of Maxwell's theory oscillate backwards and forwards along the electrostatic tubes of force, and would consequently give rise to circular magnetic lines of force surrounding each tube. These magnetic circles are equivalent, according to Stokes's theorem, to a shell of rectangular magnetic lines of force lying in the planes joining the edges as the condenser plates. The magnetic effect of these lines would tend to deflect the cathode rays in exactly the same direction as is shown by Schmidt and Ebert's experiments. But it remains to be seen whether in other respects this magnetic force is sufficient to account for the phenomena observed.

Ebert makes use of several arguments to show that, notwithstanding this partial agreement between the predicted and the observed results, the deflections are *not* due to the influence of the displacement currents. One of the strongest is the answer to the following question : Is the movement of the cathode rays in phase with the charging of the condenser, or with the displacement current ? If G is the electrostatic potential gradient, the displacement current is determined by dG/dt, and therefore differs in phase from the charging of the condenser by a quarter period. If the deflection is due to the

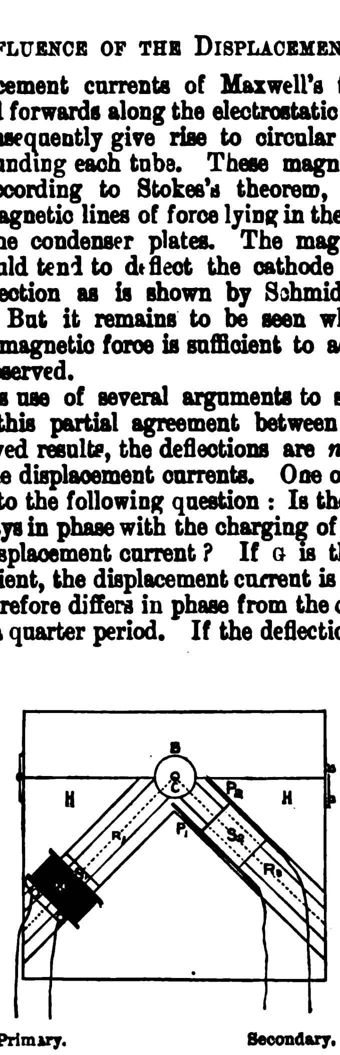


Fig. 3.

magnetic effect of the displacement current, it should have a phase displacement of about 90° relatively to the curve of tension. In order to determine this point, the primary current of the transformer was made use of for comparison. By causing the two forces, whose phases are to be compared to act on the cathode beam at right angles, the shape of the resulting curve will give the required information, in accordance with the well known rules for combining simple harmonic motions. In the primary circuit of the transformer was interpolated a small solenoid, M, fig. 3. This solenoid or bobbin was mounted on guides, B_1, at right angles to the axis of the Braun tube, B. The condenser, consisting of the two metal plates, P_1 P_2 and an intervening vulcanite block, S_2, was mounted on guides, B_2, at right angles to the axis of the tube and also to the guides, B_1. The bobbin, M, produces a magnetic deflection of the cathode rays at right angles to the magnetic lines of force, and the condenser, P_1 P_2, produces a deflection in the direction of the electrostatic lines of force. These two deflecting forces, therefore, produce deflections at right angles to each other, and the bobbin and the condenser can be adjusted at such distances from the tube that the deflections are equal.

As the result of numerous experiments, Ebert found that the figures produced by the combination of these two perpendicular oscillations were invariably approximately circular ellipses. This showed that the phases of the oscillations differed by as nearly as possible a quarter period. Now we know that the phase difference between the primary and secondary of the transformer must in this case be quarter period, and it follows, therefore, that the oscillations of the cathode rays are in phase with the charging of the condenser and not with the magnetic field produced by the displacement currents.

Ebert has also shown, by calculation, that the deflection which would be produced by the magnetic field produced by the displacement currents would be only $\frac{1}{300000}$ of that actually observed.

It may be taken, therefore, as proved, that the oscillations of the cathode rays between the plates of a rapidly charged and discharged condenser are *not* due to the magnetic effect of the displacement currents.

II.—The Electrostatic Charges on the Walls of the Vacuum Tube.

It is well known that a vacuum tube in which cathode rays are being produced shows strong electric charges on its walls. In the Braun tube, which is somewhat different in shape from the ordinary Crookes tube, the distribution of the surface charges can be easily ascertained by a proof ball and an electroscope. The proof ball (of brass) is fixed on the end of a glass rod; different parts of the surface of the active tube are touched by the ball, and the charge on the ball is then tested by the electroscope. By exploring the surface of the Braun tube in this way, Ebert found a very strong negative charge on the cathode end of the tube, which covered the whole surface of the tube to about half way between K and A (fig. 1). The charge was so strong that sparks could be drawn from the surface of the tube, and the surface charge lasted for a considerable time after the discharge in the tube had stopped. The negative charge was gradually neutralised towards A, and before A was reached was replaced by a positive surface charge which, however, was not quite so strong. This positive charge continued in varying amount up to the diaphragm, D, reaching a minimum shortly before D was reached. In the cylindrical part of the tube behind the diaphragm, D, there was found a very strong positive charge, which increased steadily towards the end, S, and reached such an intensity on the surface of the pear-shaped end, that small sparks could be drawn off after the discharge in the tube had ceased. The positive charge outside the tube implies a corresponding negative charge on the inner surface of the tube. In the active Braun tube, therefore, all parts of the inner surface of the section D S, even where the cathode rays do not strike, are coated with a layer of positive electricity, which binds a corresponding negative charge outside.

By these surface charges the course of the cathode rays is essentially influenced. It is well known that the cathode stream always moves along the axis of the tube, even with considerable variations in the shape of the cathode; but if the surface distribution on the tube is disturbed by putting one part to earth, or by drawing off sparks, the beam of cathode rays jumps at first suddenly to one side, and then returns slowly to its original position. The return of the rays to the axis of the tube is evidently due to the restoration of the surface charges by the action of the tube.

The oscillating electric field will evidently have the effect of periodically changing this surface distribution, with the result of producing oscillations of the cathode stream, in the same way in which a single disturbance produces a temporary deflection. Some idea of the mechanism by which this deflection is produced may be obtained from what follows.

III.—The Influence of the Cathode Phenomena Called Into Existence by the Oscillating Electric Field.

Ebert and Wiedemann have shown* that when alternating electric tensions are applied to electrodes on the outer surface of a sufficiently evacuated tube, cathode rays, with all their attributes of dark space, &c., are produced opposite the electrodes inside the tube. It was found sometimes, however, that these phenomena could not be obtained, though all the essential conditions of the experiment appeared to have been fulfilled. Then it was discovered that the cathode phenomena could always be started again by sending a direct discharge through the tube from internal electrodes. From this it would appear that the cathode discharges produced by alternating potentials applied to external electrodes are only possible when there are considerable surface charges on the walls of the vacuum tube.

From what has been said above, it will be seen that these conditions exist in the Braun tube, as used in Schmidt's and Ebert's experiments. When the tube was examined in a dark room, sparks could be seen passing between the condenser plates and the sides of the tube, but no corresponding cathode discharges were observed inside the tube till after the main cathode discharge had taken place.

Ebert and Wiedemann have shown† that the dark space from one cathode offers a great resistance to the passage of rays from another cathode. They described one experiment, in which, by means of a movable cathode, the rays were brought gradually closer to the dark space of another cathode. As they were brought closer they failed completely to penetrate through, but became deflected and bent round the outline of the dark space.

These experimental results can now be applied to explain the oscillation of the cathode rays in the oscillating electric field. The electric oscillations proceeding from the condenser plates, will project a dark space into the interior of the tube, first from one side and then from the other. These alternately projected dark spaces bring about the observed oscillations in the main cathode beam. According to the experiments of Kaufmann and Aschkinass,‡ the deflection *ceteris paribus* is proportional to the potential gradient of the deflecting cathode. There must, therefore, with a regular periodic electric force, be an oscillation of the cathode rays obeying the sine law. And this is exactly what has been observed.

These interesting experiments of Ebert's appear to show that the deflection of the cathode rays in the oscillating field are not primarily due to the potential gradient of the electrostatic field but to a cathode discharge which is created by this gradient. Why the dark space should have this curious resistance to the passage of cathode rays remains unexplained, though it appears to be a well-established experimental fact. Ebert, indeed, with true scientific caution, does not consider that his experiments exclude the possibility of direct electrostatic influence, but only that such influence if it exists is too weak to be shown by the Braun's tube. These experiments, however, appear to be fatal to the view that the whole of the electric current is carried by the particles of the gas in the form of electric charges. They point rather to the view that the current inside a Crookes tube differs only in degree from what takes place when a current passes through a gas outside the tube.

Ebert points out that his apparatus, illustrated in fig. 3, forms a very convenient and sensitive arrangement for measuring the difference of phase between the primary and secondary currents in transformers, and recommends its use to electrical engineers.

* *Wied. Ann.* 50, p. 42, 1893.
† *Sitzungsber. Physikal Societät Erlangen*, 24, p. 114, 1891.
‡ *Wied. Ann.*, 62, p. 588, 1897.

THE SECRET OF THE KEELY MOTOR.

Probably in no other civilised country in the world are the people more characterised by a mixture of shrewdness and credulity than most folks are in the United States. This perhaps accounts for the reason why he whom we have called quack, charlatan, and swindler, viz., the man Keely, has managed to keep alive the public interest for 25 years. We have dealt with the man and his pretensions on many occasions, and have not hesitated to state our opinion in the plainest of terms; we judged him by his works and his record, and there is no reason to alter our opinion. An opportunity of seeing the celebrated motor, and of testing its alleged performances was never presented to us, otherwise we doubt not we should have succeeded, as we have done in other instances, in showing that Keely was at best only a clever old juggler. He exhibited his greatest cleverness, however, in keeping his motor in his own workshop. We are not aware that during all the years that he was levying toll upon the purses of his enthusiastic admirers, he ever presented one of them with even a little model as a token of his affection and regard. He would invite them on to the platform, so to speak, and assure them there was no deception; but, of course, he could not be expected to give his bag of tricks away.

Keely is getting old now, and possibly, like the late Tichborne claimant, he is driven to earning a precarious dollar by getting himself interviewed, but has not now the cuteness necessary to recognise a skilled scientist in the garb of the newspaper man. At any rate, Keely has been interviewed by Mr. E. A. Scott, of the Philadelphia Engineers Club, and this "chiel taking notes" has also been taking observations, from which he concludes that the great magician's famous "apergy" seems to be only an ingenious combination of compressed air and electricity.

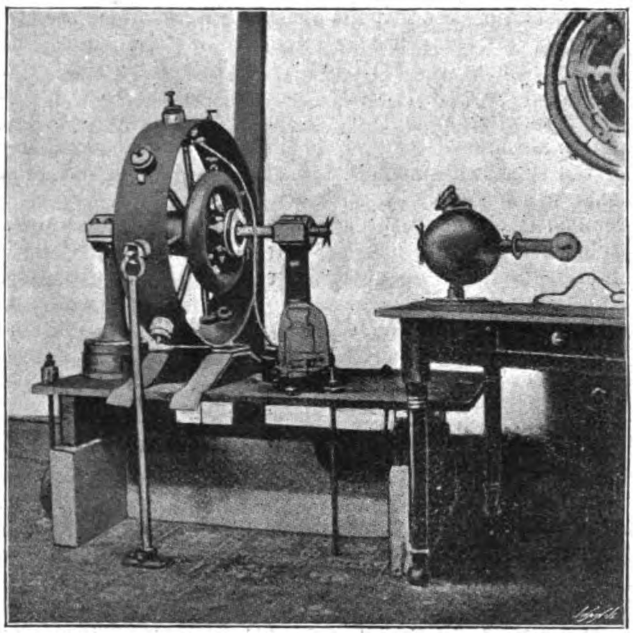
The results of the interview did not go to adorn the columns of a dime newspaper, though probably Keely thought that his interviewer was simply searching for copy (for the war had not broken out then), but were made the subject of a paper of considerable length, read before a meeting of the Engineers Club at Philadelphia.

Mr. Scott said the Keely motor has been a matter of greater or less public interest for 25 years, and yet there is now as little knowledge of what it is as when it was first announced. Probably no other enterprise making as little progress was ever kept alive so long. Keely has carefully guarded his secret; even the Courts could not extract it from him. In fact, the secret constituted the entire property, of which Mr. Keely was the treasurer, and even the company formed to exploit his supposed invention was never able to wrest it from him. Any effort on the part of the stockholders to do so has been met with the objection that Keely controlled the situation, and the value of their property depended on their keeping on good terms with him.

Many investigators, scientific and otherwise, have seen his experiments; United States Government officials and experts have witnessed them; capitalists, with millions at their disposal, have sought to control his inventions; yet there has always been an unreadiness on the part of the inventor to do anything practical. He is now over 70 years of age, and the possibility of his secret dying with him has aroused those who have supplied him with funds to the desirability of having him communicate his knowledge to someone who could continue his work.

Probably the idea of raising more money in this way originated with the man himself who, with one foot in the grave, still hopes to continue his success as an exploiter of public credulity.

The Keely motor or engine is the last of the long series of Keely's inventions, of which the previous apparatus are only experimental studies. It is supposed to embody the principles which Keely has laboured so many years to establish. He says it is operated directly by "apergy," a force hitherto unknown; that apergy consists, like light, in extremely rapid vibrations of ether, or matter of infinite divisibility which pervades the universe, the problem being to devise apparatus which will respond to these vibrations. This apparatus he calls the vibrodyne, which is thus described: A heavy cast-iron bed-plate, supported 18 inches above the floor by an iron slab at each end, bolted to the floor at each of the four corners by heavy iron rods and braced from the side walls, forms the foundation of a machine which can be prevented from running by the pressure of a finger, or stopped when at full speed by grasping it with one hand. A flat brass ring, about 4 feet in diameter, is supported on two wooden slabs resting upon the iron bed-plate, which are held to it by brass straps. On the outside of this ring, at equal distances apart, are fastened clusters of short tubes, each about a half inch in diameter and 3 inches long, called resonators. These tubes are partially filled with amalgam, or stopped up with diaphragms at varying distances from the ends. There are nine of these clusters on the circumference of the ring, and on the outside of each is a hollow binding post, to which wires can be attached. On the inside of the ring, immediately opposite the resonators, a "sensitised disc" is attached. On the inside of this disc is another binding post similar to the one outside the ring, which is also hollow, and making an open passage between the inside and the outside binding posts. There is thus a



The Vibrodyne or Keely Motor.

set of nine binding posts and discs pointing inwards, which are connected together by the mysterious platinum wire which figures in nearly all the experiments. The outside resonators and inside discs are about 2 inches apart.

Concentric with and inside of this ring is the revolving wheel. Its axis is supported at each end upon large iron pillars enlarged at the bearing of the axle. A large hub in the middle of the axle has radiating from it eight spokes, one less than the number of opposing discs on the inside of the flat ring. These spokes do not terminate in a rim, but on the end of each is a disc similar in size and character to those which project inward from the ring. There is also upon the axle near the hub a heavy iron ring about 14 inches in diameter, which revolves with it, presumably as a balance wheel to make a steady motion.

Keely set the wheel revolving in the following manner: Taking a 10-inch sympathetic negative transmitter (a large brass ball), he placed it on a table having a glass top, on one side of the room, and connected it with the vibrodyne by a platinum wire, attaching one wire to the binding post of the transmitter and the other to the binding post projecting from a resonator on the top of the vibrodyne. Then snapping some of the wires on the scale of the transmitter, and turning the handle backwards and forwards, the wheel commenced to revolve, slowly at first, and with gradually increasing speed, until the revolutions were about 180 per minute. Keely suggested that he could stop the wheel in several ways, two of which he illustrated. He pulled the wire out of the binding post of the transmitter, and it stopped. Again starting it, he stopped it by pulling out a plug in a hole in the binding post of the machine, the hole being a continuation of that hole into which the wire was thrust on the other side.

This left the transmitter attached to the machine, and gave Mr. Scott an opportunity to confirm his belief, formed from previous observations, that the so-called platinum was a small platinum tube. On the occasion of this experiment he took his seat next to the revolving wheel, not following Keely's suggestion to take another position. When Keely pulled out the plug from one arm of the binding post (which is in the form of a "T," and is hollow), leaving the wire sticking in the other arm, the other end of the wire still being connected with the sympathetic negative transmitter, he moved his face close to the hole left by the plug being removed, and distinctly felt a blast of air from the "wire." To make certain that the air current did not come from the revolving spokes, he kept his face in the same position until the wheel had stopped, and still felt the full force of the blast of air from the tube. Here was a confirmation of his belief that the wire was a tube carrying compressed air, the reservoir of which was the 10-inch globe of the "sympathetic negative transmitter." It was evident, however, that a sufficient amount of power to run the wheel for any length of time, or to run it at all, could not be stored in a globe of that size. His conclusion was that the air pressure performed the office either of an automatic switch closer or an automatic pole changer on an electric circuit. "The construction of the machine," says Mr. Scott, "points directly to electricity acting through magnetism." The unnecessarily heavy parts of the machine afford every opportunity for the concealment of the small wires necessary for the power developed, or the bolts which run down through the floor to hold the iron foundation could serve as conductors. It was an easy matter to bring a current to electro-magnets concealed in the nine interior discs, and no great amount of ingenuity would be required to construct a switch, operated upon both by the compressed air and magnetism, which would cut the magnet into or out of circuit at the proper time to attract the armature on the end of each revolving spoke. Had there been nine spokes as well as nine opposing discs, the wheel would have got on a dead centre, and could not have always been started; but with only eight spokes there were always some in a position to receive a magnetic pull before the magnets were cut out of circuit by the opposing discs being exactly opposite each other. The evidence of design here is sufficiently strong to warrant the conclusion that the wheel is operated by electro-magnets. "Apergy" would not have required this arrangement.

Mr. Scott declared that some of the most important of the experiments had since been duplicated by very simple means, which may have been the very means used by Keely. One of these was the well-known levitation experiment, by which, apparently, heavy weights are made to float in water. It was explained that the weights in the jar might be so constructed as to just sink in the normal condition of the jar, and to rise when a slight increase of air pressure was put upon the surface through a fine tube carrying compressed air, after the principle of the "Cartesian diver." This tube, called a platinum wire by Keely, was said to form an essential part of most of his apparatus.

Mr. Scott's conclusions from his personal investigations are in substance precisely the same as those to which we have always arrived, viz., that the man Keely cannot substantiate his claim to have discovered any hitherto unknown natural force, but that he is a juggler of superior ability.

OIL FUEL FOR STEAM RAISING.

A great deal has been said and written in favour of water-tube boilers in particular, and boilers of small water capacity in general, with special regard to rapid steam raising, not so much on the score of rapid steam production from cold water, but when a boiler is at work, on rapid increased production. Many who argue on the point do so entirely without thought. Assuming that the boiler is worked at a temperature of 300°, if the fire becomes more fierce there is more steam made, and if the safety valve is of proper size, the temperature of the boiler does not rise above 300°. If no rise in temperature takes place, the amount of heat in the water does not become greater. Therefore, all the additional heat of the fiercer fires has been applied in furnishing latent heat to water at 300° to convert it into steam at 300°. We see no way out of this conclusion. No heat has entered the water, for had it done so the water would be hotter, and, being so, the steam would rise in pressure. Our conclusion being inevitable, it must follow that whether the boiler contains 5 tons of water or 15 there can be no difference in the rapidity with which it will answer to a pushed fire. With engines working with 300° steam the addition suddenly of other similar units makes a demand for more steam at 300°, not for steam at 310° or 315°. If steam at a higher temperature were called for, there would be more rapid reply to a pushed fire by that boiler whose steam space was least or whose water content was least. This plain fact is quite overlooked by those to claim rapid reply to calls on behalf of boilers of small water capacity. In one respect only does a large capacity tell against a boiler, and that is where the circulation is poor, part of the water lies dead and cold in the boiler bottom, and a sudden livening up sets this water in circulation and checks the steam production instanter. But this is a fault which ought to be otherwise remedied, as, for example, by a pump to transfer the surface water to the boiler bottom continuously, a system absorbing very little power, as the pump would work in a closed circuit and have no tight pistons, or it might be a centrifugal one.

Apart from faulty circulation, the cry for little water content in a boiler required to give sudden demands is erroneous and essentially unscientific, and based on entirely false assumptions. The same additional heat will form the same amount of steam, no matter what the water or steam capacity, so long as the feed water is supplied at the same temperature in each case.

Where sudden calls for steam are made, there is wanted a fire that will quickly respond to an increased demand as signified by a wider damper opening or an increased fan speed. No solid fuel fire can immediately rise to the call made suddenly, and a sudden demand for steam must almost invariably be first met by a reduction of pressure which allows the water in the boiler to give up some of its heat by lowering its temperature. Here, then, we see the advantage of large water capacity, and an ability to give off considerable heat without too great a fall of pressure. But what is really needed is a sudden accession of fire. With a boiler at 300°, a sudden addition to the fire would give an almost instantaneous addition to the steam supply.

The problem thus narrows itself down to a means of securing the necessary increase of the fire. This must not be done at too serious an expense of costly fuel, nor can it be done at all with solid fuel, except in the shape of air-carried dust. A careful consideration of all the conditions involved, points strongly to liquid fuel as the auxiliary. Liquid fuel can be blown into an ordinary coal burning furnace without any change being made in the furnace conditions. Take Holden's system as an example. In this system a locomotive has two holes in the fire-box, through which the oil fuel is blown by compressed air in a fine spray upon the fuel on the grate. Only a light fire of coal and chalk is carried; but if desired, a heavy fire could be carried, and merely supplemented on gradients by a temporary admission of oil. We have travelled on one of Mr. Holden's oil burning locomotives with a heavy train behind, and were astonished at the ease with which the fuel supply could be regulated to suit the demand for steam, and at the way in which, at a stopping station, the oil was shut off completely, and at once re-started at exactly the previously existing rate of flow, when we moved out again.

For general power purposes, the one question is that of expense. To the central electric station engineer the demand for steam is foreseen from hour to hour the year through. The load curve, combined with a weather observation, is sufficient for estimating the proper time to get fires ready to spring into activity in time for the big demand. But in the English climate, and particularly in the peculiar situation of London, sudden unforeseen obscurations of the sun are apt to occur, with little or no warning. Under these circumstances a single movement of a lever would fill the furnaces with brilliant flame and increase steam production to a maximum. In the Holden system, oil is injected by means of a peculiar nozzle, consisting of a central mixed jet of air and oil impelled by steam, and surrounded by a ring pierced with small holes, through which steam issues, and induces a good air supply to burn the pulverised oil as it is diffused over the fire-box and the fuel on the bars.

Approximately, 1 lb. of liquid fuel will do the work of 2 lbs. of coal, and this figure can be used in conjunction with the relative prices of coal and "oil" in determining the cost of oil fuel. The cost of oil will often be prohibitive; it would soon become prohibitive if everyone took up its use, but, for sudden demands, its cost is well worth incurring for a few minutes to get over the peak of a load curve with otherwise insufficient boilers, or to get matters in order when a fog or a thunderstorm sends up the demand for current. Current demand falls off nearly as rapidly as it rises; with solid fuel the drop in demand may find furnaces full of fuel and in full swing; with oil fuel the *régime* of the furnace can be restored instantly, and further expense at once stayed.

We are confident that station engineers who undertake to try liquid fuel, say, in one boiler, will appreciate its convenience and the aid it will afford them. Liquid fuel is easy to apply, the apparatus required is small, and it need not interfere with the ordinary arrangements of a boiler. Indeed, in the Holden system, either liquid or solid fuel can be used at will. The operation of changing from one to the other may be said to consist simply in the picking up or throwing down of the coal shovel, and the opening or closing of a valve. The elasticity is perfect.

BATTERIES v. GENERATORS.

In a young industry like electricity supply, a large amount of energy has to be expended in educating the public to the adoption and use of electricity for domestic and other purposes. This accomplished, attention is turned to the best means of supplying the want which has been created.

The question of pounds, shillings and pence, enters largely into the calculations, in fact, it is the controlling factor, on it hinges everything. Before expending capital a reasonable prospect must be visible of receiving an adequate yearly profit, or great difficulty would be experienced in raising the necessary money to erect electricity supply stations.

The electrical engineer has devised various means and systems of supplying electricity for various purposes, and naturally these are all based on the economical generation and distribution of electricity, and rightly so.

Engines, boilers, generators, transformers, mains, lamps, &c., are all chosen with the above considerations well in view, and the result has been an ever-increasing and important industry has sprung up, affecting the whole community, the importance of which cannot be over-estimated.

The general demand for electricity keeps on increasing in every city and town where a supply has been established, and the little station of a year or two ago, put down as a "feeler" as it were, has grown to be an important concern which bids fair to rival, if not eliminate, the local gas industry.

This at present, to the sceptical, may seem impossible and absurd, but where do we find a customer who has once experienced and appreciated the comfort, cleanliness, and safety of the electric light, expressing a wish to go back to gas with its dirt, danger of fire, explosion, and asphyxia? The rush light was superseded by the candle, the candle by the oil lamp, the oil lamp by gas, and now a greater power in the land than even gas has appeared.

Just as each of the new means of illumination was more expensive at its introduction, until the demand and supply regulated the price and brought it to its proper level, and its increased advantages and better illumination slowly but surely gained for it the preference, so each of the older means of illumination will gradually die a natural death, but not without a struggle. Many were the blows aimed at the new comer, but it has come to stay. It is only a matter of time, and we believe a very short time, until the prejudices of to-day, many of them interested prejudices, will have disappeared, for the simple reason that no opposite interests will exist, or if they do their feeble attempts at depreciation will be treated with scorn by the majority of those who at present side with them, for by that time they will be using the new illuminant and will have learned to appreciate and rely on it.

It is the question of "reliance" which we wish to emphasise. Various means are adopted to ensure a constant and uninterrupted supply. Spare plant in the shape of engines, boilers, generators, transformers, accumulators, &c., are all in use to-day for this purpose, but who can truthfully say we have any reserve?

In cases of emergency, valuable time is lost in "getting away" with the spare plant; and if continuity is preserved at least pressure is often sacrificed. No matter how well it looks on paper to have a certain proportion of spare plant to take up the work in case of accident, we know that time must elapse before a stand-by boiler can be got up to proper working pressure, or an engine run up to full speed and put on to the work, and we also know that the expedition and precision with which these are done depends largely on the intelligence, experience, and coolness of the men on duty. The motives of economy which govern all electricity works throughout the country render a number of *spare men* an impossibility. In times of peace the men on duty have, especially during the the period of greatest demand, their hands full, but when things begin to go wrong and attention is diverted from the running plant to getting under way the spare plant, many a threatened calamity has become only too real by the insufficiency of men at these critical moments.

The vulnerable spot, which is well known to electricity's enemies, is no doubt a danger of sudden extinction. Although they are becoming fewer and fewer, and when they do occur their duration is briefer, yet their seriousness does not diminish but rather increases, for the danger is not removed. The important question which will shortly have to be faced is: Shall we continue to depend for a stand-by on spare units of plant, or shall we tackle the storage battery question in a proper spirit and have a reserve of electricity which will make us quite as independent of temporary disarrangements of machinery as gas suppliers? We say gas works store gas because they cannot make it as it is wanted, and we generate electricity because we can make it as it is wanted, and because it is more economical so to make it, and because we cannot store it in sufficient quantities to be of much use as a reserve. What evidence have we to support this latter assertion?

Electricity is undoubtedly generated cheapest when the machinery is working at full load, but this comes for such a short time each day that a great many makers of late years have been designing their plant to give best results at or about three-quarters load, because they are called upon to work under these conditions many more hours in a given time. The hours of heavy load each day are very short indeed, the peak seldom lasting more than 20 minutes to half-an-hour, yet we have to keep plant to supply current and maintain the proper voltage over the system at this time, and in addition have in reserve a reasonable amount of spare machinery.

If the output of a year was averaged over the 24 hours of the day for the 365 days, it would be found that the current could have been generated by an astonishingly small unit of plant; probably one of the station exciter engines and exciters would have been ample. It would certainly seem that if ever complete reliance can be placed on electrical supply, storage batteries must enter more largely into the composition of supply stations than at present. The installations of accumulators to be met with in various stations presumably kept as a reserve in case of need, but principally to supply the current in the hours of minumum demand, are a delusion. They are only toys compared with what they should be. If occasion arises when an unusual demand has to be put upon them they fail utterly.

Consider for a moment a station equipped mainly of huge storage batteries composed of plates nearer the size of billiard table tops than the cover of a pocket note book and we get something like a battery. As mentioned above, if the year's demand was spread out evenly over the 8,740 hours in a year of 365 days we begin to realise what a small sum would have to be spent in generating machinery. The small plant would be worked day and night in charging the huge accumulators, and as they would be working at or nearly full load the current would be generated as cheaply as possible, and this would tend to lessen the loss in efficiency in the batteries as we at present know them.

When we remember that the commercial efficiency of a battery is somewhere between 50 and 60 per cent., although the makers place it as high as 75 per cent., it is not so very far behind the commercial efficiency of a modern plant working under ordinary conditions. Coal is the largest item in out-of-pocket expense in the production, and it often happens that this item in a summer month is three times as much as in a winter month per B.T.U. generated; when this is borne in mind, the apparently wide gulf between the two systems narrows perceptibly.

A large amount of running plant requires an extensive and efficient staff, generally multiplied by three to cover the 24 hours of the day. By the storage system the wages bill would be cut down at least one-half, if not more. Wages form the largest of establishment charges, and with one-half abolished we witness a still further reduction in the great gulf fixed. Maintenance and depreciation affects both systems. No doubt the heavy charges of present batteries is largely due to having from time to time to work them under unnatural conditions. Sudden heavy overloadings do not tend to improve them, and if often repeated do great harm.

If batteries amply large are in use, then overloading should never, or very rarely, occur, and this alone would tend to lengthen the life.

Battery suppliers will gladly enter into a maintenance contract for a number of years from 7½ per cent. upwards on the original cost, making good all deterioration due to fair wear and tear.

We usually put aside 5 per cent. on the cost price of our machinery for depreciation, but this sum does not cover maintenance, which will not come far short of another 2½ per cent. Where, then, is the difference if the two systems cost the same money to instal? If the battery system costs more, should we not gladly pay more to ensure absolute immunity from interruptions in the supply from the generating station.

Interruptions from causes exterior to the generating station must be dealt with in precisely the same manner, and do not enter into the question.

Accumulators are engaging the attention of engineers at present, due, no doubt, to the prospect of motor-car traffic developing, and the efficiency and mechanical strength will increase, while the depreciation and maintenance figures will diminish.

THE ECONOMICAL USE OF STEAM IN NON-CONDENSING ENGINES.

For many years the technical papers were full of the beauties of automatic and variable expansion gear, and the advantages of the steam engine indicator. We seem likely now to be equally supplied with papers rubbing out the arguments so long advanced. The *Engineering Magazine* contains one from the pen of Mr. Jas. B. Stanwood, advocating the throttle governor for non-condensing compound engines. He quotes Mr. C. T. Porter as saying that nothing so unsuitable as the automatic variable gear could have been devised if it had not been already in use.

The range of economical working of an engine is much wider than expansion faddists would once allow. Men who swore by the indicator now find it better to pay more attention to the relation of indicated to effective horse-power, and are learning to pay attention to the internal friction of large engines which so soon puts a limit upon the desirable expansion ratio, especially when taken in combination with various other losses, such as initial condensation and interest on first cost. Mr. Stanwood realises that Corliss—and he might have added pre-Corliss English inventors—effected a big economy not because of variable cut-off but because they abolished ridiculously late cut-off, and made a valve gear capable of cutting off at about a quarter stroke. The variability was with Corliss a mere accident. It could have been well dispensed with so long as a fair cut-off was secured, any load variation being dealt with by the throttle. Had Corliss been compelled to run his engines at light loads demanding cut-off at an eighth or a tenth, he would have seen the error of variable cut-off, for the full effects of cylinder action and waste spaces would have been more apparent, and the low mean pressure compared with the friction diagram would have made the fuel cost per effective horse-power very serious. The terminal pressure would have been only 5 or 6 lbs. below atmosphere, the piston being dragged against the atmosphere. Sometimes this occurred, and disappointment followed the use of too large engines. In old style transmissions with so very much shafting and belts to move, there was always a heavy dead load on an engine, and the ratio of light load to full load was not so far from unity as with a dynamo engine which may vary from full load to a mere engine friction load, and these light loads could not be operated economically with expansion gear, the limit of expansion being soon reached, varying, however, with the type of engine—being shorter with short stroke engines. High speed engines of short stroke were found to be more economical than similar engines at slow speeds of revolution. Engines with small clearances were similarly found to have superior economy. Long stroke engines had an economical expansion of four, some short stroke engines of only two. Thus the economic early limit of expansion was respectively five and three in the two types, the reasons being those of clearance space and condensation in the cylinder. Clearance is ordinarily 3 to 4 per cent. in long stroke engines, but has been reduced to 1 per cent. in special cases. In short stroke engines it is 15 or 16 per cent.—hence the advantage of long stroke engines, for filling up clearance of compression by no means give back the loss.

Mr. Stanwood says nothing of the importance of careful design on cylinder condensation effects. There are a dozen ways in which a nominal equality of inside exposed surface may be trebled or quadrupled by careless design. On this point a report by Mr. M. Longridge may be studied with interest.

Increase of steam pressure has intensified all the losses due to clearance, and no doubt this has done so much to counterbalance the gains due to high pressure *per se*. High pressure means more weight of steam to fill up clearance space, and it means wider range of temperature and more condensation. But high pressure enables a higher minimum pressure to be carried and reduces the expansion below atmospheric pressure. Gain from high pressure could only be secured by the compound system, but this had its limits exactly as had the single cylinder, and, unless with full loads, the non-condensing compound automatic engine was a failure and economy was found to be possible only for nearly constant loads. It has always been recognised by practical engineers to be a mistake to drag round a huge L.P. piston on a semi-loaded engine. In compound engines, non-condensing, the loss due to excessive expansion below the atmosphere is even greater than in simple engines. With increase of pressure the difficulty increases, because the minimum mean effective pressure obtainable without expansion below the atmosphere increases with the pressure, and at about the same rate as the maximum mean effective pressure. Hence the ratio of the minimum to maximum mean effective pressure is not reduced for light and heavy loads as in the simple engine. Where both cylinders are controlled by the governor this drag develops in the H.P. cylinder whenever its terminal pressure falls below the high receiver pressure induced by early L.P. cut-off. Control of both cylinders involves large clearance spaces to avoid stresses due to high compression. Experience seems to point to the desirableness of not controlling the L.P. cut-off by the governor but of fixing it at about $\frac{7}{16}$ths stroke, and regulating in the H.P. cylinder only. Mr. Stanwood, however, would control both cylinders and reduce clearance losses by suitable compression and by avoiding early cut-off. Obviously the compound engine must have only a moderate expansion in each cylinder, otherwise cylinder condensation and clearance losses are brought about, and the non-condensing compound engine is only economical at uniform load and when properly proportioned to such load.

Taking into consideration all the difficulties and data, our author advocates fixed cut-off to determine full-load and throttling governing, and proposes to more fully discuss the subject in a second paper.

THE HEFNER LAMP.

In order to express measurements of light so that the results are strictly comparable with each other, all light intensities must be expressed as a multiple of a fixed unit. For technical purposes the only units available are flames, since these alone are cheap, always reproducible, and handy to use.

As the result of the investigations of the German Reichsanstalt, the Hefner lamp alone fulfils all technical requirements. The light of the Hefner lamp is designated a *Hefner candle* or simply *a candle* (H K). The definition of a Hefner candle and Hefner lamp is as follows:—

The unit of light is the light intensity of a flame burning freely in still, pure atmospheric air; the flame being produced from a massive wick saturated with amylacetate which completely fills a circular wick tube of German silver, 8 mm. internal diameter, and 8·3 mm. external diameter, and 25 mm. long; the height of the flame being 40 mm. from the edge of the wick tube, and no measurements being made till at least 10 minutes after the lamp has been lighted.

The Hefner candle was accepted as the international unit of light by the Electrical Congress at Geneva in 1896. In Germany this unit has been adopted by the societies representing the electrical and gas industries.

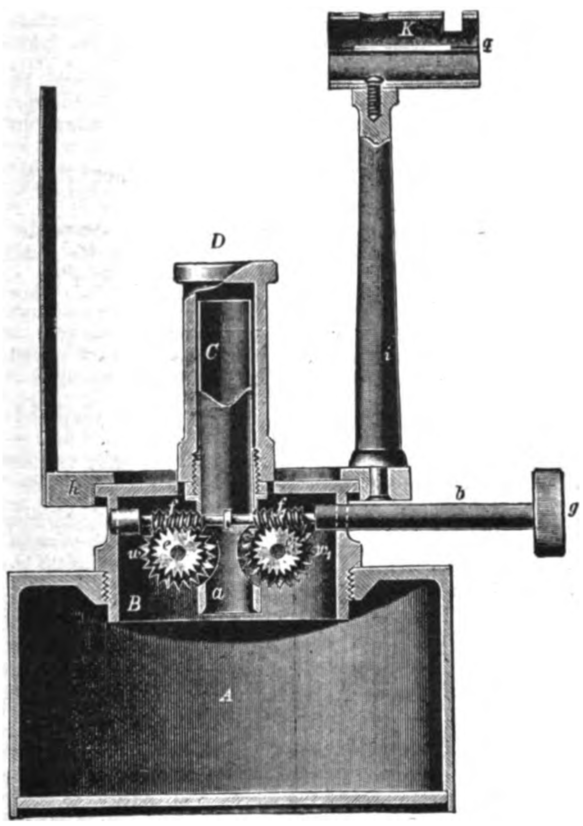


Fig. 1.—The Hefner Lamp.

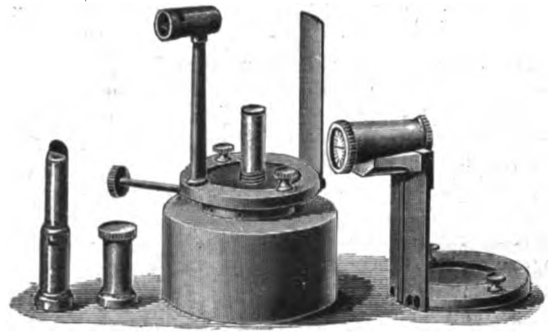
The light intensity of the Hefner lamp varies to a certain extent with the condition of the surrounding air. The influence of the height of the barometer and humidity is shown by the diagrams, figs. 3 and 4. In the neighbourhood of the normal barometric pressure, the variation of the light is of no practical importance. The variation of the light-intensity with change of humidity is also of little practical importance. On the other hand the intensity of the light is very much influenced by the amount of oxygen in the air in which the flame is burning.

One of the first conditions, therefore, for accurate photometry by means of the Hefner lamp is that the space in which the lamp is used shall be sufficiently large and sufficiently well ventilated.

The following is a description of the Hefner lamp as manufactured by Siemens & Halske, which is shown in section in fig. 1.

The reservoir, A, for the reception of amylacetate is made of brass or bronze and is tinned inside.

The cap, B, supports at its centre the tube *a*, and the mechanism for raising and lowering the wick. This wick mechanism consists of two axes, on which are mounted two toothed rollers, *w* and w^1, projecting through the sides of the tube. Fixed on the axes of the rollers are two toothed wheels, *e* and e^1, which can be turned in opposite directions by a pair of endless screws, $f\ f^1$, mounted on the same axis, *b*. This axis, *b*, terminates in a milled head, *g*, with the help of which the wick mechanism can be set in motion. The tube, *a*, projects above the upper plate of the cap, B, about 4 mm., and on this projecting end a screw thread is

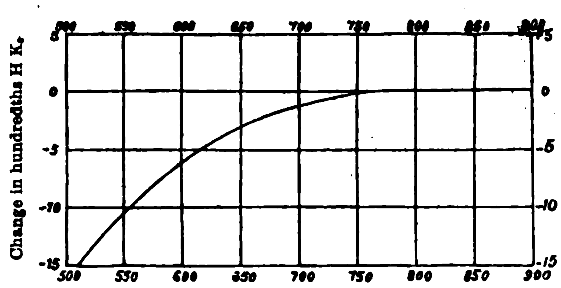


Gauge. Hefner lamp with Hefner flame measurer. Krüss flame measurer.

Fig. 2.

formed on which the tubular cover, D, can be screwed. Close to the tube, *a*, there are two openings in the top plate of the cap, to admit air to take the place of the liquid consumed.

The wick tube, C, is made of German silver without a soldered joint; its length is 35 mm., its internal diameter

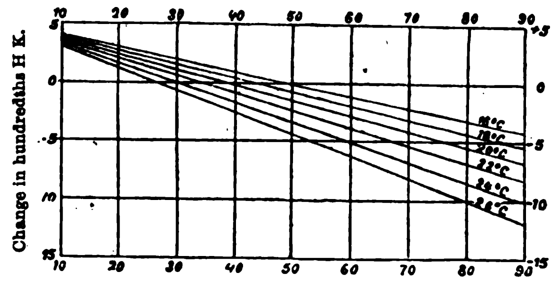


Change of light intensity of the Hefner lamp with the height of the barometer.

Fig. 3.

8 mm., and the thickness of its walls 0·15 mm. It is pushed down into the tube, *a*, till it comes against a shoulder.

The flame measuring apparatus for determining the length (40 mm.) of the flame, is mounted in a ring, *h*, which in



Relative moisture in hundredths.

Change of light intensity of the Hefner lamp with relative moisture at different temperatures.

Fig. 4.

turn is mounted on the top plate of the cap B, so that it can be lifted off or turned round and fixed in any position.

The apparatus of von Hefner-Alteneck or of Krüss (fig. 2) may be used for measuring the flame. The Hefner flame measurer (figs. 1 and 2) consists of two pieces of tube, one pushed inside the other, and fixed so that their horizontal axis passes through the vertical axis of the wick tube. The inner tube is cut in two longitudinally, and supports horizontally a polished steel plate of 0·2 mm thick, with a rectangular opening. The under side of the steel plate is 40 mm. above the upper end of the wick tube.

The Krüss flame measurer (fig. 2) consists of a tube about 80 mm. in length, of which the axis is also horizontal and passes through the axis of the wick tube. A small lens of about 15 mm. focal length is fixed in the end of the tube next the flame, and at the opposite end is mounted a disc of ground glass with its ground surface next the lens. At the centre of the disc is a black horizontal mark not more than 0·2 mm. thick. The image of this mark over the centre of the wick tube is 40 mm. above the top of the tube.

The gauge (fig. 2) serves to fix the position of the upper end of the wick tube, as well as that of the flame measurer. If the gauge is pushed over the wick tube so as to rest upon the cover of the cap B, then by looking through a slit in the tube, a line of light less than 0·1 mm. will be seen above the end of the wick tube when the latter is at the normal height; the slit at the top of the gauge should lie in the same plane as the steel plate of the Hefner measurer. With the Krüss arrangement, the image of the slit on the top of the gauge should coincide with the mark on the ground glass.

All the metal parts of the lamp, except the wick tube and the steel plate, are etched to a dull black colour.

THE BRITISH ELECTRIC TRACTION COMPANY.

On Thursday evening, the 26th ult., the staff dinner of the British Electric Traction Company, Limited, was held at the Trocadero Restaurant, Mr. Emile Garcke, managing director, being in the chair. Amongst the company, which numbered about 45, we noticed Mr. Godfray, Sir Edward Gourley, M.P., Mr. George Herring, Sir Ch. Rivers Wilson, C.B., Major Cardew, R.E., Sir Charles Freemantle, K.C.B., Mr. Atherley Jones, Q.C., M.P., Mr. Sidney Morse, Mr. Alfred Dickinson, Mr. George Flett, Mr. H. Hatchett, Mr. R. Simpson, Mr. W. Alderson Smith, Mr. Percy Sellon, Mr. J. S. Raworth, Mr. W. B. Jeffries, Mr. A. R. Monks, Mr. W. H. Scott, Mr. J. W. Alison, Mr. B. Gibson, and Mr. H. F. Woodward.

The dinner was a thoroughly enjoyable one, worthy of the occasion and a credit to the caterers, and it was pleasant to observe the mutual confidence which exists between Mr. Garcke and his able staff, a confidence which we may be permitted to hope will continue for many years to come to the advantage of not only employers and employed, but to the benefit of the travelling public. The principal toast was that of "The British Electric Traction Company," proposed by the chairman, in which he said:—

In proposing this toast, I would prefer, of course, to be able to afford you entertainment, instead of speaking of the affairs of the company, which are already too fully engrossing the attention of most of you, but the circumstances of our gathering are somewhat exceptional. Several members of the staff have only lately either joined the company, or entered upon their present duties, and there are several gentlemen present who are connected with our associated companies. It has been suggested to me that they would like some fuller information than we have yet had the opportunity of giving them as to the policy and business of the company.

The extensive character of the business will be seen from the large number of undertakings which we have already under our control, to say nothing of those which are in course of being established or promoted, and its complex nature will be at once appreciated when I explain that we not only arrange for the acquisition or leasing of existing tramways undertakings, but also undertake the initial promotion of new schemes, with a view to working by electric traction. This, I need not say, is a work requiring a great deal of judgment and discrimination. It involves difficult and weary negotiations with the local authorities, and applications to the Board of Trade, to Parliament, and to the Light Railway Commissioners for the necessary powers. When these have been obtained the work of construction has to be undertaken, and when the line is ready to be opened for traffic, a totally different kind of talent and experience is required for carrying on the business. A large number of men have to be engaged, and traffic arrangements have to be carried out which require a very close study of local conditions.

It will be seen, therefore, that the operations carried on by this company require, in their various stages, abilities and experience which it is impossible to combine in any one individual. Moreover, our various undertakings are scattered over the entire length and breadth of the United Kingdom, and are not continuous, like railways, but are divided, at any rate at present, into relatively small sections.

Having regard to the multifarious duties to be performed, the board have come to the conclusion that the highest efficiency and the greatest economy in the conduct of so extensive an enterprise can only be attained by a carefully arranged system of devolution, combined with a scheme providing for watchful supervision of details. This the board believe they have secured by a specialisation of duties, and by the appointment of district superintendents, very much on the lines adopted by the large railway companies.

For instance, the board have appointed a permanent way engineer, who will attend to nothing but the permanent way of the various undertakings of the company wherever they may be located. The tramways, which in one form or another we control, cover between 80 and 90 miles, and the tramways for which we have already obtained powers, and which have to be constructed within periods specified in the orders, cover another 60 odd miles, and this does not include any of the new lines we intend to promote.

Then we have a traffic superintendent whose duty will be to establish, as far as possible, uniform traffic arrangements. We estimate that when our present tramway undertakings are electrically equipped we shall have at least 500 or 600 cars running, and shall directly or indirectly employ upwards of 2,000 men.

Then we have a power engineer whose duty is to superintend the construction and the maintenance of the electrical machinery. We estimate that when the tramways to which we are already committed are in full working order, we shall either have to generate or purchase upwards of (10,000,000) 10 million Board of Trade units of electricity per annum.

We have created a department for carrying on the responsible work of promoting and obtaining powers from Parliament, the Board of Trade, and the Light Railway Commissioners. The undertakings in regard to which we have made definite agreements for the adoption of electric traction are governed by no less than 60 Acts of Parliament or provisional orders, and the negotiations we have to carry on with the local authorities and other bodies involve a thorough knowledge of the provisions of all these Acts and orders. In addition to these we have at the present time some 15 or 16 light railway orders in progress, and have made agreements for the promotion of about 20 further Acts of Parliament, provisional orders or light railway orders. That is as far as we can see to-day, but we are not standing still, and are negotiating fresh business from day to day.

There are several other departments, but those I have mentioned are sufficient to show the principles which have guided the board in the distribution of the duties. So much for the technical staff. Now I will say a word or two as to the geographical divisions. We have grouped our various undertakings into districts with a superintendent for each district, who will be officially associated as a director, or in some other suitable capacity, with the undertakings in his district, and he will be in direct communication through the secretary with the heads of the technical departments. In this way each undertaking or company will obtain the benefit of the best expert advice and of a wide experience at only a small proportionate cost.

The geographical divisions we have decided upon have been determined mainly by the large centres of population in which our present business is chiefly concentrated.

By-the-bye, it will be of interest to state that our Kidderminster line was opened for traffic to-day, and this little line constitutes an exemplification of British electric traction in the truest sense of the word, for all the plant and rolling stock has been manufactured in this country by our friends the Brush Company. This is, I believe, the first electric tramway in this country of which this can be said.

From what I have said you will see that we are engaged in developing an extensive and important business, and it will be satisfactory to our financial friends to know that in nearly all the undertakings we are engaged upon, the expectations of earning dividends upon the capital to be invested are not based merely upon the faith that we have in the future of electric traction. In nearly all cases we have based our calculations upon the results obtained by the companies whose lines we are converting; and we all know that if a company working an inadequate service, by steam or by horses, is making a profit, we are certain to show better results when we put upon the lines a more frequent service at a lower cost of working. I may add that the capital we have employed in building up this business is already productive of profits, and, contrary to the Ricardian law of diminishing returns, every addition to our capital is calculated to produce an increasing margin of profit over the fixed interest we have to pay.

Sir Rivers Wilson, at the annual general meeting of the shareholders, referred to the subject of municipalisation of the tramways—a question which, I think, is surrounded by a good deal of misapprehension on the part of local authorities, who do not seem to realise the great difference between the municipalisation of horse tramways, which are generally confined within the limits of municipal areas, and electrical tramways or light railways, which, to attain their highest development and fullest utility, should be constructed with a view to connecting outlying towns and villages with the cities.

Sir Rivers Wilson struck the key-note of the matter when he said that municipal boundaries do not coincide always with the centres of population, and if the municipalities construct tramways, they have to confine themselves to their own boundaries, so that the outlying villages and towns are not reached, and it is because electric traction is particularly suitable for the working of tramways extending over long distances that electric traction is not a suitable industry for municipalisation.

No one would dream for a moment of municipalising our large railway systems, and the arguments against the municipalisation of railways, telegraph and similar enterprises, which pass from the area of one municipality to another, apply will equal force against the municipalisation of electric tramways. The present tendency of Corporations to undertake the working of tramways will have the serious effect of retarding and restricting the natural growth of an industry, which, if not thus hampered, will, I am sure, extend as it has done in other countries in every direction, and contribute very largely to the convenience and welfare of hundreds of thousands of people who have to travel from one town to another, and to intervening places. If the policy of municipalisation of electric tramways advances, most of the smaller outlying places will be deprived of tramway facilities.

Not only the theoretical arguments, but the physical facts of the case demonstrate that the working of electrical tramways by municipalities will prove a social calamity. I am in sympathy on political and social grounds with the expansion of the sphere and scope of municipal life, and I am not at all averse to the municipalisation of undertakings which are confined within the limits of the municipal area, and which do not raise such large social questions as is the case with electrical tramways.

I have often spoken and written in favour of the municipalisation of electric light undertakings, but it is a question whether even this policy has not been carried too far. There are many small municipalities in the country which are not large enough to enable electric lighting business to be carried on with the greatest possible economy, and it is found now that electricity can be supplied more cheaply if generated on a large scale at a central point and distributed to these small authorities in bulk, but the fact of a local authority having established its electric light station is not the same thing as if it had been done by a company. In the case of a company making a mistake the unfortunate shareholders are inevitably brought face to face with a liquidation, and the competition of new comers leads to the survival of the fittest, but when a local authority is carrying on a relatively unprofitable business, this beneficial and effective competition is impossible because the local authorities have the power to prevent the larger and better supplier coming into competition with them.

In this way we see that the municipalisation of some undertakings stands in the way of industrial progress, and the advantages obtained from the working by municipalities, whatever those advantages may be, cannot be such as to compensate for these evils.

Now, let me refer to one or two of the physical obstacles which I venture to say municipalities cannot and will not overcome.

The difficulty of the variation of gauges in towns adjacent to each other has already been pointed out, but it is not generally recognised how widespread this anomaly is.

Which of these local authorities will make the gauge throughout the district uniform for the benefit of the others?

In our South Staffordshire scheme we proposed to alter the Wolverhampton gauge so as to bring it into conformity with the other tramways of the district.

I ask anyone will the Corporations—can the Corporations—do what the companies can and will do in the matter?

But the difficulty of municipalising electrical tramways are not confined to Corporations with small areas.

If the principal of municipalisation is sound, Manchester surely should demonstrate it. But what do we find there. Very nearly half the lines worked by the Manchester Carriage Company are outside the municipal boundary.

Among the suggestions made by the Manchester Corporation to the other authorities is one that each authority shall fix the fares in its own district. Now, this suggestion alone destroys the whole advantage to be derived from the control by one central authority.

Another suggestion is, that the several local authorities shall provide the necessary energy and electrical equipment for the working of the tramways within their districts. It is impossible to see what advantage so chaotic an arrangement of working such a large system would have over the uniform arrangements which a company working the whole of the lines would be able to organise.

I must not weary you by discussing all the other aspects of this question, but it will become our duty to face the problem before long, and we shall have to be prepared to expose all the other fallacies upon which local authorities are proceeding in this matter. If local authorities are not put right, we shall be responsible, because we have studied the question, and know the real facts. For my own part, I shall be prepared to contest the arguments advanced by those who favour municipalisation. I shall be prepared to show that the oft-quoted cases of municipal working do not support this doctrine. Then we are told that in the case of municipal tramways the profits go back to the ratepayers. Yes, but not to the same ratepayers who have produced the profits. I have been told by the mayor of a town in the North that about one-third of the total rates are paid by the railway company whose lines pass through the town. What comfort is it to the labourer in that town to know that by patronising corporation tramways he will produce profits, one-third of which will go to reduce the rates paid by the railway company?

Then we are told that corporations can borrow money more cheaply than companies; but this resolves itself merely into a question of tenure. If you give a company a tenure of 62 or 90 years, the slight financial advantage in favour of municipal loans disappears. Moreover, the grant of a longer tenure would have the enormous advantage to the community of enabling sparsely populated districts to be developed. The present system of granting concessions for only one-life period necessitating, as it does, a heavy sinking fund, precludes the possibility of either corporation or companies doing what has been done on so large a scale in the States—putting down electric tramways in anticipation of, and to encourage the growth of cities and industries.

But I have said enough to show that the subject deserves further discussion, and I only wish, in conclusion, to again emphasise that I have been prompted in what I have said on this subject of municipalisation, not so much by the immediate interests of the British Electric Traction Company, but by the feeling that, besides doing the work which lies before us, we have also the duty and the responsibility of promoting the general advance of electric traction. The work we have to do will offer scope enough for our energies and our ambition, it is a useful work, and I may say a noble work, which it is our intention to do, not only with profit to our shareholders, which, of course, is our first duty, but also with satisfaction to the public and with pleasure and advantage, combined with credit and honour, to ourselves. I propose to you success to the British Electric Traction Company, and health to Sir Ch. Rivers Wilson, our chairman.

Sir Ch. Rivers Wilson responded to the toast, in the main seconding Mr Garcke's contentions. Mr. Raworth, "in lighter mood," proposed the toast of "The Electrical Industry," to which Mr. George Herring and Mr. Percy Sellon responded. "The Visitors," proposed in a ponderously humorous vein by Mr. Stephen Sellon, and replied to by Major Cardew and Mr. Madgen, completed the toast list.

It must have been most reassuring to Mr. Garcke and his friends, for the success of their future operations, if, indeed, it did not come as a complete surprise, to hear Mr. Madgen disclaim that he represented *Lightning* on that occasion, and eloquently repudiate the policy of that journal, endangering its *raison d'être*, in fact, by agreeing wholly with Mr. Garcke's views, and boldly asserting that local authorities and the parish pump were all a huge mistake. To secure such a valuable ally is a feat of which Mr. Garcke may well feel proud, and probably this was one of the schemes to which he briefly alluded as having to deal with, but to which he did not, for many reasons, deem it necessary to specifically refer in the course of his very suggestive and interesting post-prandial oration.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

At the meeting of the Institution of Electrical Engineers, held at the rooms of the Society of Arts, on May 26th last, Mr. J. W. Swan, president, in the chair, Prof. Charles A. Carus-Wilson read a paper on "The Design of Electric Railway Motors for Rapid Acceleration." The writer gave an explanation of the contents and scope of his paper instead of reading it in full, the diagrams being projected on a screen and fully described. As will be seen from our columns, in which a reprint of the paper itself is given, the writer deals with the important question of the incidence of design as regards the motors employed in what in this country we prefer to call tramway systems, *i.e.*, those lines in which frequent stops are made, the intermediate runs being of comparative shortness. It is pointed out that in such cases efficiency may be of less importance than rapid speeding-up, while the loss of energy in the rheostatic controller, or even in the motor coils with a S. P. controller, may be so large relatively to the utilised energy, that any means of modifying the design to enable such loss to be reduced must be of value. To assist his argument, Prof. Carus-Wilson has introduced such terms as "induction factor" and "force factor."

The discussion was of a character which does not lend itself to useful summary; indeed, as several speakers remarked, the paper is one which requires careful and quiet study to do it justice, and we would apply the same statement to the discussion upon it. The speaker who opened the discussion drew attention to the idea of the controller introduced by Prof. H. S. Short, which is claimed to continue the acceleration more closely until the final speed has been reached. In his reply the writer may be said to have effectively combated the notion that Prof. Short has achieved any important advance in controlling by the aid of his apparatus. Down grades at the starting point were also referred to as straightening up the acceleration curve to a straight line.

Mr. Mordey had just returned from a short visit to the United States, and summarised his investigation of the present practice by saying that motors are now being made as large as can be worked with, the field being as strong as can be got, the tendency being to develop more and more powerful motors. The main principles seem to be much as they were years ago, the difference being in strength of field size and weight. Study and ingenuity is being largely exercised in improving controllers, although many are even now imperfect, notwithstanding all the experience on the other side. Mr. Mordey joined with several other speakers in expressing pleasure that this subject should have been brought up just now for consideration.

Prof. R. H. Smith thought that quick time service was the importance matter on electric railways. It seemed to him that the calculations in the paper were carried out on the basis of a constant train resistance. Resistance could be divided into internal and external, the former being approximately constant; but this remark does not apply to the latter. The paper seemed to regard the matter from one point of view, the possibility of covering a certain distance in a certain time. Prof. Carus-Wilson afterwards acknowledged that if the stoppages were infrequent, the ideas embodied in this paper became of less and less importance as the steady runs occupied more and more space, and the length traversed at constant speed increased relatively to that in which acceleration was allowed. Prof. Smith pointed out another view, how to get work done as quickly as possible with minimum stresses in the machinery, and certain cases could best be met by dividing the whole distance traversed into two sections, in one of which uniform acceleration, and in the other uniform retardation, reigns.

Prof. Ayrton followed Mr. Mordey in his appreciation of the service done by the writer in preparing this paper, based on experience in a country where data from actual examples on a large scale was available. He appreciated the importance of reckoning the size, &c., of motors, as is done in the United States by the draw-bar pull, which he thought was the proper way to make motors. Nevertheless, he regarded some points in the paper as blemishes: he did not, in the first place, fall in with the unnecessary use of new words. We have names which have caught on with the British public—power factor, form factor—because of the word "factor." There was the expression in the paper "induction factor," which represented the induced E.M.F. at one revolution per second: he did not particularly know the use of the term "force factor." Prof. Carus-Wilson gave his reason for using the former term as being useful when the motor was at rest; there was a certain "induction factor" to be considered, although there were no induced volts whatever—it was therefore perfectly definite and necessary. Prof. Ayrton thought that air resistance had been entirely ignored in the paper, although different velocities were considered. In the case of a railway train air resistance cannot be ignored, and will certainly not be constant. Again, the argument would be modified, if the object was not to cover a distance in a certain time ending at full speed, but from a state of rest to rest. It was interesting that, although series motors were universally used, and had been always recommended so as to start freely, that the writer had shown that they were not merely better from a speed point of view, but also from an economy point of view.

Mr. E. K. Scott referred to the connection of motors. On some lines they were always in series, on others always in parallel. The use of down grades at the starting points might modify the practice of series parallel control. He also mentioned that the curves would be affected by the use of roller bearings, and asked the writer for some information as to the modification of the curves in this case.

Another speaker took Prof. Carus-Wilson to task for his terms and notation, and wanted to know whether his formulæ were empirical or rational. He considered that all formulæ of this kind should have attached to them sufficient explanation. Then the paper seemed to be dotted all over with assumptions. It was desirable that it should be stated to what extent these were purely arbitrary, and he rather thought some of these must be wrong. One word he would say on the question of acceleration. Some people seem to think that the design of the motors was the first thing done on a railway scheme, whereas the engineer found that the number of people to be carried per hour—the load per mile in a given time—had been settled before the problem was put into his hands, and he had then to design his trains to run on a schedule already prepared.

The President felt that the paper could be utilised as a record of valuable experience, as we are now beginning the construction of electric railways. Prof. Carus-Wilson then replied. The more important of his remarks have been noted above. The meeting then adjourned, the general impression apparently being that those members who found time hang on their hands in the coming holiday season could effectively dispose of it by studying the paper read that evening.

THE EFFECT OF LIGHTNING UPON OVERHEAD POWER CIRCUITS AND THE CHEAPEST METHOD OF DISTRIBUTING POWER.

By ARTHUR H. GIBSON, A.I.E.E.

The growing importance of an effectual protection against lightning, and the admitted inefficiency of most arresters, induces the writer to record these observations, with the hope that they may be found useful to some of your readers.

It was a long while ago that the spark discharges from influence machines suggested the zig-zag appearance of the lightning flash to be the natural side view of a spiral discharge, inasmuch as sparks from the machine had a zig-zag appearance, whilst, when viewed endwise, appeared as rings.

It is noticed that in altitudes of 5,000 feet above sea level the lightning discharges rarely present this appearance so familiar at lower levels, but take the form of a more or less wavy line, often bifurcating in its downward course. This is possibly merely an elongated spiral due to the rarefied air.

In power and lighting circuits, drum armatures, especially smooth cores, are very liable, indeed, to damage by lightning; ring-wound armatures are less so, whilst hole, or slot-wound alternating current gear and transformers are rarely damaged, though some alternators with coils laid upon flat iron surfaces are frequently in trouble.

The following concerns a power transmission plant installed in South Africa by Messrs. Siemens & Halske, of Berlin.

The district is particularly infested by lightning, and the arresters used were invented by that firm.

The whole plant has run through the rainy season without any serious damage attributable to this source.

The generators were approximating to "hole-wound," pressure being 3,000 volts between lines.

An arrester was fixed upon each of the three-phase lines, generally on entering a building. The arrester itself resembles a much enlarged I. H. arrester, but has no magnetic arrangements whatever. It consists of copper wire bent to shape, and supported *in situ* upon porcelain insulators, the distance across the two outermost points at the top being about 2 feet; each earth sector was carried to a separate earth plate.

It is interesting here to remark that the ohmic R, between two earth plates, each 5 feet by 3 feet, buried near to one another, was found to be 20 ohms. The soil at times is remarkably dry.

The arresters worked well, but were unfortunately arranged rather too close together; the distance between arrester and arrester was only 13 inches, resulting in a strong tendency to arc from pole to pole, with consequent burning and cracking of the porcelain insulators.

The action of the arrester evidently depends upon the arc to E, being carried rapidly upwards by the natural action of the heated air. The rising arc, rapidly increasing in length (owing to the shape of the conductors), eventually breaks.

When a set of arresters work, the effect upon the generators is much like that of a partial short circuit, and the generators emit a peculiar note as the speed falls for a second, during which time the arc has broken, and the machine being well governed runs up to normal speed and all goes on as before.

In more severe cases the circuit fuses will go, and possibly some instruments may suffer as well.

The nature of the discharges to E vary much; sometimes one or two bright sparks like those from a Leyden jar will snap across to E on one pole, only without any arc.

When the spark gaps are adjusted as close as $\frac{1}{8}$ inch, the discharge is explosive in character, and the circuit fuses go more often than they would otherwise.

The discharge which takes place when no current is on the line does not appear to be materially different from the usual, except that it may be of less duration.

Ordinarily the lightning seems to start the arcs to E, which are vigorously maintained by the 3,000-volt current.

As the plant runs continuously, testing any line meant a stoppage of machinery somewhere, thus it came to pass that tests were not often made.

It was soon found, however, that when an E was formed on a H.T. line it was made known, first, by the telephone system becoming paralysed, and, secondly, the arresters on that particular circuit worked more frequently than they should do.

It is interesting to record that for about a fortnight, a few hours after sundown, on each day a particular arrester in the largest power station worked when there was no lightning to be seen. This one was fixed too close to the roof, and in spite of asbestos linings, a volume of vaporised copper and reddish flame accumulated round the top of the arrester, not being able to escape by rising, the flames or arcs seemed to absorb the whole power from both power stations robbing all the circuits for about a second, the flame spread in an alarming way, giving out considerable heat. This diurnal discharge was assumed to be due to accumulated static charge of lines.

The telephone circuits, which ran underneath the H.T., suffered to a much greater extent than the power circuits—discharges which hardly effect the latter damage the telephones considerably.

As a result of observations, it may be said that electrical lines cannot be struck anything like so often as arresters work, or as often as damage is done.

Those who have had the privilege of seeing a flash actually strike within 1,000 yards, will have a distinct recollection of the circumstances, and, by the way, the writer and others who have done so, noticed a snapping sound apparently quite close, and a fraction of a second before the crash.

When such discharges do take place, every dweller within 1,000 yards radius may be pardoned for imagining, momentarily, that his own house is the particular spot.

Such a discharge will cause arresters to work and blow fuses in a circuit nearly half a mile away.

The following hypothesis explains these phenomena. If a lightning discharge strike the earth in the vicinity of a highly insulated line, or any insulated area, the earth potential in the locality is suddenly changed sufficiently to cause a smaller discharge to pass into the line to equalise potentials. The lightning flash only restores potentials to normal. The sun is the real offender, and it is not necessary here to recount the process of evaporation, electrification, condensation, and consequent accumulation of static charge which goes on preparatory to the flash.

If this supposition is correct, then discharges in most cases pass from earth to line, instead of *vice versâ*; but the effect upon the apparatus is the same.

Here arises the question. Why should earthed lines suffer? such as tramways, telegraphs and telephones. Prof. Oliver Lodge has shown what the impedance of a turn or two of wire means in the case of such discharges as these, and thus the trolley wire or telegraph line becomes a condenser of considerable capacity, whose outer coating is the world in general and the air the dielectric, the only path being the motor coils or relay magnet, which have such a high impedance that the current makes a short cut, so to speak, through the insulations.

Arresters of many forms have been tried, but the one that can effectually protect a smooth core drum armature does not appear to exist. Taking a general view of the question to-day, the wisest course to adopt in distributing power, where lightning is troublesome, is to stow the drum armature away and adopt the inevitable at once, *i.e.*, polyphase machinery, with sunk windings or hole wound. Apart from the lightning question, in any power distributing system in England there is a strong tendency to hang on to continuous current and perfect the commutator (only a reformed reprobate at best), while our neighbours across the pond have thrown it out altogether, and have their shops filled with orders in consequence. No worthy reason can be advanced for this slowness.

So long as our engineers persist in connecting up the alternator coils for single-phase, and then spending golden days at the infernal task of making motors to suit, so long shall we be at the tail end of progress. The time and money might be better spent in fighting out the patent right, seeing that we are legally supposed to be fenced in and the neighbours raking in the harvest outside.

Electric lighting will soon form only a fractional part of electrical work. Tramways will make enormous headway, and when the possibilities of electrical traction become generally known, the busy railways must, and will, be operated electrically. To-day the cost of copper and transforming stations for a 500-volt collection would make the would-be promoter's hair stand on end, but necessity will provide a better system; and here lies the crux of the railway problem—one rather too large for consideration at present.

The railway can become a duct of power and light, and the owner of the cotton mill by the wayside will cast out the boiler and engine and put in some motors, "because it is cheaper."

These prophetic remarks some may disagree with, but calmly work out the possibilities of a power station at the pit's mouth, with modern automatic coal-handling gear, and half-a-dozen marine engines of about 5,000 H.P. each and a 30,000-volt transmission, it will then be clear that such is possible, and must be cheaper than conveying coal to the various points. In other words, it is cheaper to send the power along the wire.

When this is recognised, the sooner the problem is tackled the better, or Uncle Sam and others will be demonstrating, just as in the case of the tramway. In fact, Uncle Sam is at it already.

MECHANICAL DRAUGHT.

THOUGH, perhaps, open to the charge of special pleading, the publication by the Sturtevant Company of anything upon the subject of mechanical draught will command attention as representing the experience of makers of fans who have had a considerable experience in schemes of draught. Chimney draught, or so-called natural draught, is, *prima facie*, at fault, or it would not be found so often supplemented. For many years assisted draught was simply chimney draught helped on by other means, but now the chimney has come to be looked on in the light of an expensive superfluity. Artificial draught is made variously by steam induced air currents, by blowing engines and air compressors, and by fans, exhausters, and positive rotary blowers. The Sturtevant Company object to all except the centrifugal fan, which to-day is the accepted substitute for the chimney, and it may be applied in two ways, either to give a plenum by blowing air into a closed boiler room or a closed hearth pit, or by exhausting from the outlet end of the furnace, and merely a low chimney is required to deliver the gases at some height above floor line. Such was the system first, we believe, employed in England at the factory of Sir Henry Edwards, near Sowerby Bridge, in Yorkshire. Fans were placed at the back of each boiler which delivered air to a chimney only as high as the mill. The arrangement was said to have been due to a personal quarrel and litigation over a chimney, Sir Henry finally deciding he would have no chimney. With the closed ashpit system there is a tendency to blow flame out of the door, and obviously some chimney action is necessary to prevent this. Hence the use of double fronts in marine practice which serve to keep back the flame, and, of course, the air blast ought to be automatically stopped when the door is opened for stoking. By this system the air may be heated by means of the wasted gases, an arrangement not practicable with the closed stokehold system. The ss. *Dania* showed an economy of 13 per cent. per day and a shorter voyage by 5 per cent. when fitted with fans as below:—

Conditions.	Days run.	Knots speed.	Coal per day.
Natural draught	17·00	7·50	9·76
Forced draught	16·21	7·58	7·75

The closed stokehold system is usually impracticable on land, and chiefly useful for naval purposes when ordinary steaming can be performed on natural draught, and the forced draught is used for emergencies to maintain high power, during an engagement for example. In the induced system, which is the most easily applied because it involves no change of arrangement, the fan can simply be placed in the flue to the chimney. Its leakages are always inward. Mr. Blechynden is quoted to the effect that with ordinary good arrangements a fan draught enables the steaming power of a boiler to be increased safely by 30 to 40 per cent. for continuous work, and by 100 per cent. for short runs, and this may be secured with a smaller fuel consumption per H.P., probably because the better draught permits of thicker fires and reduces the excess of air. Inferior fuel may also be employed, and we have known considerable economies to be thus secured. Equally important is the elimination of all weather conditions which sometimes put a stop to work. Fans may be large or small, as necessary to location, speed being inversely as size, and they may be of cast-iron or sheet steel.

It is recommended that as far as possible the fan driving power should be independent of other sources of power. The fan should have its own independent engine direct connected where possible, as usually it is with large fans. Induced draught by fans seems to be almost a necessity with garbage destructors. Thus at the Shoreditch destructors 12 cells, each of 25 feet square feet of grate area, heating six water-tube boilers, are blown on the closed ashpit system by three motor-driven fans of a capacity of 8,000 cubic feet per minute. They deliver by underground duct to the ashpits at a pressure of 3 inches of water, and they draw their air from the sewers, and to some extent from the space above the cells, where otherwise the men engaged dumping the rubbish would find the heat unbearable.

With a chimney, a certain temperature of the waste gases is an absolute necessity. With a fan there is no heat required, and where a fan is employed it is only reasonable that the waste gases should be cooled much lower than they ought to be with a chimney draught. The problem for engineers who employ fan draught is to secure this reduced waste temperature. With a better draught and properly arranged thicker fires on perhaps shorter grates, the excess of air admitted to a furnace will be reduced, and the furnace temperature will be higher, so that even the same final temperature will represent a less proportion of the initial heat, or, in other words, the final temperatures with and without fan may be alike, yet with the fan the weight of escaping gas may be only two-thirds or three-fourths of what it was without the fan. This itself means a large saving but with lessened temperature as well the economy will be even greater. Waste temperature may be reduced by using the gases to heat an air trunk to carry air to a closed ashpit where such a system is possible, and there are many factories where steam is used for heating drying stoves that could as well be worked from the heat of the waste gases either passed directly through pipes, or perhaps better used to heat air to be blown into the drying room by an independent fan.

ELECTRICAL SHOP TRANSMISSION.

In a recent paper by Mr. Dimick, read before the Chicago Electrical Association, attention was chiefly confined to a description of a plain two-wire 220-volt system with motors belted to line shafting in the various departments. Other systems used to some extent in American practice are the 220-volt three-wire and the 500-volt direct and alternating systems.

The author refers to the use of separate motors to each machine requiring power, but while this may be the most economical as regards power, unless the motors are needed of at least 5 H.P., the first cost is prohibitive in most cases. For 5 H.P. motors, however, it may be employed, seeing that motors can be purchased at per horse-power.

The two cases which usually come under an engineer's attention are the changing of the belt or rope driving of an existing shop, and the equipment of an entirely new shop, which is, of course by far the easier problem. The first case is often complicated by the necessity of avoiding any stoppage of machinery during the change, and this demands a good deal of ingenuity and scheming. The great question to decide is how much power does each section require, what will be the minimum, maximum, and average loads, and what allowance is needed for future extension. Often mere assumptions must be made, and on this point we think much might be done with transmission dynamometers, instruments for which there ought to be a considerable demand. Assuming that the various powers have been decided upon, the author states what is the practice in modern power plants with regard to the size of generator to be employed. Units are to be as large as possible, with one in reserve, especially if the day be of 24 hours, and it will usually be practical to have a small unit of 50 or 100 kw. for periods of small load and for overtime.

Besides the usual switchboard outfit there should be a recording ammeter or wattmeter in series with the bus bars, and a recording voltmeter. Distributing switches should be of ample capacity to provide for futures. An ammeter on each circuit is desirable, as it will save many future tests. There should be provision for ground test through the voltmeter. Cables from the generator to the board of not over 800,000 circular mils cross-section are easy and convenient for use. They can be doubled, trebled, or quadrupled, if needful, in parallel, and are cheaper to put up, and use less copper than larger cables. They should be lead covered between the board and generator.

The most expensive, and by far the best system of feeders to distribution circuits, are the lead covered cable in iron pipe, or in iron armoured conduit. The objection is the difficulty of tapping a circuit, but the cables are safe from injury, and from sagging and loops.

The terminals should be sealed or soldered into the fixtures. With lead-covered cables, a large sleeve is wiped onto the end of the cable and filled with a compound that will not run out if the end is pointed downwards.

For sub-division there is needed a switch and a plug fuse for each motor circuit on each floor at the junction with the main riser or feeder. The switches may be dispensed with—they are costly—but the fuses should remain. Fig. 1 shows the arrangement of boards on the floors, while fig. 2 shows a branch block to be used on the ends of sub-feeders from the boards where more than one motor was required.

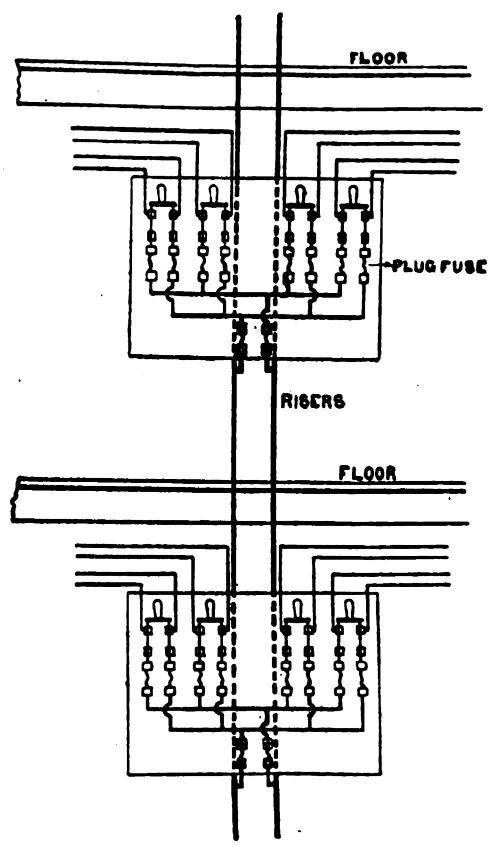


FIG. 1.

It ought to have a plug switch or fuse, and a fireproof cover.

The motor-starting apparatus ought to be alike all over the system. The switchboards should be of slate and uniform in size, and should carry a switch, a fuse, a starting box or rheostat, pilot lamps and ammeter, which is worth its cost, even if not absolutely necessary, for it shows when the motor is overloaded. The chief item is the rheostat.

There are two good rules. "Put in a motor big enough to do the work without over strain;" "use a good automatic starting rheostat;" on these two depend the success of

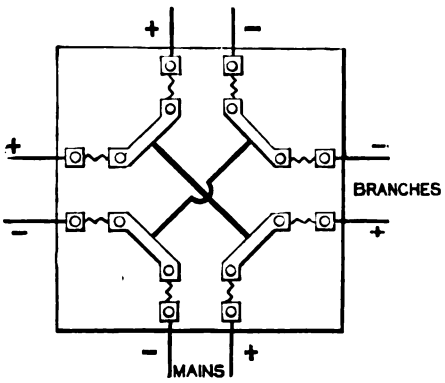


Fig. 2.

a motor transmission; say there are 100 or 150 motors in operation, and as many starting boxes, all the rheostats must return to the starting point of the circuit breakers open at the generator.

An automatic rheostat means, properly, one that will open the armature circuit as soon as current ceases to flow, and make it impossible to start again until all the resistance is in the circuit. Lately, overloads have been included also. A good rheostat ought to be thoroughly fireproof; the resistance steps should be proportioned to avoid injurious sparking at the switching segments or allow too great a difference of current to flow before the armature is up to speed; the segments should be large and massive; the contact arm easy to work, and the contact piece itself ought to be the point of wear and tear, easily removable and cheap. The segments and moving contacts must be kept clean and free from burned spots.

The automatic part is usually a magnet to hold the contact lever in position when the resistance is all out, and when the circuit opens from any cause the lever is thrown back to starting position by a spring, or by gravity.

Another magnet, or the same one, performs the same operation for an overload. These magnets are in series with the field, in series with the armature, or across the feeder terminals. The common troubles are the failure to act when it should, or it acts when it should not, and the burning of the segments or contact. Minor troubles are the burning out of the resistance coils or magnet spools, spring breakages, screws loose, contacts overheated, &c. There is a field for the rheostat that will perform its duty as above, and be free of half the troubles named.

Motors for steady work should have a 10 per cent. margin. Motors for a heavy load of a few hours, and a light load for the balance of time may be 15 per cent. over size. Motors rapidly changing from no load to full load, or reversed often and quickly, must be 20 to 25 per cent. larger; large liberal allowances will soon pay for themselves in repairs, especially in commutators and the waiting for new ones to be put in. Then there is always room for more machines in every large factory, and they ought to be provided for in a margin.

When completed, tests should be made to show where improvement is possible. Every machine can be tested as regards the power it consumes, and on this point we think engineers generally might tabulate any useful data by giving the power absorption of all machines they can indicate. Such information is very much needed. There is very little real knowledge of power absorption outside the textile mills, and there only with the addition of shafting, so many spindles going to a horse-power. Engineers' machinery, grindstones, grinding mills, cement grinders, and all manner of machinery in general trades are run very much on guess work. This is not as it should be.

No one seems to really know how much power it requires to run even a railway carriage, or, if known, those who know stick to the information.

CORRESPONDENCE.

Re Nash's Patent.

In your issue of May 27th you give a notice of the decision of the Comptroller *re* the Electrolytic Company's opposition to the grant of Nash's patent. As the terms in which the notice was made would convey the idea that the opponents had succeeded against us, we send you a copy of the Comptroller's decision, and copy of Nash's specification will be sent by our agents, Messrs. G. F. Redfern & Co., from these you will see that the decision is entirely in favour of Nash's patent. The word ordered to be struck out, and the disclaiming clause, do not interfere in any way with the construction of the apparatus.

So far from being a copy of any other patent, it has distinct advantages on any other apparatus for this purpose. The deposit is very ductile—a result which has not hitherto been obtainable. A substantial deposit is made in one-third the time in that taken by the opponents; it is much more convenient to use, the container being lifted from the vat without the use of ropes and pulleys, and, by using a duplicate container, the apparatus can be kept continually at work. By the use of specially made insulating material in the construction of the container we avoid the deposit of metal upon the apparatus, this being a decided advantage over the opponents.

To sum up the advantages of this apparatus we would claim:—a better deposit, convenience in use, and economy in time and material.

Kindly give this notice of correction in your next issue.

W. Canning & Co.

Lumford Mills, Bakewell.

Doubtless your paragraph with reference to our firm having purchased the above mill was inspired from some local paper. The facts are as follows:—We obtained an option of purchase of the mills, which we afterwards transferred to the D.P. Battery Company, who are now the owners of the mill. As there is 150 H.P. laid on from two large water-wheels, besides 150 H.P. from a "Marshall" condensing engine, we have little doubt that the company will shortly be producing accumulators at a price which has hitherto been considered impossible for first-class work.

Drake & Gorham.

ELECTRIC ELEVATOR INSTALLATION.

Americans shout so much over their performances which, when different from European practice by reason of climatic and other environment, they claim as evidence of superiority, that it is a marvel they have so little to say in respect of their systems of elevators, for in this branch of engineering they are really and without contradiction far ahead of Europe. Should an American ever enter the mouse ladder as it is found at, say, the Mansion House Chambers, he would become hopelessly insane before he reached the fourth floor. In America tall buildings and rapid elevators have acted and re-acted upon each other, until the one has grown out of all reason and the other has become a very perfect piece of machinery. Stairways in an American office building are there, but are hardly used. Some idea of the business in elevators may be gathered from the *Engineering Magazine*, wherein Mr. P. R. Moses states there are more than 6,000 in the city of New York alone, and these make over 500,000 trips per day, and carry more passengers than the tramways or the elevated railroads combined. Our author considers that the new electric underground railways of London will concentrate business in London in the same way as it has done in New York, and lead to 12-floor buildings in spite of the building law. While we do not think the author can have appreciated the different conditions of London and New York, and the fact that the concentration of New York business is not likely to be paralleled in London, we do entirely agree that there is room for an entire change in the London system. In London, office buildings are much too small, and their arrangement is of the worst. The building we have referred to is an example of thorough badness; it is also an example of one large enough if properly arranged to afford at lease three rapid elevators. London office buildings are badly worked, in fact, there is no working at all about them. An ideal office building is warmed and lighted, fitted with a centrally-controlled clock, and supplied with at least one elevator for each 75 rooms, under charge of an attendant who is there when wanted. Compare this with Leadenhall House, with its slow service and minutes of waiting, and it is easy to see why upper floors in London bring such small rents, while in New York they bring in practically as much as the lower floors. The future elevator will be electrically operated. Elevators are machines demanding severe mechanical conditions to be fulfilled. They attain a speed of 600 feet a minute in about five quarter seconds without a jerk, and they decelerate equally quickly. They must be safe. They have the enormous advantage that they always have a clear road, and can be fully open for inspection. Passenger elevators of high speed vary from 300 to 700 feet per minute. Below 150 feet is considered low speed. Freight elevators do not exceed 300 feet. Three types of electric elevators have been perfected. One is the device of a screw and multiple sheaves, the screw taking the place of the ram of the hydraulic Otis lift, and the cage hanging upon the single fall end of the rope, which is wound round the multiple sheaves.

The second type embodies the double worm gear drum, and the third type is that of the single worm gear drum, the second variety having the advantage over the third in the well-known balance effects of the double worms. Each of the worm gear types has the motor on the worm-shaft, the worm operating a large worm-wheel on the cage rope drum. Motion is arrested by removal of power, and by brake on the motor-shaft, or by closing the motor circuit through a resistance, and causing work to be done by the car through the motor. The screw type, which was contrived to imitate the Otis type, raises the cage by power, and lowers it by gravity. Ball-bearing nuts are used on the screw, and the multiple sheaves multiply the nut travel about 10 times. In a 200-foot building the nut must, therefore, travel 20 feet on the screw. The conditions to be filled are very various, and depend on the kind of work and the space available. A small available space may be utilised by high speed machines and skilled attendants. Apartment houses, with women and children, obviously require different treatment from a busy office building. In small buildings the power to be used becomes a question, if available from some public station.

Again, the heating system of a building affects the type of engine to be employed. Safety is the primary requisite. Hence there must be safeguards against dropping, should ropes fail; against excessive speed; against all sorts of conditions of overload, and for automatic arrest of motion at the limits of travel. All parts of vital importance, as the sheaves, ropes, lines, &c., must be of far excessive strength, which costs little.

One system of control allows of speed being varied by the attendant in the car; the second does not, except for starting or stopping. The first method is secured in two ways: by a pilot motor operating to vary the resistance on the main circuit, as in the Sprague system, with an inverse variation in the motor field strength; the second, by the Leonard or variable voltage control, where each motor has a separate generator, and the car speed varies in accordance with the electric pressure in the generator, this being determined by a resistance in series with the small field current, and is adjusted from the car. The Leonard system is employed only on worm gear machines, and could not be operated on the screw machines. The system of varying voltage is an ideal one for start and stop, either from the economy or comfort standpoint. On the other hand, from the point of total economy, the rheostat control is advisable, because of the continuous operation, and the first cost of a separate generator for each machine. The proportion of time during which the car is moving rarely exceeds five-eighths, and generally falls below one-half the total nominal hours of work. Each generator must be sufficient for starting loads, and therefore runs at a low efficiency. Data of 17 elevators picked at random from 100 tests show speeds of 60 to 450 feet per minute; maximum capacity 1,500 to 3,000 lbs. live loads from a minimum of 150 to a maximum of 1,600 with an average of 593. In a tall office building the average load was under a seventh of the maximum, and even where elevators were worked to their fullest capacity the average load did not exceed a fifth of the maximum.

Applied to worm-gear machines, the system of variable voltage is shown to be less economical and simple than the rheostat control, but is superior in smooth starting and operation. In low speed buildings, where variable speed is not essential, a solenoid control answers well; it may be operated by electricty from the car, or the shipper rope and wheel may be used to close switches, and operate a brake.

House elevators have automatic control, and include push buttons on each floor, to bring the car to the landing; automatic locks to hold the doors till the car is there; door switches to prevent movement while the door is open, and a means to prevent the car being called by more than one person at a time. Spring and trigger actions are to be avoided, and positive action substituted. An important branch of control is the car stopping which has to operate under such various conditions of load and speed, and where loads are heavy, the car ought to perform work, and a device for this is necessary to easy operation. For high-speed machines the car must likewise do some work on the brake band, as well as electrically by short circuiting.

The use of brakes with worm gear depends upon the variety of worm. Low pitched threads, of course, will not start under car pressure, but coarse pitches will reverse, and a brake must hold the car or it will run the worm. With fine pitches the brake becomes simply an emergency stop. The flat pitch worm is less economical, but has the added element of safety. The question of counterweight is important, and theory shows that a minimum of inertia must be sought. The car should in practice have a fourth to a half more downward force than the balance weight. On drum machines there may be two weights, one on the car of two-thirds its weight unloaded, the other on the drum equal to the unbalanced weight of car and to the average load. In high buildings a variable counterweight attached to the balance and to the car to balance the rope variation may be used in the form of a chain hung to both car and balance.

In high speed service a car must never be over-balanced, the excess counterweight system is at fault and should be abolished, for in case of accident, the ropes are sure to break when the car is at the top and drop the car, if safety appliances fail. Counterweights may be arranged to move at half or a third the car speed. This reduces inertia, and reduces the cost of the weight guides and ropes. A useful speed is that which in any building will make the round trip without a stop in half a minute. This is a good rough approximation, and may be modified to suit exigencies. Special elevators for upper floors only are a doubtful success. Call pushes at the various floors and car position indicators help the service speed. In high buildings the large inertia, due to high speed, must be met by strong cables, fixed limits of travel, and underbalanced cars, with slow moving counterweights, conditions only filled by hydraulic or screw electric machines, and not at all suitable for gear drum machines, which cannot accomodate triple ropes on the drum.

With the screw and ball nut there are multiple sheaves on the nut, the rope from the last sheave going to the bottom of the counterweight and to the top sheave of the weight, other ropes pass to an anchorage at the building top, and to the overhead sheaves of the car. An interval of one second, with the screw making 250 turns per minute, would carry the car 8 feet 4 inches, with a 20 to 1 multiplication. Any higher speed must be by increasing the speed of screw. Worm gear drum elevators are all right below 350 feet velocity per car. They are accorded little cars in residences, apartment houses, or sidewalk hoists, and must be self-oiling, have self-cleaning switches, enclosed motors and parts, and arc arresters. All types of elevator require strength, sparkless commutation, ventilated armatures, carefully secured lugs and winding, no sharp corners, fields variable and balanced, and they ought not to be highly speeded. Hoistways should be skylighted, fireproof, and with screen below overhead machinery. There must be a space above and below as a safeguard against slip or stretch of ropes.

With worm-gear elevators in numbers, descending cars help to raise those rising, and economy results.

Elevators are more cheaply worked by electricity than by any other means. The power per car-load in office buildings varies from 2 kw. hours, with overbalanced worm gear, to 4 kw. hours with unbalanced screw. Central station costs, of 10 cents per H.P. hour for small, to 10 cents per kw. hour for large consumers, are \$3 to \$10 for residences, \$10 to \$20 for apartment houses, \$15 to \$40 for loft and small office buildings, and \$40 to \$60 for tall office buildings, per month. To the question of safety, the answer is that no person has been killed outside their own fault. No electric elevator has fallen, and they run in most unsuitable places for machinery.

Surely, in London, where there is such an outcry for the day load, something might be done to get electrical elevators to work, even in such buildings as do exist. But we wonder continually that our architects have absolutely no ideas as to the conveniences and uses of buildings. Their one idea is to present something that will look well from the street—we don't say they even do this; but they certainly are destitute of all internal ideas, and in this respect they ought to study America. One need not go up 12 floors or even eight. A properly designed six-floor building would provide double the convenience of an existing London office building. Why has London not absorbed the desk room idea. In New York a man hires simply desk room in a large building as big as a bank. He has room for his desk, a safe, and has the use of all conveniencies and a good address for money that would only rent a poor room out of sight in a dirty corridor up a back flight of London stairs. We have much to acquire from Americans in this respect, and the elevator is what is wanted to secure this end. Once get a large number of elevators in London, and the rebuilding or internal remodelling would be bound to follow.

THE CHELMSFORD SHOCK FATALITY.

At the inquest held at Chelmsford on 23rd ult. into the death of Edward Fell, of the Chelmsford Electric Lighting Company evidence was given to the effect that deceased had been in the employ of the company since they first undertook public lighting eight or nine years ago.

Ernest Garrard, an articled electrician at the arc works, said that on the morning of the 21st ult. about a quarter past ten, he was with the deceased in Conduit Street. He was going to switch off a transformer, and witness assisted him to remove a lid from a surface box. They took the lid off, and deceased got down into the pit.

The Coroner: When the lid was on, the current would be running?—Witness: Yes, unless it was switched off at the works.

Is it possible to switch off the current in the pit?—No; only the secondaries.

Did you receive any instruction that morning at the works as to where you were to work?—No.

Did deceased tell you that the current was running, as he had not switched it off?—No; we knew it was charged.

Where would he switch it off?—In the engine room, on the switchboard.

When you go to these boxes, whose duty is it to switch off the current?—The switchboard man, but if he is not present the man who is going on the circuit would switch it off, place a ticket on the board with the words "on circuit" upon it, and then sign his name in a book.

What happened when he got into the pit?—He switched off the transformer. This means that he cut off the current between the transformer and the private houses, but that the current between the transformer and the works was still running.

Was there anything to show that there was current running between the transformer and the works?—No; but the transformer was humming, and he knew it was on.

Had he said anything about turning it off before leaving the works?—It was not necessary, as we were only going to take off the secondary wires; and, for that purpose, the switching off of the transformer has the same effect as if the current is switched off at the works. I do not think that he thought anything about the switching off until he got to the pit.

Was he in the act of switching off the transformer when this happened?—He had already switched off, and, as far as I could see, was coming out of the pit when his right hand accidentally touched the wire. He did not catch hold of the wire, but simply touched it.

And he was accidentally killed?—Yes.

The wire was charged to the extent of 2,000 volts?—Yes.

Is it usual for men to work in these pits when the current is running through them?—If a man goes to work in a pit, he knows which circuit he is going on, and he switches the current off at the works before going into the pit.

Did you hear deceased give anyone instructions to have the current switched off that morning?—No.

Has he worked in the pit before with the current running?—Yes.

Is it a rule to work in them when the current is on?—It is a rule that the men should not go into a pit when the current is on. They have no right to touch the "leads" at all.

The man had no right to work in this pit with the current on?—Certainly not.

Replying to further questions, Witness said the men who worked in the pits were supplied with rubber gloves and boots, and also with a written notice stating "No one is allowed to touch wires carrying high-pressure currents, except in cases of emergency, and then only when wearing rubber gloves." Deceased was not wearing gloves on Saturday.

Do you know why?—Because he had no intention of going on the high tension circuit.

How large are these pits?—Some are very large, but this one is very small. It was never intended to be a transformer pit, but he put a transformer into it.

A Juror: Are the wires protected in any way?—Witness: They are insulated.

How was it that when he put his thumb upon it this insulation did not act?—Simply because the current inside was at such high pressure, and I think the cable was damaged by the wet. He had no gloves on. There you are!

Do you think that if he had had gloves on this would have happened?—I do not think so.

A Juror: If he had touched his leg against the wire do you think the effect would have been the same?—Witness: I think so.

A Juror: Are these wires supposed to be safe if you touch them?—Witness: Oh, yes; the contractor guarantees them to be, but we won't take the risk.

Was it damp when he touched it?—Yes, it was wet, and the ground was damp. This had a great effect upon it.

Mr. Duffield (representing Messrs. Crompton): Is it necessary for a man to get into a pit at all?—Witness: Not in this case; but I think this is the only one of its kind.

Mr. Gray (representing the widow of the deceased): If a man is not going to touch the high pressure wires he will not wear gloves?—Witness: No.

Are there any printed regulations dealing with these secondary wires?—No; they are not necessary.

Then he did nothing out of the usual that morning, apart from the accident of touching the wire?—Nothing out of the ordinary.

Was this transformer a temporary arrangement?—No; but the big pit near the Oak is being constructed to abolish all these wretched little pits.

The present little pit with a transformer is not considered satisfactory?—No, I do not think so.

The Coroner: In your opinion it is not satisfactory?—I am not a judge; but if a man is to be killed as easily as that, I should say it is not satisfactory.

In reply to further questions by Mr. Gray, Witness stated that on Saturday morning deceased received instructions from Mr. Entwistle to remove the hoarding which had been erected over the pit at the Royal Oak corner.

Mr. Duffield: The removal of that hoarding had nothing to do with this accident?—Witness: Yes, it had, because in order to remove two lamps on the hoarding the transformer had to be switched off.

A Juror: Did Fell know that the wet was so great that it would make the wires dangerous?—Oh, yes.

Yet he went into the pit?—Yes.

Do you consider it was his own neglect that brought him to his death?—Yes.

A Juror: Has Fell ever been suspended for a week for not wearing gloves?—Witness: Not to my knowledge.

Not after his last accident?—Not to my knowledge.

In reply to another juror, Witness added: If the pit had been larger I could have got down and knocked him off the wire, but it would have been of no use. I ran over for James Brown, and we lifted him out.

Mr. Gray: What reason have you for saying that his death was caused by his own neglect?—That is a very hard question to answer.

You have told us that he did nothing out of the usual way, and that the touching was an accident. Where was the neglect?—Going into a pit in which there were high tension wires without gloves.

But you told me that it is not usual to wear gloves when a man is only going to touch secondary wires?—That is so.

Then it is not true to say that there was any neglect?—No.

These wires being guaranteed insulated, you would not expect a shock?—No.

A Juror: I have seen the man down this pit several times. It is so small that I do not think he could take a knife out of his pocket without touching the side with his elbow.

The Coroner at this point announced that he should not conclude the inquest that day, and that, after hearing the doctor's evidence, he should adjourn in order to give the Board of Trade an opportunity of being present.

Dr. Bodkin stated that when called to the deceased he was quite dead. Witness examined him and found an injury to his right hand. The thumb, together with a portion of the joint, had been what he might describe as blown away—burned off. There was a tracing up the arm where the electricity had apparently gone, the skin being taken off just as one would peel an onion. Death was due to shock, and had been, he believed, instantaneous.

The Coroner: Did the shock go to his brain?—Witness: No; I think it went through his body to the earth, and so interfered with the heart's action.

The inquiry was adjourned till Thursday, 26th ult.

When the inquiry was resumed the Coroner said: Since our last meeting, I have communicated with the Home Office with regard to this matter, and their inspector was down here just now, but he considers that it is not a matter that comes within his department. I understand that Major Cardew has been down and made investigations for the Board of Trade. Therefore, if he considers it a case which he ought to advise the Board of Trade to afterwards take up, he may do so; but we shall have no one here from the Board this afternoon.

William Entwistle, engineer to the Chelmsford Electric Lighting Company, said that he superintended the running at the lighting station. On the Friday evening he gave deceased instructions to remove the hoarding around the work which had been going on near the Royal Oak Inn. Witness knew that there was a wire on the hoarding which it would be necessary to remove, because he ordered it to be put on. Deceased placed it there himself a fortnight before.

The Coroner: Was it necessary to switch off the transformer in order to remove the wire from the hoarding?—Witness: It was not necessary; and Fell switched it off for his own convenience.

Then it was not absolutely necessary to switch it off?—Not necessary at all. Could the wire be removed with perfect safety without being switched off?—Yes, with perfect safety.

Was there any necessity at all for the deceased to get into this pit on this particular occasion?—There was no occasion for him to get into the pit to switch off the transformer. I do not know whether he had any other reason for getting into it.

Could he have carried out his work quite as well without doing so?—Yes.

Can you tell us the size of this pit? Is it an ordinary-sized pit?—It is one of our smaller pits, and the approximate dimensions are 2 feet 6 inches × 2 feet.

A Juror: Inside the pit is only 21 inches × 26 inches.

The Coroner: Have you ever had occasion to speak to the deceased for doing any work without wearing gloves?—Witness: I have never had occasion to do so.

Have you ever warned him?—I have admonished him. I do not mean that I have ever caught him handling wires without gloves, but I have warned him against touching them.

Are these wires supposed to be safe?—If the wires are in a thoroughly sound condition, they should be quite safe when charged, even if touched without rubber gloves.

Is dampness likely to make them dangerous?—When the rubber insulation is sound it should not make them less safe.

Are you of opinion that this small pit was safe to work in?—It was not safe for any man to work in. I should forbid any man on the job, barring Fell, to get into the pit.

Owing to the smallness of it?—Yes.

I presume you mean by that that Fell was the most experienced man you had?—Yes. As foreman it was his place to forbid anyone to get into this pit without his permission.

You are of opinion that he was aware of the danger he was running in going into it?—I am certain he was.

Can you form any opinion as to what possessed the deceased to get into the pit?—The only reason I can think of was to have a look round the pit and inspect it, to see whether it was wet. It was usual for him to inspect the pits after wet days to see if there was any water in them. To do this it was not absolutely necessary that he should get into the pit, but he could inspect them better by getting into it.

Replying to Mr. Gray, Witness stated that it was not usual to switch off the current merely for inspections, but such inspections would not include the handling of wires.

Mr. Gray: Then the getting into this pit was the correct thing to do?—Witness: As an intelligent workman he should have thought it was not the correct thing to do, and if I had been there I should have warned him against it.

Have you not been in this pit dozens of times?—Yes.

When the current was on?—Sometimes.

Therefore you would not think it a foolhardy thing to do?—No, but an unwise thing.

Yet you have done it dozens of times?—Yes.

There is plenty of room to get into the pit without touching the wires?—Yes, if they are properly adjusted. Fell had put in some new cables about a week previous, and left them in such a manner as to be almost dangerous.

Replying to Mr. Duffield, Witness stated that he had known Fell for some time, but he did not think he was a careless man; he was a very fearless man. He had been a sailor, and was in the habit of doing things on the poles which witness would not attempt.

Witness, continuing, stated that deceased had an accident about four years ago, and after that he was more careful for a time. It was improper for deceased to touch the high tension wires without gloves, and witness did not think that he did so deliberately on the morning of the accident. It might have been done under some sudden impulse.

Mr. Duffield: Was the getting into that pit dangerous?—Witness: I consider it was, in the condition it was in that morning.

Was Fell in a position to know that?—He did know it: I am sure of that.

A Juror: Would the damp make the electricity pass through the covering of the wires?—Witness: Damp will not affect the covering if the rubber insulation is sound.

Do you think he touched a bare wire?—He touched a piece of wire which was imperfectly insulated. The insulation of it had been weakened by water.

A Juror: Had the deceased made some temporary joints?—Witness: Yes, and they were defective.

And it was by touching one of these joints which he had himself made that he met with his death?—Yes.

The Coroner: Do you think that the joints were unsatisfactory?—Witness: Yes.

James Brown, a labourer, in the employ of the company, said: I had been working in the new pit near the Oak Inn with the deceased and a man named "Sonny." The deceased went across to the new pit. Shortly afterwards Garrard ran to me, and said, "Where is Sonny? Teddy has got a shock." I went across at once, and saw the deceased lying at the bottom of the pit with his thumb touching one of the leads. Sparks several inches long were running off his thumb. I knocked his hand off the wire, and pulled hold of his coat and lifted him out as soon as I could.

Mr. Bennell: Had Fell had a shock the day before?—Witness: I have heard that he had one the day before, on the Baddow Road.

The witness Garrard was re-called. He said that when the deceased received the shock he had hold of some leads in one hand, and in some way the other hand came into contact with the high tension lead. Whether this was done accidentally he could not say. He could not understand how Brown could have knocked deceased's hand off the wire, and thought that what Brown saw was the installation on fire.

Mr. A. H. Pott, the chief engineer of the company, said deceased was an excellent workman, but was very careless in his work, and witness had had to caution him lots of times. He had not, however, caught him doing anything absolutely dangerous for some years. On one occasion he saw him handling wires with gloves that were so wet that sparks were crackling down the back of his hand, and on another occasion his hat touched a wire, and sparks crackled all down his back. Deceased merely said that he felt queer, and witness told him to get away from the wire. The pit in which deceased was killed was one of the first two erected in the town, and was passed by Major Cardew before it was used.

Replying to Mr. Gray, Witness stated that he was surprised to hear that Fell had been in the pit, even to inspect it, when the current was on. He did not know that Mr. Entwistle had also been in it; to get into it when it was wet was a very foolhardy thing to do.

The jury, having consulted in private, returned a verdict of accidental death.

Mr. Duffield said the company were exceedingly sorry that this accident had happened. The deceased had been an excellent servant, and the company had trusted him, perhaps, more than they had trusted any other man in their employ.

The Coroner said that, from what he had heard, Fell must have been an excellent servant, although he might have been a little too venturesome.

BUSINESS NOTICES, &c.

The Care of Steam Boilers.—Messrs. R. Hargreaves and Sons, 4, Richmond Terrace, Blackburn, are sole agents for Waddicar's improved patent for preventing formation of scale in steam boilers, and removing dirty waters and sediment. It may be fitted to any part of the boiler considered most convenient. It is connected to the outside of the boiler by a pipe, which allows dirty water to be drawn from the bottom of the boiler at any time when working. The apparatus is constructed to allow of a rotary motion, which prevents the sediment adhering to the bottom of boiler, so that by the regular use of this apparatus the formation of scale is entirely prevented, thereby maintaining the evaporative power and efficiency of the boiler. The apparatus has to be opened three times a day, and one inch of water drawn off each time.

Electrical Wares Exported.

Week Ending May 31st, 1897.

	£	s.
Albany	47	0
Alexandria. Teleph. mat.	118	0
Amsterdam	60	0
Bangkok	24	0
Berbia	35	0
Bombay	441	0
Boston	24	0
Bundaberg	8	0
Buenos Ayres	522	0
" Teleg. mat.	223	0
Calcutta...	250	0
Cape Town	3,528	0
Colombo...	418	0
Copenhagen	110	0
Demarara	20	0
Durban	593	0
East London	537	0
Flushing	11	0
Fremantle	16	0
Gothenburg	19	0
Hiogo	26	0
Hong Kong	12	0
La Plata	38	0
Malaga	23	0
Malta. Teleg. mat. ...	38	0
Melbourne	207	0
" Teleg. mat.	387	0
Passages...	260	0
Penang. Teleg. mat. ...	65	0
Port Elizabeth... ...	2,564	0
Rosario	200	0
" Teleg. mat. ...	62	0
Rotterdam	12	0
" Teleg. mat.	31	0
Rouen	40	0
St. Petersburg	300	0
Singapore	28	0
Stockholm. Teleg. mat.	1,103	0
Sydney	341	0
Teneriffe. Teleg. mat.	290	0
Trieste. Teleg. mat. ...	220	0
Trinidad	60	0
Yokohama	56	0
Total ...	£13,337	0

Week Ending May 31st, 1898.

	£	s.
Antwerp	36	0
Brisbane. Elec. fuses...	50	0
Buenos Ayres	24	0
Calcutta...	70	0
Cape Town	193	0
Christiana	33	0
Colombo	311	0
Durban	211	0
East London	400	0
Fremantle. Elec. fuses	50	0
Geraldton	99	0
Gothenburg	59	0
Hamburg	20	0
Havre	15	0
Madras	15	0
Melbourne	65	0
Port Elizabeth	227	0
Rangoon	44	0
Rouen	230	0
St. Petersburg	42	0
Shanghai	266	0
Singapore	1,292	0
Sydney	85	0
Trinidad	21	0
Wellington	117	0
Yokohama	30	0
Total ...	£4,010	0

Foreign Goods Transhipped.

	£	d.
Bangkok	1,550	0
Leghorn. Electric meters	43	0
Total ...	£1,593	0

	£	s.
Shanghai. Teleph. mat.	6	0
Trinidad. Teleph. mat.	56	0
Total	£62	0

Change of Address.—Mr. R. F. Yorke has removed from 51, West Regent Street to 48, West George Street, Glasgow.

Electric Pumping Plant.—The Better Bed Coal Company, owners of the Fell Greave Colliery, Huddersfield, have for some time experienced delays and difficulties in working the coal owing to the flooding of the mine. To overcome these difficulties the company have ordered an electric motor and pump to be fixed in the workings. The dynamo is compound wound, capable of giving 230 volts and 18 amperes at 1,050 revolutions per minute. It is driven by the hauling engine at bank, and is connected to motor and pump by a pair of 7/18 vulcanised cables at a distance of 400 yards, the motor being geared down from 1,050 revolutions to 60 revolutions by belt and pinion wheels. The motor is of the enclosed type, the lubricators being of the ring pattern. Dynamo and motor have been made by Messrs. Rosling & Appleby, of Bradford. The pump is of the double action type, and has been made by Messrs. G. Kendal and Co., Huddersfield. It is capable of delivering over 1,200 gallons per hour. The work has been carried out under the superintendence of Mr. J. Makin, electrical engineer. The plant has been working for three weeks, and has given entire satisfaction, having overcome serious drawbacks.

Electric Cranes.—It is stated that it is proposed to erect powerful steam or electric cranes at Calais and Dover for the transfer of mails and baggage.

Fined.—The Tudor Accumulator Company, Limited, were fined £3 at Dukinfield Police Court, for a breach of the special rules of the Factory Acts by not providing a bath for the use of their workpeople engaged in dangerous occupations. It was stated by the Government inspector that over a dozen cases of lead-poisoning had occurred among the workpeople.

Harrison, Coles & Co.—Notice has been given that the electric lighting business lately carried on by Harrison, Coles & Co., at Richmond, S.W., will in future be carried on by the Thames Valley Electrical Engineering Company.

Liquidation Notices.—Last Friday's *London Gazette* contains notice to the effect that at a meeting of the Fowler-Waring Cables Company, Limited, held on May 25th at 110, Fenchurch Street, E.C., it was resolved to wind up voluntarily. Mr. Geo. Fleming, of 9, Billiter Street, E.C., and Mr. J. A. Blackwood, of 110, Fenchurch Street, E.C., were appointed liquidators. It will, of course, be remembered that this concern was recently taken over by the Western Electric Company.

A meeting of the Wigston Electrical and Engineering Company, Limited, is to be held at 24, Friar Street, Leicester, on Friday, July 1st, at 3 o'clock, to hear an account of the winding up from the liquidator.

A meeting of the Gas and Oil Engine and Dynamo Company will be held at 1, Queen Street, Cheapside, E.C., on Tuesday, June 28th, at 4 o'clock, to hear an account of the winding up from Mr. Edward Lintott, the liquidator.

At meetings of the Cowper-Coles Zinc Extraction Syndicate, held at the offices, Mellanear, Hayle, Cornwall, on May 5th and 21st, resolutions were passed to the effect that it is desirable to reconstruct the company, and for that purpose that the company wind up voluntary, Mr. T. S. Lowry, of Camborne, being appointed liquidator.

Lists.—Messrs. Washington & Co., of Sowerby Bridge, Yorks, send us an illustrated price list of continuous current electric m tors.

Messrs. Strasser & Rohde, Glashütte in Saxony, have issued a list, showing various micrometers of conveni nt sizes.

Lloyd & Lloyd v. D. & W. Henderson.—On 24th ult. Sheriff Strachan delivered his judgment in this case at Glasgow. The action it will be remembered was taken at the instance of Messrs. Lloyd & Lloyd, of Coombswood, Birmingham, the holders in the United Kingdom of the letters patent of the Benardos system of electric welding, against David and William Henderson & Company, shipbuilders and engineers, Glasgow, to recover the yearly royalties for 1895, 1896, and 1897. The Sheriff assoilzies the defenders from the conclusions of the action, and in the note to the interlocutor his Lordship remarks that the indenture and agreement bear that full license and authority was granted to defenders to use the inventions, and in consideration of the license defenders bound themselves to pay on January 1st, 1893, £200, and on each succeeding January 1st, £200. They paid pursuers in 1893 £200 and in 1894. On December 18th, 1894, they intimated that they were not to use the patented processes any longer. Pursuers insisted on payment whether the processes were used or not, and in this action they sue for the royalties due in 1895, 1896, and 1897. It was maintained by defenders that no valid or effectual license was entered into between the parties. On January 17th, 1893, the license was signed by Mr. Andrew Pitcairn Henderson, a partner of the defenders' firm, with the consent and authority of the other partners, but not in presence of witnesses. In consequence of the plea stated by the pursuers the Sheriff says he directed a case to be prepared and submitted to English counsel for his opinion on the question whether the indenture and minute of agreement was a valid and effectual license according to the law of England. Mr. Danckwerts, an English barrister, has given an opinion thereon to the effect that the deed was not valid or effectual according to the law of England. The pursuers objected to the opinion, but his Lordship considered the objection not well founded. If the validity of the deed was to be determined by the law of Scotland the Sheriff had no doubt it must be held invalid. Not one of the solemnities required by that law in regard to the execution of deeds had been complied with. If the deed was held invalid and ineffectual the action fell.

The Royal Engineers and Electricity.—General Sir Richard Harrison, K.C.B., C.M.G., the newly appointed Inspector-General of Fortifications, paid his first official visit to Brompton Barracks, Chatham, this week, and among his various duties he inspected the Electrical School at St. Mary's Barracks. This school is now very important, as the Royal Engineers are so very deeply connected with this branch of science, and both officers and men daily undergo instruction in all branches of electricity here.

Royal Institution Soirée.—On Friday last, at the Royal Institution *soirée*, the Edison and Swan United Electric Light Company showed the latest 1898 improvements in Ediswan apparatus. These included a patent dry cap lamp for use in damp places, or for outside lighting. The cap is attached by means of a brass disc, and is fastened to the glass bulb by specially prepared cement, which is thoroughly damp proof. Also a patent casing cut-out. Each casing cut-out is provided with four brass thimbles, adapted to the connecting cables, and these are held in position by the form of the porcelain case, without screws, and are easily removable. Provision is made for holding reserve fuses. There was also a patent direct contact high voltage lamp and holder; the holder is wired without being taken to pieces; the wires pass direct to the spring contact pieces which enter cavities in the lamp socket; there is claimed to be no possibility of short circuiting, and the work of wiring is greatly facilitated. Also the patent anti-shock switch for high voltage, an improved "Tumler" pattern, with patent enamel liner, and the patent anti-shock holder for high voltage, an improved "S" holder, with patent enamel liner.

Smoke Nuisance.—At the Greenwich Police Court on Thursday last week, the summons brought against the Crystal Palace District Electric Supply Company, Limited, and Mr. B. G. Blanchard, their secretary, of Springfield Works, Wells Road, Sydenham, by the Lewisham District Board of Works for an abatement of a smoke nuisance was adjourned *sine die* on payment of five guineas costs by the defendants, it being stated by Mr. E. Wright, clerk to the Board, that the nuisance had been abated.

The Metropolitan Electric Supply Company was, on 26th ult., again summoned at the Marylebone Police Court, at the instance of the Paddington Vestry, for causing a smoke nuisance from their Amberley Road station. After discussion the summons was adjourned *sine die*

At Clerkenwell on Tuesday Messrs. Walter Scott and Co. were summoned for using, at the Chancery Lane Station of the Central London Railway, a furnace and steam engine which were not so constructed as to consume the smoke arising therefrom. The Holborn District Board of Works prosecuted. The magistrate, after hearing evidence and arguments, dismissed the summons, holding that the furnaces were, as far as possible, constructed so as to consume their own smoke.

Testing Magnetic Steel in Bulk.—Mr. Robert Jenkins, of 88, Bishopsgate Street, E.C., writes as follows:—"I see in this week's REVIEW a communication headed 'Testing of Magnetic Steel in Bulk,' wherein a reference is made to the output of the 'South Staffordshire Steel and Ingot Company, Limited.' This name is incorrect. The firm whose analysis and whose output are given is that of Messrs. Alfred Hickman, Limited, of the Staffordshire Steel and Ingot Iron Works, Bilston, for whom I act as agent in electrical business."

Veritys, Limited, v. Sharp.—With reference to the above in our last week's issue, Mr. Sidney Sharp, of 34, Victoria Street, Westminster, desires us to state that he does not carry on contracting work, and that the defendant in this case is not in any way connected with him, or known by him. We have much pleasure in giving publicity to this disclaimer.

ELECTRIC LIGHTING NOTES.

Aberdeen.—Mr. Blackman has resigned the position of electrical engineer to the Council, he having secured an appointment as electrical engineer to the Poplar Board of Works. A successor is to be advertised for at £225 per annum.

Asylum Lighting.—The Richmond District Asylum electric lighting scheme is not to be proceeded with until it is known when the Dublin Corporation new electricity works will be likely to be ready.

Bangor.—The Lighting Committee has reported that as the area of the fields adjoining the gas works was too restricted for the erection of electric light works, gasometer, and offices combined, and would not allow of any extension in the future, if found necessary, it is highly advisable that the land adjoining the gas works should be devoted to gas business only, and that the electric lighting works be erected on land at the corner of Dean Street. They advised the purchase of a site there, and Lord Penrhyn had expressed his willingness to sell the land to them. The Council had a discussion on the point, and finally the minutes were adopted.

Bath.—The Electric Light Committee has purchased for £90 the dynamo and 30 lamps which they had had on hire from the old company. Mr. Hammond remarked that if they had taken them over in the first place, they would have had to pay £1,950. The contractors for the new engines are arranging for their erection to be commenced on June 6th, and the first set of new plant, it is anticipated, will be ready by July.

Bethnal Green.—The Vestry has been advised on the electric lighting question by Prof. Robinson, who foresees a large measure of success for an installation. The County of London and Brush Provincial Electric Light Company's letter *re* a scheme was acknowledged by the Vestry without discussion. Prof. Robinson advises the Vestry to carry out an installation for 5,000 lamps of 16 C.P. This would entail a capital expenditure of £33,000, exclusive of land. Of this sum, £4,100 would be spent upon buildings, £10,500 on mains, £2,400 on house connections, and £11,500 for machinery. Prof. Robinson has no doubt whatever that the undertaking will at once prove remunerative, and he puts down the profit at the end of the first year at £200, at the end of the second year at £350, and at the end of the third year at £1,010. The charge for private consumers is put down at 6d. for the first year, and 5d. afterwards. The report says that the profits might with advantage be applied towards improving the public lighting. Two schemes are submitted. It is estimated that to provide arc lamps for 9,000 yards of main street would cost £16 per lamp, as compared with £3 8s. for the present gas lamps. A large number of standards would be displaced, and the increased cost, therefore, would be £1,090 per annum for increasing the total candle-power from 2,000 to 6,500 before midnight, and to 3,200 after midnight. If, on the other hand, two incandescent burners were substituted for the present gas burners the increased cost would be £278, and the illumination would be increased from a total of 2,750 candle-power to 7,040. The extra cost could ultimately be met out of the profit on the general supply, and extra lamps of higher power placed in important streets. The change would be advantageous, not only in the lighting, but because it would transfer revenue from the gas company to the electricity department. The professor thinks that refuse destruction would lead to a saving of nearly £1,000 a year on the present arrangement.

Birmingham.—At a meeting of the General Purposes Committee on 25th ult., the report of the sub-committee appointed to consider the projected purchase of the electric lighting undertaking was fully discussed. It was resolved to recommend the Council to accept the terms provisionally indicated on behalf of the company in whom the electric lighting is at present vested. These terms fix the price of the £5 shares at £10 10s., their value in the open market. Apart from the price, there are various matters of detail outstanding.

Blackpool.—A Local Government Board inquiry was held at Blackpool on Tuesday regarding an application on the part of the Corporation for power to borrow a further sum of £40,000 for electric lighting extensions. Mr. Quinn, the electrical engineer, said that the £40,000 would only meet immediate demands, and if the demand for the current continued, another £40,000 would be asked for.

Bolton.—At the monthly meeting of the Town Council on Wednesday, Councillor Panton, as chairman of the Electricity Committee, called attention to a report of the engineer (Mr. Arthur Ellis), in which that official recommended a change from the alternating system to the continuous current for the central portions of the town. The subject, he said, was of considerable importance, and he was prepared to have the matter referred back, so that members of the Council might be placed in possession of the report and the estimates. He added that one of the advantages in changing would be that the loss in generating would only be 10 or 12 per cent. as against 25 to 30 per cent. under the alternating system. Another advantage was, that they would be able to extend and supply power for all purposes. The matter was referred back, so that the chairman's suggestion might be carried out. In his report the engineer says that the question of extensions for the coming year has had his careful consideration, and he is firmly of opinion that it is not advisable to extend on the present system, but to adopt the continuous current for the central portions of the town. By this means they will get rid of a great source of trouble and danger, as well as a great loss in the transformers, by being able to run direct from the works to the consumers' premises, with nothing in between to go wrong. In regard to the proposal to use electricity for tramway traction, Mr. Ellis lays emphasis on the fact that, by changing to the continuous current, the lighting plant could be so utilised for this purpose, the plant being made interchangeable. This would mean that the Corporation would not have the same amount of spare plant idle. The Electricity Committee have approved of the recommendations.

Bray.—A number of electric lights are to be placed along the sea wall marine promenade for the ensuing season.

Brighouse.—Mr. J. W. Garside, Brighouse, has been appointed electrical engineer to the Town Council.

Bulawayo.—On April 21st the new lamps on the suburban stands were lighted for the first time. The current is now kept on all night. The electric light company is now putting meters in the houses of all consumers, and when these are all installed the charge will be 2s. per Board of Trade unit, a reduction of 25 per cent. There are now some 800 private lights being used in the town, and 65 street lights. Only one dynamo is being used, the other being kept in reserve for emergencies. The engines are by Macintosh and Seymour. About six tons of red wood, supplied by the Timber Supply Company, are burnt nightly, which fuel is delivered alongside the building on Willoughby's special siding. It has been proved that "mapani" wood is no good as fuel.

Canterbury.—The Corporation has received a considerable number of orders for the installation of the electric light. The laying of the mains is being rapidly carried out, and it is expected that the public lighting will be completed by November.

Cardiff.—The Lighting and Electrical Committee decided on 26th ult. to reduce the prices for current from 6d. per unit for the first two hours, and 3½d. per unit afterwards, to 6d. for the first hour, and 3d. per unit afterwards. Increased consumption is expected to well make up for the consequent reduction in revenue.

China.—The *London and China Telegraph* says that Yang, a Taotai, has been commissioned to manage the electric light department for the Chinese Bund. He has obtained $10,000 from the Shanghai Taotai's Treasury for the purchase of machinery, and also the assistance of a military official in the management of affairs.

Conway.—On Thursday last week the Mayor of Conway and several members of the Cowlyd Water Board, with Mr. Marks, of Llandudno, as professional adviser, visited the board's property of the Turbine, near Cowlyd Lake, to report as to utilising the water power for the purpose of generating electricity. The Mayor stated that the result of the inspection quite warranted the action of the board, and that the property is likely to lead to important developments.

Croydon.—The Local Government Board has sanctioned loans for the electric lighting extension.

Darwen.—On 25th ult. a Local Government Board inquiry was held *re* the proposal to borrow £30,000 for electric lighting.

Derby.—The borough electrical engineer having written to the Guardians asking them to consider the advantages to be secured by using electric lighting at the Workhouse, the matter has been referred to the House Committee.

Dundee.—The Gas and Finance Committees have reported that in the electric department there has been a surplus of £1,328 4s. 3d. The charge for current up to 20 units is to be reduced from 7s. 6d. to 6s. 8d., and the supply above 20 units will be charged at the rate of 4d., being ½d. under last year's price. Current for power purposes will be supplied at 2½d. per unit.

Gloucester.—At the last meeting of the City Council the electric light question again came up for discussion. The installation has some time ago been decided upon, and plans for the works, together with dust destructor, were drawn up by Mr. Hammond and approved. The site was the chief difficulty, and this was the matter which occupied the Council's attention last week.

Hampstead.—Last week Mr. A. P. Johnson, the clerk, reported to the Vestry that the profits on the electric lighting undertaking for the past year had exceeded all expectations. The revenue for the year amounted to £8,081 0s. 9d. They had paid £2,960 8s. 3d. interest on capital, and they had also repaid £1,187 12s. 10d. instalments of capital, leaving the net profit £3,905 3s. 4d. Sir Henry Harben, the chairman, pointed out that, if the Vestry were a trading corporation, and had not to repay the capital by instalments, the profits for the year to rank as dividends would exceed £5,000. The total amount of capital expended up to the present is £100,167.

The Vestry has resolved that, "in view of the fact that the electric arc lighting of Haverstock Hill, Rosslyn Hill, High Street, and the southern portion of Heath Street is now satisfactorily completed, the Lighting Committee be instructed to bring up a report as early as possible upon the question of lighting Heath Street, north of its junction with High Street, by means of electricity, such question having been deferred by the Committee from December 13th last."

Hotel Lighting.—The order for the complete plant and wiring of the St. Anne's Hotel, St. Anne's-on-Sea, has been given to the National Electric Free Wiring Company, Limited, who have also secured the orders for the wiring of Jones's Hotel, Suffolk Street, S.W., and the residence of Mr. Ernest Franklin, 50, Porchester Terrace, W.

Hull.—There has been considerable delay in the completion of the Sculcoates Lane electricity station, but it is probably to be finished early in July. The chairman and deputy-chairman of the Electric Lighting Committee and the electrical engineer are to attend the Municipal Electrical Association Convention next week. The mains are to be extended in certain thoroughfares. With regard to the subway proposed to be erected by the Gas Committee under Queen's Dock Basin, the electrical engineer advises that owing to the distance from the line of main feeders, it would not be advantageous to the Electric Light Committee to join in the affair.

Kilmallock.—This small Irish town, having a population of about 1,000, is lighted electrically. Mr. J. J. O'Sullivan, J.P., who some years ago had an installation put down for lighting his mineral water factory, has now lighted the business houses and streets. There are nine public lamps. The plant was supplied by the Edison & Swan United Company, and consists of an 18-H.P. horizontal engine and a dynamo giving 60 amperes at 200 volts.

Lancaster.—The budget on the electric light department of the Lancaster Corporation, as presented at the monthly meeting on Wednesday, May 25th, was considered to be very satisfactory. The committee reported a profit of £598 7s. 2d. on the year, and Mr. Johnson, the engineer, submitted the comparative statement for the years ending March 25th, 1897, and March 25th, 1898, as follows:—

CURRENT SOLD, &c.

	March, 1897.	March, 1898.
Current supplied to public lamps ...	20,580	26,752
" " private consumers	85,545	120,423
" " used at works ...	2,923	3,344
	109,050	150,519

Generation of electricity.	March, 1897.			Cost per unit. 1897.	March, 1898.			Cost per unit. 1898.
	£	s.	d.	Pence.	£	s.	d.	Pence.
Coal, oil, waste, water and sundries...	472	15	3	1 04	581	0	7	92
Wages at generating station	332	10	5	·73	371	1	9	·59
Distributing	25	1	5	·05	22	12	1	·03
Public lamps	67	16	1	·14	69	2	11	·11
Rents, rates, royalties ...	121	1	10	·26	96	19	11	·15
Management, salaries, and sundries...	174	5	4	·38	194	17	1	·31
	1,193	10	4	2·60	1,835	14	4	2·11
				...				·49 decrease.

INCOME.

	March, 1897. £	s.	d.	March, 1898. £	s.	d.
Sale of current, less discounts ...	1,710	10	8	2,382	9	10
Rent of meters	119	6	9	1	9	3
Public lighting	384	13	7	504	19	6
Miscellaneous	12	10	0	13	0	0
	£2,227	1	0	£2,901	18	7

Mr. Clough (the borough accountant) reported that the electricity department has made considerable progress, the balance transferred to the district fund being £510 in excess of the previous year. The financial results, so far, have been:—

	£	s.	d.	£	s.	d.
Loss 1894-5	373	11	7			
„ 1895-6	539	8	11			
				913	0	6
Profit 1896-7	87	19	8			
„ 1897-8	598	7	2			
				686	6	10
Net loss				226	13	8

It was estimated that there would have been a profit on the year amounting to £260 1s. 6d., and it is pleasing to have to report that this department has done better than anticipated. The comparative figures are as follows, shillings and pence omitted:—

	1895-6.	1896-7.	1897-8.
Income:—	£	£	£
Sale of current, less discount ...	1,337	1,795	2,494
Rent of meters...	87	119	1
Public lighting...	366	384	504
Sale and repairs of lamps, &c. ...	352	248	273
Expenditure:—			
Manufacture of electricity	919	805	952
Dist. and management...	611	447	480
Rents, royalties, and taxes	52	97	84
Debt redemption, interest on loans, &c., or contribution to stock dividends account	992	992	992

Capital expenditure upon the electricity works amounts to £24,211 4s. 4d. The increase during the year was £1,313 16s. 2d., but the premiums obtained on the Corporation 3 per cent. redeemable stock, less compensation to mortgagees, brought forward from last year, reduces this amount by £319 17s. 9d. Amount set aside for redemption of stock during the year was £831 9s. 3d., and the liability on March 25th amounted to £24,680 2s. 4d., the same as the previous year. Mr. Hall moved the confirmation of the minutes of the Electricity Committee, drawing attention to the large increase of electricity during the year, which the Committee were prepared to meet by putting down fresh plant. The comparative statement was well worth considering, because it showed at once the large increase in the consumption of electricity. The cost of production was very favourable indeed in comparison with other low tension stations in the country. He believed they stood the highest in England under the low tension system in regard to the low price at which they produced electricity. He hoped they would be able to keep that position. Mr. Heald seconded, and the minutes were confirmed.

Leigh.—The District Council has decided to apply to the Local Government Board for sanction to borrow various sums, including £10,500 for proposed electricity works.

Liverpool.—The Lighting Committee has resolved upon extension of mains in several thoroughfares at a cost of nearly £700.

London.—At last week's Court of Common Council Mr. Brooke Hitching asked the chairman of the Streets Committee if the law officers had reported on the reference as to whether the Corporation was able to erect and maintain a municipal electric lighting station, having regard to the agreement which had been entered into by the Corporation with the City of London Electric Lighting Company; and further, whether the law officers were unanimous in their opinion that the erection of such a station would be a breach of the agreement in question. No reply to the question was forthcoming.

The Board of Trade has issued provisional electric lighting orders to the Bermondsey and Marylebone Vestries for the whole area of their respective districts.

Mauritius.—Mr. F. J. Warden-Stevens has been appointed to prepare a scheme for the electric lighting of Port Louis, Mauritius.

Morecambe.—At a special meeting of the District Council on May 23rd, Mr. Krauss (the contractor for the installation of electric lamps and pillars on the Promenade), wrote asking to be allowed to put up the arc lamps and pillars on the Bare Promenade. The Council refused, informing Mr. Krauss that the time had already passed when, under his contract, he should have handed over the Promenade to the District Council, completed. The delay was causing them considerable inconvenience, for which they held him responsible. Notice was given to Mr. Krauss that the Council would themselves proceed to lay the cables and put up the arc lamps and pillars after 14 days from that date.

Pembroke.—A Local Government Board inquiry is to be held to-morrow, June 4th, regarding the Township's Commissioners' proposal to raise £33,000 for electric lighting.

Poplar.—The Board of Guardians has adopted a report of its Electric Lighting Committee with reference to the hot and cold water and steam supply at the workhouse, and embodying schemes for lighting the workhouse and the offices at North Street by electricity. Mr. Warden-Stevens' original scheme was adopted, and he has been instructed to prepare the necessary plans and specifications. Application is to be made to the Local Government Board for a £9,000 loan for the purpose.

Portsmouth.—The balance-sheet and revenue accounts of the Electric Lighting Committee for the year ending March 31st last, which was issued on Thursday last week, shows total receipts amounting to £16,265 3s., and an expenditure of £9,469 13s. 9d. This leaves a gross balance of £6,795 9s. 3d. on the year's working. Of this sum the Committee carry £6,750 to net revenue account, leaving a balance of £45 9s. 3d. to be carried forward. Out of the £6,750 the Committee have paid £3,180 19s. 4d. for interest of borrowed capital, and £2,793 13s. 7d. towards redemption of loans. No sum is written off to provide a reserve fund to maintain and renew the machinery.

Provisional Orders.—The electric lighting provisional orders relating to Batley and Ossett were confirmed in the House of Commons on Monday last week.

Saltburn.—Messrs. Burstall & Monkhouse are preparing a report on electric lighting for the District Council. There are two schemes—one promoted by the Cleveland and South Durham Assets Company, and the other by the Urban Council.

Shoreditch.—Mr. C. N. Russell, the chief electrical engineer, has issued a list of streets in which the Vestry's supply mains are laid, or will be laid within the next few weeks. The list is as follows, the mains in some cases being laid on one side, and in others on both sides of the street:—Bateman's Row, Brunswick Place, Cropley Street, City Road, Commercial Street, Curtain Road, Charlotte Street, Charles Square, Church Street (to boundary), Calvert Avenue, Coronet Street, East Road, Eagle Wharf Road, Great Eastern Street, Garden Walk, Hackney Road, Hoxton Street, Hoxton Square, High Street (to boundary), Holywell Lane, Huntington Street, Kingsland Road, Leonard Street (Sq. to boundary), Motley Street, New North Road (from East Road to Eagle Wharf Road), New North Road (Pitfield Street to East Road), New Inn Yard, Nile Street, Old Street (from City Road to Pitfield Street), Old Street (Pitfield Street to High Street), Paul Street and Wilson Street, Pitfield Street, Rivington Street, Rufus Street, Sun Street, Shepherdess Walk, Tabernacle Street (to boundary), Wenlock Street, Worship Street, Ware Street.

Tunbridge Wells.—It is stated that the surplus for the year ending March 31st on the electric light undertaking at Tunbridge Wells is close upon £2,400.

Twickenham.—The District Council have had laid before them proposals by Edmundson's Electricity Corporation, of Broad Sanctuary Chambers, Westminster, to light the town by electricity. The Corporation offer to form a local company, free of all expense to the Council, to light the districts of Twickenham and Teddington by electricity. They would consent to the inclusion in the order to be obtained from the Board of Trade of a clause that light to be used for the streets or public buildings should be supplied at 3d. per unit, for private dwellings 7d. per unit, and that the Council should have the option of taking over the undertaking at the end of 14 years. The communication was referred to a special committee, but members expressed the view that the Council should be careful how they tied themselves down, for there might be a time coming when they could destroy dust and manufacture electric light at the same time.

Wandsworth.—The Board of Works has given consent to the application of the County of London and Brush Provincial Company to lay mains in Lower Richmond Road, Putney.

Westgate.—On 21st ult. Major Cardew, R.E., resumed the public inquiry opened on the 13th ult. in the matter of the application by the Isle of Thanet Rural District Council for a provisional order. A good deal of evidence was given, and the Major said he would report in due course.

Whitechapel.—We learn that the District Board, on 24th ult., decided to lay down its own electric light installation for the district.

Wimbledon.—It is expected that the electricity works will be completed about March next year, and the District Council is inviting intending consumers to lodge their applications for current. Mains will be laid in every street.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Birmingham.—The report of the Public Works Committee recommends the City Council to adopt overhead electric traction upon the Sparkhill and Small Heath routes. There has been a serious divergence of opinion in the committee with regard to this proposal, which was only adopted by the bare majority of one, five being in favour of permission being granted and four against. It should be understood that the committee still retain their favourable opinion towards the conduit system, but the utter inability to come to terms led to such a deadlock that they felt compelled to adopt some other means of settling the difficulty, which, in its quiescent state, was causing the public no small amount of inconvenience. On the routes mentioned there was a strong growing feeling of antipathy towards the steam trams, and in view of this the larger half of the committee supported the proposal the Council will be asked to adopt. It must be clearly understood, says the *Birmingham Post*, that this is merely a four years' trial of the overhead system, which has been adopted in several places where the tramways have been municipalised. If, at the end of that period, the overhead method does not meet with the approval of the Corporation, we understand the company have undertaken to remove it at their own expense, but, in the meanwhile, members of the Public Works Committee feel strongly that the experiment in question will be preferable to the continuance of the present system. In addition to this recommendation the report includes an offer of Messrs. Dick, Kerr and Co., Ltd. The whole matter will be discussed on Tuesday next, June 7th. Messrs. Dick, Kerr's offer is for the provision of a tram service upon roads in the city along which there is at present no such accommodation. They undertake to adopt either the underground electric conduit or the cable system of traction as may be found suitable to the various routes; they stipulate that the term of concession must be for 21 years, and agree that if the Corporation purchase the business of the Birmingham Electric Lighting Company, as is proposed, they will become customers for their electric power. In lieu of rent a profit-sharing arrangement is suggested, contingent upon paying 5 per cent. interest upon the capital of any company that may be formed, and the laying aside of a sufficient annual sum to provide for a sinking fund for the whole of the capital. Finally, at the expiration of the term of concession the whole of the lines within the city would revert to the Corporation without payment. It is understood that the chairman of the Tramways Company does not now adhere to his recent statement that the Corporation had given verbal permission to instal the overhead trolley system in certain parts.

Brierley Hill.—Last week the first sod was turned at Round Oak in excavating the foundations for the power station of the British Electric Traction Company.

Dublin.—Early last Friday morning a successful trial trip was made on the newly completed section of the electric tram line between Haddington Road and Nelson's Pillar. Mr. Astrom, the electrical engineer of the Dublin United Tramways Company, accompanied by other officials of the company, ran one of the motor cars from Haddington Road into O'Connell Street *viâ* Merrion Square, Westland Row, Great Brunswick Street, and D'Olier Street, This section was to be open for traffic this week. In this line centre poles are placed throughout the entire distance, but otherwise the installation is exactly the same as that on the Clontarf section. The Board of Trade inspection was expected to take place this week. The electrical equipment of the various other lines is proceeding rapidly. Poles are now being erected along the north quays, where the cables are also being laid. The laying of the underground conduits is being pushed forward rapidly all over the city. The great central power station at Ringsend is progressing quickly. Already the foundation excavations have been made, and the work of erection commenced. The line connecting Rathmines with the sea is now almost constructed. Pending the electrical equipment of this line, which will be shortly taken in hand, it will be worked, says the *Dublin Nation*, by horse haulage.

Dudley.—The contract for the new electrical power station at Brierley Hill has been secured by Messrs. J. H. Whittaker and Co., Dudley. The contract amounts to £7,000. The work has to be completed in about four months.

Glasgow and Paisley.—A sub-committee of the Upper District Committee recently had a conference with the Glasgow Tramway Committee *re* the proposed construction of electric tramways in Paisley and district. The members of sub-committee, having considered the proposals by Glasgow, resolved to report that, in their opinion, it would be preferable to enter into an arrangement with the Glasgow Corporation in connection with the construction of tramways on the Paisley Road, rather than with the British Electric Traction or other private company, who, moreover, it is understood, propose to lay, in the first instance at least, only a single line of rails on the road, to which the sub-committee entertain the strongest objection. The sub-committee also resolved to request a conference with representatives of the burgh of Paisley regarding the proposal of the British Electric Traction Company to construct a tramway on the Leith Road, between the burghs of Paisley and Johnstone, to be held either at Glasgow on Wednesday, 25th curt., or at Paisley on Thursday, 26th curt., as may be most convenient for the Paisley representatives.

Gorton.—The Electric Lighting Committee has been considering the Manchester Corporation's proposal regarding the working of the tramways. The proposals were that the authorities in the out-townships should acquire the lines in their respective districts, and provide electric energy and the necessary equipment for the working of the tramways on the same system and at the same voltage as proposed to be adopted in Manchester, at their own cost. Such an arrangement, if agreed upon, was subject to a revision at the end of three years' working. The Committee, whose proceedings were confirmed by the Council, decided not to accept the proposals. The chairman of the General Purposes Committee and the clerk subsequently met representatives of the Denton District Council and the British Electric Traction Company. Arrangements have been made for a conference to be held at an early date between the members of the Gorton Council and the representatives of the district upon the Lancashire County Council.

Helston to Lizard.—The Board of Trade has issued the modified and now confirmed order made by the Light Railway Commissioners authorising the construction of a light railway, commencing by a junction with the Helston line of the Great Western Railway at its termination, and terminating at the Lizard, a distance of over 11 miles. Clauses are inserted to enable the company to work the line by steam, mechanical, or electric power.

Kew Bridge.—The Middlesex County Council at its meeting on Thursday last week, resolved to oppose the proposals of the London United Tramways Company to carry electric trams over Kew Bridge. They, however, acknowledged the receipt from the joint Kew Bridge Building Committee of the following recommendation:—"That it be a recommendation to the County Councils of Middlesex and Surrey, that a double line of tramway be allowed over the proposed new bridge, subject to the tramway company paying the whole cost of the widening of the proposed bridge and its approaches, in accordance with the suggestion of Sir John Wolfe Barry, and subject to other conditions being satisfactory as regards the method of working, maintenance, and in other respects."

Kirkcaldy.—Prof. Kennedy has been collecting further information locally for completing his report on the proposed electric light and traction scheme.

Leeds.—On Tuesday night a guard wire broke when a car was running along North Street toward Briggate.

Llanfair and Beaumaris.—The Light Railway Commissioners have come to the decision, respecting the above line, that they would not be justified in submitting to the Board of Trade an order authorising the construction of the line. The decision has caused the greatest disappointment in the Menai Bridge and Beaumaris and Llandegfan districts, through which it was intended to run the line.

Middlesborough.—The Streets Committee on 27th ult. discussed the laying of the track for the new electric tramway service, the ground of complaint being that the scored brick paving was considerably above the level of the rails. At a previous meeting a resolution was passed allowing three months in which to give the bricks opportunity to settle, upon an undertaking that if at the end of that time they were not level with the rails the company would make them so. Last week it was resolved that the former resolution be rescinded, and that the Corporation consistently oppose the granting of the license till the pavement is made on a level with the rails.

Rochester, Chatham and Gillingham.—The Light Railway Commissioners will continue at Chatham, on Monday, June 6th, their adjourned public inquiry into the application which has been made by the Rochester, Chatham, Gillingham and District Electric Railways Company, Limited.

Southall.—The District Council last week considered the proposals of the company in regard to its application for an order to construct a light electric railway in the Council's district. On Friday last the Council interviewed Mr. George White, chairman of the London United Tramways, Ltd., and Mr. J. Clifton Robinson, managing director, and subsequently decided *nem. con.* to sanction and approve the scheme on the following conditions: That the pattern and positions of the trolley wire standards be approved by the Council; that the company wood-pave its track through the High Street (about a quarter of a mile); that the fares be no more than 6d. from Shepherd's Bush to Uxbridge, 4d. from Shepherd's Bush to Southall, and 2d. from Southall to Uxbridge, workmen's fares to be not more than half the ordinary fares; and that the Council have the use of the trolley wire standards for lighting or other purposes.

Southend.—The Corporation of Southend-on-Sea have just let a contract to Messrs. Alexander Penney & Co., of London, for the provision of a siding and passing place in connection with the electric tramway on the pier. This has been necessitated owing to the almost phenomenal growth of the traffic on the tram. The whole length of this tramway is one mile. It has a gauge of 3 feet 6 inches, and the weight of the rails is 45 lbs. per yard. These are secured to wooden longitudinal deck beams by steel clips and ⅝th inch coach screws. The joints of the rails consist of ordinary fish-plates and bolts with copper strip bonds. The line is straight with equal forked siding at the pier head. The power station is arranged under the pier entrance. It is provided with a 12 H.P. horizontal engine and locomotive type boiler by Messrs. Davey Paxman & Co., of Colchester. There is a Crompton dynamo of 200 volts giving out 100 amperes. The current is carried direct from the dynamo along a centre rail, the car rails taking the return current. The traffic is worked by means of three trains, each consisting of a like number of open or summer cars. The motor car is fitted with a Crompton 10 H.P. motor geared by means of a phosphor bronze spur gearing on the hind axle. In the busy season a 15-minute service is worked, and, of course, with the extra facilities provided by the new siding and passing place the service will be accelerated. This work, it is expected, will be completed in two or three weeks' time. Messrs. Penney are also building an improved tram of three cars. The speed is limited to 8 miles per hour, and the line appears to admirably answer its purpose. The traffic is well managed by Capt. Kelly, whilst the machinery is under the control of Mr. Frank Norton; Mr. F. H. Gill is in charge of the new works, and Mr. E. Martin is resident engineer.

The Spen Valley.—The proposal to construct an electric tramway in the Spen Valley of Yorkshire has speedily taken shape, and before long some definite steps will in all probability be taken. As a result of the visits paid to the district by a representative of the British Electric Traction Company a letter has been received by the various authorities concerned, in which the company says that it proposes to take the necessary preliminary step with a view to obtaining the necessary powers for constructing an electric tramway connecting Ravensthorpe, Dewsbury, Staincliffe, Heckmondwicke, Liversedge, and Cleckheaton. "We propose to proceed under the Light Railways Act, 1896, as," adds the company, "under this Act by the local inquiry held by the commissioners better facilities are afforded to the local authorities for the discussion of the whole question than is the case under the Tramway Act. Under this Act the application can be made in November next and the intervening time will give us ample opportunity to discuss the whole details of the scheme with you." The letter has not been discussed by the authorities yet, but it has been relegated to the various committees. The line will be some 12 or 13 miles in length.

Sunderland.—The Council has adopted a report of the Tramways Committee, recommending that a deputation be appointed to visit Hamburg, Brussels and Leeds, and to report to the Council upon the systems of electrical or mechanical traction in vogue there.

Surrey and Middlesex Light Railways.—The opposition which from the first was displayed in Richmond towards the London United Tramway Company's proposed light railway over Richmond Hill to Kingston has not in any way diminished. Other local authorities have followed the lead of the Richmond Town Council in giving notice of intended opposition. The Ham District Council at their last meeting discussed the proposal, and came to the conclusion that the railway would be of no benefit to Ham, and it would be an obstruction to traffic, that it would be dangerous owing to the steep gradient running down through Petersham Wood from Richmond Hill, and that the narrowness of the roads at places would increase the danger. The result of the debate was the passing unanimously of a resolution to oppose. At the Kingston Town Council the points urged against the proposal were that light railways were intended for agricultural districts, not for towns like Richmond and Kingston, that no provision was made for the purchase of the undertaking by the Corporation, that a monopoly should not be tolerated in the borough, that it would injure the residential district, that there would be danger on the roads, that the district was well served in means of communication, and that if tramways were wanted the Corporation should provide them. It was also argued that the Town Council should oppose with a view of getting roads widened, and particularly securing the reconstruction of of Kingston Bridge over which the line would pass into Middlesex. A recommendation to oppose was unanimously agreed to. At the meeting of the Middlesex County Council also it was agreed without discussion to oppose the order, inasmuch as it related to the County of Middlesex.

Swansea.—The British Electric Traction Company, into whose possession the Swansea Tramways recently passed, commenced on Tuesday to relay the system and to equip it for electrical traction.

TELEGRAPH AND TELEPHONE NOTES.

The Alternative Cable to the Cape.—In the Legislative Assembly at Cape Town last Friday, Sir J. Gordon Sprigg intimated, that, subject to the approval of Parliament, the Government agreed to construct the land wires for the "all British cable from England to Australia," and that subject to a reduction of cable rates the Government favoured a further subsidy to the Eastern Telegraph Company. Mr. Merriman pointed out that Mr. Hofmeyr was in favour of the proposition that the cable should be owned by the Cape and the Imperial Governments, thus abolishing the company's monopoly. The matter will come up for discussion at an early date. In the meantime we learn that the cable steamer *John Pender* is about to sail from the Cape for England, with instructions to take soundings along the proposed cable route on her voyage home. The length of the proposed cable will be about the same as that projected across the Pacific, and, judging from the few soundings already taken on the southern portion of the proposed line, the depths will be about the same as those found in the Pacific along the intended cable route. It is to be hoped that the survey by the ss. *John Pender* will not occupy so long as the cable route survey still being carried on by the Admiralty across the Pacific, which has been going on for about ten years. There is some talk of extending the Cape cable on to Australia; but this idea does not meet with much encouragement from the Australian Premiers. At the Hobart Conference it was pointed out that there was no willingness shown by the telegraph companies to reduce rates to the public, in spite of the fact that last year alone, which was a year of reduced traffic, the money collected was £50,000 in excess of the guaranteed amount, yet the company was only prepared with a concession amounting to about £4,000, which was wholly inadequate. In view of the large subsidies the company had received during the past 20 years it would have been reasonable to have offered to take public messages at 4s., which would have reduced the company's takings to about the guaranteed amount. The company was disinclined to do anything except on the understanding that the colonies entered into the new project of an alternative route *viâ* the Cape. Unless it could be shown that the Cape route afforded Australia advantages beyond strategic and sentimental ones from an Empire point of view, the conference could not recommend the respective colonies to accept the arrangement. That was the view taken at the meeting of premiers. They would not subsidise the Cape cable. The better alternative route would be *viâ* Canada. He moved—"That in the absence of a satisfactory proposal from the E.E. Company and of any proposals at all except on the basis of an alternative cable *viâ* Africa, this conference is unable to make any fresh arrangement with that company." Mr. Duffy seconded the motion. He said no company must be allowed to fetter Australia with a monopoly. The motion was put and passed. Mr. Dickson advocated the Pacific cable route as tending to reduce charges and be all in British territory. He moved a motion in favour of that consummation as speedily as possible, and communications be made with Canada and England, that if they will contribute one-third each Australia would give the other third. Mr. Duffy seconded. The motion was put and passed.

The New Gotland Cable.—Messrs. W. T. Henley's Telegraph Works Company completed the laying of this cable, connecting Gotland with Sandon, Hufvudskor, Ornon, and Dalaro on the 1st inst. The cable steamer *H. C. Oersted* returned to Copenhagen the same evening.

The Pacific Cable.—The *Times* Ottawa correspondent says that on the 26th ult. a discussion took place in the Canadian House of Commons on the Pacific Cable question. Members on both sides of the House urged the Government to endeavour to push forward the project. Sir R. Cartwright, for the Government, said that the people of Canada were far less directly interested in the project than the Australasian colonies; and, as the Imperial authorities had contributed heavily to Imperial projects by constructing the Canadian Pacific Railway of Canada, he thought they should not be asked to contribute beyond a reasonable share. The negotiations had not resulted in action, yet the Government has not abandoned the hope of a successful issue.

Telegraphic Interruptions and Repairs:—

CABLES.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 8th, 1898 ...	...
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Cable beyond Gurupa ...	April 4th, 1898 ...	
Cyprus-Latakia	Feb. 10th, 1898 ...	...
Bolama-Bissao	April 12th, 1898 ...	...
Maranham-Para	" 17th, 1898 ...	...
Hong Kong-Manila	May 3rd, 1898 ...	...
Zanzibar-Mombassa ...	" 18th, 1898 ...	May 31st, 1898
LANDLINES.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Cartagena-Barranquilla ...	July 4th, 1896 ...	...
Majunga-Tananarive ...	May 23rd, 1898 ...	May 25th, 1898
SIBERIAN LANDLINES.		
Djalinda-Blagowestchensk ...	May 27th, 1898 ...	May 28th, 1898

The Telephone Agitation.—The conference between the London County Council and representatives of Metropolitan local authorities has been postponed till June 10th. The Select Parliamentary Committee will meet again on Tuesday next, 7th inst., and continue the examination of Mr. J. C. Lamb, C.B.

Telephones in Switzerland.—There are some interesting remarks on the success of the telephone system under State management in the latest Swiss Consular report. The number of members on the Berne Exchange is 2,025, the subscription being originally fixed at £4 16s. for the first year, £4 for the second, and £3 4s. for the third and subsequent years, the subscriber being entitled to 800 messages per annum. The rates, says a financial contemporary, have since been reduced to £4, £2 16s. and £1 12s. respectively, with an additional charge of 5 centimes (½d.) for every message. The number of central stations is 225, and the total number of stations, counting the dwellings or offices where instruments for the use of subscribers are placed, amounted to 23,671.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belfast.—June 6th. The Harbour Commissioners are inviting tenders for the supply of three belt-driven, continuous current, series wound dynamos, to give 15 amperes, 2,850 volts, at 800 revolutions per minute, for 18 hours' continuous running without undue heating. Harbour engineer, Mr. G. F. L. Giles, from whom particulars may be obtained. See our "Official Notices" May 27th.

Belgium.—June 10th. The Provincial Government Authorities in Brussels are inviting tenders for an installation of electric lighting in the Bibliotheque Royale, in the Place du Musée, Brussels. Tenders to be sent to Le Gouvernement Provincial, Rue des Augustins, 17, Brussels, from whence particulars may be obtained on payment of 4s. 6d.

Bournemouth.—June 20th. The Corporation is inviting tenders for the supply, &c., of cables, arc lamps, incandescent lamps, wiring, switchboards, fittings, &c.; also steam dynamo, &c. Particulars from the borough engineer, Mr. F. W. Lacey, also see our "Official Notices" May 27th.

Bury St. Edmunds.—June 13th. The Corporation invites tenders for the supply and erection of Lancashire boilers, three 60-kw. steam dynamos, transformer and booster, accumulators, street mains, and various other machinery and apparatus for the electricity undertaking. Consulting engineer, Mr. F. H. Medhurst, 13, Victoria Street, S.W. See our "Official Notices" May 13th.

Coventry.—June 7th. The Electric Lighting Committee invites tenders for electric mains, switchboards, arc lamps, posts and apparatus in connection therewith. For particulars of the several sections see our "Official Notices" May 13th. Mr. Gilbert S. Ram, city electrical engineer.

East London (Cape Colony).—June 28th. The Town Council is inviting tenders for erection of buildings and the supply of electric lighting machinery, electric tramcars, plant, rails, &c., and for their maintenance for six months from completion. Particulars from Messrs. Dyer & Dyer, 17, Aldermanbury, London, E.C., on payment of £5, repayable on the receipt of a *bonâ fide* tender.

Edinburgh.—June 14th. The Corporation wants tenders for the electric wiring of the police chambers (400 lamps). Particulars from the electrical engineer, Dewar Place, also see our "Official Notices."

Hammersmith.—June 8th. The Vestry is inviting tenders for the supply and erection of a Ledward evaporative condenser and tanks, air pump, circulating pumps, and pipe work. Consulting engineer, Mr. A. H. Preece. See our "Official Notices" May 27th for particulars.

London.—June 21st. The London County Council is inviting tenders for engines, dynamos, accumulators, switchboards, feeders, distributors, and service mains and all accessories, to be fixed complete in buildings at the Crossness Outfall Works, near Erith, Kent. The L.C.C. also requires tenders for providing and fixing cables, wires, conductors, casing, pendants, brackets, and other fittings, columns, lanterns, lamps, switches, and switchboards, distributing boards, fuses, cut-outs, &c., necessary for the lighting by electricity of the Crossness pumping station and works, near Erith, Kent. Particulars of both contracts from the Engineer's Department, County Hall, Spring Gardens, S.W. See also our "Official Notices" May 27th.

Sheffield.—June 13th. The Tramway Committee is inviting tenders for the erection of an electric power station for its tramway scheme. Particulars from the City Surveyor.

Southampton.—June 20th. The Corporation invites tenders for the supply and erection of lamp columns, arc and incandescent lamps, automatic switches and fittings. Consulting engineers, Messrs. Kincaid, Waller & Manville. See our "Official Notices" this week.

St. Mary, Newington.—June 6th. The Vestry Electric Light Committee is inviting tenders for the supply and erection of engines, generators, and public lighting plant for the electric lighting scheme. Engineers, Messrs. Kincaid, Waller & Manville.

St. Pancras.—June 14th. The Vestry wants tenders for condensing plant, steam pipes, &c., for the Regent's Park electricity station. Particulars from the chief clerk, Electricity Department, 57, Pratt Street. See our "Official Notices."

Taunton.—June 6th. The Corporation invites tenders for the supply and erection of engines and alternators in exchange for existing alternators and transformers, also alterations to switchboard, supply of rectifiers, &c. Messrs. Kincaid, Waller and Manville, engineers.

Tynemouth.—June 20th. The Corporation wants tenders for the supply of steam dynamos, balancer and boosters, &c. Consulting engineers, Messrs. Lacey, Clirehugh & Sillar. See our "Official Notices" this week for particulars.

Victoria.—June 24th. The Council of the city of Hawthorne (Colony of Victoria, Australia) is inviting tenders for the supply and erection of buildings, boilers, engines, dynamos, transformers, mains, meters, arc lamps, poles; also running the plant for three years. See our "Official Notices" March 11th.

Watford.—June 8th. The District Council is inviting tenders for the erection of an electric light station adjoining the new sewerage works. Particulars from the architects, Messrs. Gordon, Lowther & Gunton, Finsbury House, Bloomfield Street, E.C.

CLOSED.

Belfast.—The Corporation has accepted the tender of Mr. W. H. Drennan for wiring the new police office and cells for electric lighting.

Southampton.—The City Council has accepted the tender of Mr F. Osman for trenching and laying conduits for electric light mains, at £1,029 odd. The other tender received was from Messrs. Reid Bros., £1,280.

FORTHCOMING EVENTS.

1898.

Wednesday, Thursday, Friday, and Saturday, June 8th, 9th, 10th, and 11th.—Municipal Electrical Association Conference. See our "Notes" last week.

Friday, June 10th, at 8.30 p.m.—The Institution of Junior Engineers at the Westminster Palace Hotel. Special meeting to welcome Sir T. Salter Pyne, C.S.I., honorary member of the Institution.

At 5 p.m.—Physical Society. Agenda:—1. Exhibition of a Model illustrating Dr. Max Meyer's new theory of Audition, by Prof. S. P. Thompson, F.R.S.; 2. "Attenuation of Electric Waves along a line of negligible Leakage," by E. H. Barton, D.Sc; 3. "Diffusion Convection," by A. Griffiths, B.Sc.

Thursday, June 16th, at 9 p.m.—Institution of Electrical Engineers' Conversazione at the National History Museum, South Kensington.

NOTES.

Mr. C. E. Dolbear's Submarine Telegraph Tests.—The manifest necessity of establishing communication between vessels at sea and the shore in time of war has induced numerous inventors to try methods for accomplishing this end. Of the electrical methods tried, says the New York *Electrical Engineer*, perhaps one of the oldest, but least developed, is that of simple conduction, that is, taking advantage of the fact that a current flowing between two points not metallically connected spreads out in waves, and covers a wide area, depending upon the conducting material, the strength of the current, and distance between the terminals. To determine the relation between these quantities and the possibility of practically employing this means of communication between American vessels now stationed in southern waters, near the Florida and Cuban coasts, Mr. C. E. Dolbear, a son of Prof. A. E. Dolbear, of Tufts College, made arrangements with the New York *World* to carry on extensive experiments in the Kill von Kull, a channel of salt water between the New Jersey and Staten Island shores. 1,500 feet of No. 14 copper wire stretched along a rocky ledge between the railway station of Sailor's Snug Harbour and an old mill. The two ends of this wire were connected to copper plates immersed in the water, and a telegraph key and a number of Mesco dry batteries were placed in the circuit. After these preliminary arrangements, a party consisting of Messrs. T. A. Edison, jun., C. E. Dolbear, W. J. Clarke, Charles Cuttriss, Chas. W. Price, Max Loewenthal, O. S. Burr, W. H. Holzer, and *World* representatives, Messrs. Young and Miller, embarked on the tug *Leonard Richards* on Thursday, May 5th, to conduct the experiments across the Kill von Kull, a distance of a quarter of a mile. A wire, whose ends were connected to plates of copper inserted in the water over the bow and stern of the tug, was cut in the middle, and a telephone receiver placed in circuit. A provisional code was adopted, and signals transmitted from the shore were plainly heard by those on the tug. The experiments may be considered highly successful, and may lead to gratifying and beneficial results.

Obituary.—The death occurred on Tuesday afternoon of Sir Robert Rawlinson, the distinguished sanitary engineer. Sir Robert, who was 89 years of age, was Sanitary Engineer Commissioner of the British Army in the Crimea, and Chief Engineer Inspector of the Local Government Board.

The *Standard* also records the death of Dr. John Barrett Melson at the age of 87. He was educated at Trinity College, Cambridge, and was appointed Professor of Natural Philosophy and Hygiene at Birmingham Medical School. When lecturing at a Philosophical Institution upon physics and electro-dynamics, the late Archbishop of Canterbury and the present Bishop of Durham were among his pupils. We understand that, at the request of Sir Isambard Brunel, he calculated the lateral oscillation of engine axles, and Prof. Faraday relegated to him the question of the economical value of electricity as a motive power.

The War and the Cables.—Mr. E. W. Parsoné writes to the *Times*, from the Constitutional Club, in regard to Mr. Holland's letter on this subject, which was reprinted in our last issue. He says:—

Without doubt many interested in submarine cable property have read with interest Mr. T. E. Holland's letter published in your issue of the 24th inst., in which, after referring to the international convention for the protection of submarine telegraph cables signed at Paris in March, 1884, he says:—

"The question is a new one, but, though covered by no precedent, I cannot doubt that it is covered by certain well-established principles of international law."

This remark would lead most people to suppose that up to the present there did not exist cases of submarine cables being interfered with by belligerents. This, however, is not the case. During the Franco-Prussian war—1870-71—cables connecting places on the French coast were systematically cut in extra-territorial waters, and later, in the war between Chili and Peru, the cables of an English company connecting those two countries were cut in territorial waters, and, I believe, also in extra-territorial waters. The Chilian Government was called upon to indemnify the company for actual and indirect loss occasioned by this action, and had the claim been submitted as a whole to the international commission which sat to adjudicate claims resulting from the war, their judgment might have formed a lasting precedent for parallel cases. The Chilian Government, however, at once admitted its liability to reimburse the company for all expenses connected with the repair of the said cables, and this sum was accepted by the company in full compensation for all prejudice sustained by it. This very frank action by the Chilian Government so far as it goes should be kept in mind as forming a precedent for the liability of States which may in time of war find it expedient in their own interests to cut submarine cables or interfere with telegraphic communication by their means.

Despatches from Washington state that the cable which the scout steamer *St. Louis* cut is one of the English-owned lines between Jamaica and Puerto Rico. It is stated at Madrid that the Americans have cut the cable between Guantanamo and Hayti, which belongs to a French company.

According to the *Times* Berlin correspondent, the *Berliner Neueste Nachrichten* devotes a leading article to the question propounded in the Spanish journal *Imparcial* as to whether America has the right or not to cut submarine cables in time of war. The article says:—

There can be no doubt that Spain could inflict a very serious blow on America by the simple process of cutting the cables connecting her with Europe. Her commerce would be materially impaired. Her Stock Exchange would undergo a panic. She could not hold out three weeks were she cut off from all connection with Europe. We are astonished that Spain has not made use of this simple but effective means of warfare. Spain should remember the maxim *à la guerre, comme à la guerre*. The German law for the protection of cables has been in force since May 1st, 1888. In time of peace the cables are protected; but, on the other hand, Powers in actual state of war have a free hand to do as they please. It is another question whether compensation should be offered to those neutral Powers whose cables have been cut or in any way damaged.

Personal.—Mr. Wm. H. Marshall, who has been for two years on the technical staff of Messrs. Babcock & Wilcox, Limited, has been appointed draughtsman to the Westminster Electric Supply Corporation. Mr. Marshall was for five years assistant to Mr. Campbell Swinton.

The Electricity Committee of the Blackpool Town Council have recommended that the salary of the electrical engineer (Mr. Quin) be advanced from £300 a year to £400.

A Hitherto Unknown Cable.—We have often had occasion to draw attention to newspaper and magazine science, and the latest example of the "talented author" type may be found on page 762 of *Pearson's Weekly*. In a new serial story, "Contraband of War," a tale of the Hispano-American struggle, a party of men land to cut a cable. In five minutes someone whispered "Here it is." He pointed to *a thick rope made of many layers of netted wire, alternating with gutta-percha, which ran down a hillside, then along the sands, then dived to its dark bed within the deep.* We have inquired of every manufacturer as to the probable date of the making and laying of this remarkable type of cable, but they all disclaim any knowledge of it. Perhaps Mr. Charles Bright can enlighten us?

A Hint to English Consuls.—We reproduce the following letter from the *Scientific American*. If our consuls in foreign parts would take a leaf out of the U.S. Consul's book and send home similar reports, English electrical manufacturers would be benefited, that is, assuming that proper regard were paid thereto:—

AN ELECTRIC RAILROAD FOR FREIBURG.

To the Editor of the *Scientific American*.

The city of Freiburg, a town of 55,000 inhabitants, with most beautiful surroundings, many large villages near by, and romantic valleys into the heart of the Black Forest, is contemplating the building of an electric railroad system and a central power station for electric light and locomotive power.

Competition for these new enterprises is open to the world, and as United States consul I consider it my duty to call the attention of American manufacturers to the same, and feel that your valuable publications are the best medium for that purpose; hence send this note to you.

Freiburg is a busy little city, very conservative and slow, but sure in whatever it undertakes, and whatever is constructed here is built, not for a day or lifetime, but for an age.

"Rapid" transit they have here, but it is the old-fashioned omnibus. Electric light is seen nowhere, but in several factories with private motors and dynamos. Hence the need of these new enterprises and the call for bids for the same, such bids to be in the hands of the Committee on Underground Structures (Tief-bauamt) before July 1st, 1898.

I mail you under separate cover the circular letter, plan of the city, plans and profiles of the projected enterprises, &c., such as the above-mentioned committee sends to parties interested, and shall be glad to procure any further information for you or other Americans who may take an interest in this matter.

E. THEOPHILUS LIEFELD,
United States Consul.

Freiburg, Baden, Germany, *April 29th*, 1898.

Electric Car Accident.—It is stated that on Whit Monday one of the electric cars at the Alexandra Palace was running down an incline loaded with passengers, when the brake refused to act. The car ran down the track at great speed and collided with another, doing considerable injury. Two men who jumped from the car, also a boy, were injured.

Forthcoming Lectures.—A course of lectures on "Dynamo and Transformer Construction" will be given at the Electrical Standardising, Testing, and Training Institution, Charing Cross Road, by Mr. James Swinburne, M.I.E.E., commencing Tuesday, June 7th.

Appointment Vacant.—The Aberdeen Town Council is inviting applications for the post of electrical engineer at £225 per annum. Applications have to be lodged with the Town Clerk by June 17th. See our "Official Notices."

NEW COMPANIES REGISTERED.

New & Byrd, Limited (57,453).—Registered May 23rd, with capital £5,000 in £1 shares (3,000 6 per cent. cumulative preference), to acquire the business carried on by A. New and R. New at 24, St. Thomas Street, Liverpool, as "Archer New & Co.," and to carry on the business of electrical and general engineers, electricians, and manufacturers of and dealers in electricity, motive power, and electrical apparatus. The subscribers (with one share each) are:—R. New, The Grove, Oxton, Cheshire, gentleman; A. New, Neston, Cheshire, merchant; P. H. Byrd, 36, The Woodlands, Birkenhead, electrical engineer; H. Gaskell, jun., Clayton Lodge, Aigburth; R. Edwards, 10, Ball's Road, Birkenhead, grocer; W. Buckaman, 44, Trinity Road, Bootle, miller; A. W. Willmar, 24, Village Road, Birkenhead, cotton broker. The number of directors is not to be less than two nor more than five; the first are R. New and P. H. Byrd; qualification, 50 shares. Registered by F. Wright, Palace Chambers, Westminster.

Paterson, Bell & Co., Limited (3,879).—Registered in Edinburgh, May 20th, with capital £5,000 in £1 shares, to establish and carry on in the United Kingdom or elsewhere the business of mechanical, steam and electrical engineers, contractors, and agents. The subscribers (with one share each) are:—R. Paterson, 28, Renfield Street, Glasgow, chartered accountant; J. Spence, 28, Renfield Street, Glasgow, accountant; S. Bell, 65, Bath Street, Glasgow, engineer; J. Service, 58, Renfield Street, Glasgow, solicitor; J. B. Service, 58, Renfield Street, Glasgow, stockbroker; H. Frew, Burngreen Kilsgth, Glasgow, cashier; G. Wilson, Springfield, Helensburgh, clerk. The first directors are: R. Paterson, M. Paterson, S. Bell, and T. Carlile, 23, West Nile Street, Glasgow. Qualification, 100 shares. Registered by Oswald & Son, Edinburgh.

Dargue Acetylene Gas and Electrical Company, Limited (57,489).—Registered May 24th, with capital £5,000 in £1 shares (3,000 £5 per cent. cumulative preference), to adopt a certain agreement and to carry on the business of patentees and manufacturers of acetylene gas apparatus, electricians, mechanical engineers, and suppliers of acetylene and other gas and electricity. The subscribers (with one share each) are:—W. H. Dargue, 72, Grey Street, Newcastle, electrical engineer; F. K. Hurman, 2, St. Nicholas Buildings, Newcastle, director; C. Percy, Alnwick, solicitor; T. C. Martin, 42, Grainger Street, Newcastle, chartered accountant; W. Percy, Belvedere, Alnwick, silk mercer; A. Blake, Alnwick, solicitor; W. Armstrong, 55A, Malvern Street, Newcastle, clerk. Table "A" mainly applies. Registered by Turner & Co., 61, Carey Street, W.C.

Hydro-Incandescent Gas Light Company, Limited (57,493)—Registered May 24th, with capital £200,000 in £1 shares, to adopt an agreement with M. J. Wells & S. B. Beckles to acquire certain patent rights for Great Britain, Canada, South Africa, India and Australasia, for gas compressing and pressure regulating apparatus, and to carry on the business of suppliers of gas and electricity, gas apparatus manufacturers, electricians, electrical and gas engineers, &c. The subscribers (with one share each) are:—P. C. Beachcroft, 1 and 2, Great Winchester Street, E.C., director; M. S. Myers, 18, Finch Lane, E.C, stockbroker; S. Samuel, Stock Exchange, E.C., gentleman; S. H. Banister, 59, Wrotham Road, Camden Town, clerk; H. Howitt, 11, Victoria Street, S.W., clerk; F. J. Moore, 29, The Avenue, Ealing Dean, clerk; H. Janes, Campsbourne School, Hornsey, writer. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first. Qualification, £250; remuneration, £200 each per annum. Registered by Faithfull & Owen, 11, Victoria Street, S.W.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

City of London Electric Lighting Company, Limited (34,406).—This company's return was filed on May 16th, when 60,000 ordinary and 40,000 preference shares were taken up out of a capital of £1,200,000 in £10 shares. £10 per share has been called on 50,000 ordinary and 40,000 preference, and £2 per share on 10,000 ordinary, resulting in the receipt of £920,000.

Corlett Electrical Engineering Company, Limited (36,200).—This company's annual return was filed on May 16th, when 620 shares were taken up out of a capital of £6,200 in £10 shares; 100 have been issued as paid, and £5,200 has been received on the others.

City of Mexico Electric Power Syndicate, Limited (55,438).—This company's statutory return was filed on May 12th, when 40 shares were taken up out of a capital of £5,000 in £50 shares; £25 per share has been called, and £880 paid, leaving £120 in arrears.

CITY NOTES.

The Brazilian Submarine Telegraph Company, Limited.

The report of the directors for the half-year ended December 31st, 1897, to be submitted to the forty-ninth ordinary general meeting, June 8th, 1898, states that the revenue for this period amounted to £100 300 4s. 3d., and the working expenses to £26,166 8s. 3d. After providing £3,200 for debenture interest and sinking fund, and £1,353 2s. 8d. for income-tax, there remains a balance of £69,580 13s. 4d.; to this is added the sum of £7,221 5s. 5d. brought forward from June 30th last, making a total of £76,801 18s. 9d. In commemoration of Her Majesty's Jubilee, and of the 25th anniversary of the foundation of the company, a bonus has been granted to the staff, amounting to £4,139 14s. 7d. First and second interim dividends, amounting to £39,000, have been paid, and £25,000 transferred to the reserve fund, leaving the sum of £8,662 4s. 2d. to be carried to the next account. The directors with great regret report the death of their esteemed colleague, Lord Sackville A. Cecil. The vacancy has been filled by the appointment of Sir John Wolfe Barry, K.C.B. Negotiations for closer working with the Western and Brazilian Telegraph Company, Limited, have been in progress, and an agreement will shortly be submitted to the shareholders.

South Staffordshire Tramways Company.

Mr. Somers L. Schuster (chairman) presided over the eighth ordinary general annual meeting of the above company held yesterday (Thursday) at the Cannon Street Hotel, and in moving the adoption of the report, said it was the first time he had been able to recommend a dividend of any sort, and he trusted they would now go from bad to better. The dividend to be proposed was 2⅝ per cent. on the preference shares. The working expenses amounted to £18,247 12s. 7d. as against £17,934 in the previous year. The general expenses were £1,917 against £3,521, the decrease being due to the absence of litigation. Repairs had cost £8,000, as against £6,895. He could hold out no hope of the expenses under that head decreasing, because the permanent way must be kept up. The total receipts were £32,916 4s. 5d., as against £31,830, but he could hold out little hope of this being much further increased. He thought, with their present method of traction, they had pretty well reached their maximum. The improvement which would take place if they had a much quicker and more regular, and he might say a better method of traction, would undoubtedly tend to increase the receipts very largely. If they had a 10 minutes' service as against a half-hourly service, it would make a great deal of difference; but that was a question for the future. There was a difference of opinion on the board. Mr. Dawson held the opinion that the one thing which would help the South Staffordshire Tramways was the system of auto-traction. That had been tried for two years under the supervision of Mr. Dawson, and the report of the manager showed that it was a ghastly failure. At a recent conference held at Birmingham, all represented, with one exception, were in favour of electric traction, whether overhead or underground.

Mr. Blundstone seconded the motion.

Mr. Roff asked if anything had been done with reference to handing over the company to the British Electric Traction Company, Limited.

The Chairman: The whole thing has been completed.

Mr. Roff said he protested against the way in which the vote was taken at the last meeting.

The Chairman said had it not been for the agreement the company would have been wound up. It was neck or nothing, and they had got neck and something.

Mr. Fuller said the money might have been raised somewhere else, and it was Mr. Dawson who was the true friend of the company.

The Chairman said he went to five of the largest financial houses to get the money required, and not one would touch it.

The report was adopted.

Great Horseless Carriage Company (in liquidation).—The liquidator of the above company is prepared to receive offers for certain shares in the Motor Manufacturing Company, Limited, and shares and debentures in the British Motor Company, Limited, not taken up by the shareholders of the Great Horseless Carriage Company.

Shannon Electric Power Syndicate.—We understand that Mr. J. F'G. Bannatyne, D. L., has resigned his seat on the directorate of the Shannon Electric Power Syndicate.

The Spiral Globe, Limited.—Letters of allotment for shares in this company were posted last week.

TRAFFIC RECEIPTS.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending May 27th, 1898, were £2,653 5s. 4d.; corresponding period, 1897, £2,473 2s. 6d.; increase, £180 2s. 10d.

The City and South London Railway Company.—The receipts for the week ending May 29th, 1898, were £1,012; week ending May 30th, 1897, £929; increase, £83; total receipts for half-year, 1898, £22,678; corresponding period, 1897, £22,390; increase, £288.

The Dover Corporation Electric Tramways.—The receipts for the week ending May 28th, 1898, were £147 1s. 2d.; total receipts to May 28th, 1898, £2,357 0s. 3d.

The Dublin Southern District (Electric) Tramways Company.—The receipts for week ending Friday, May 27th, 1898, were £577 2s. 1d.; corresponding week last year, £681 15s. 10d.; decrease, £104 13s. 9d.; passengers carried, 89,005; corresponding week last year, 98,010; aggregate to date, £9,498 3s. 2d; aggregate to date last year, £10,049 11s. 7d.; decrease to date, £551 8s. 5d.; mileage open, 8 miles.

The Liverpool Overhead Railway Company.—The receipts for the week ending May 29th, 1898, amounted to £1,412; corresponding week last year, £1,310; increase, £102.

The Western and Brazilian Telegraph Company, Limited.—The receipts for the week ending May 27th, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company Limited, were £3,077.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, May 25th.	Closing Quotation, June 1st.	Business done during week ended June 1st, 1898. Highest.	Lowest.
137,400l	African Direct Telegraph, 4 % Deb.	100	4 %	...	...	100 —104	100 —104	...	...
25,000	Amazon Telegraph, shares	10	...	...	...	7 — 8	7 — 8	...	...
125,000	Do. do. 5 % Debs. Red.	100	...	...	...	93 — 96	93 — 96	...	...
923,960l	Anglo-American Telegraph	Stock	£2 9s	£2 13s	3 %	64 — 67	64 — 67	65½	...
3,038,020l	Do. do. 6 % Pref.	Stock	£4 18s	£5 6s	6 %	114 —115	115 —116	115¾	114
3,038,020l	Do. do. Deferred...	Stock	...	...	...	15¼— 15¾	15¾— 16¼	15⅞	15½
130,000	Brazilian Submarine Telegraph	10	7 %	7 %	7 %	15¼— 15¾	15½— 16	15¾	15½
75,000l	Do. do. 5 % Debs. 2nd series, 1906 ...	100	5 %	...	...	112 —116	112 —116	...	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	4 %	...	3 — 3½	2¾— 3¼	2⅞	2¾
10,000,000$	Commercial Cable	$100	7 %	8 %	8 %	170 —185	180 —190	...	...
918,297l	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	104 —106	104 —106	105½	...
224,850	Consolidated Telephone Construction and Manufacturing	10/-	1½%	2 %	...	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Telegraph	10	8 %	8 %	7 %	6½— 7½	6½— 7½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	14½— 15½	14½— 15½	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 11	10 — 11	...	...
30,000l	Do. do. 4½ % Debs., Nos. 1 to 6,000 ...	50	4½%	4½%	4½%	103 —106%	103 —106%	...	...
60,710l	Direct United States Cable	20	2¼%	2½%	...	10¼— 10¾	10½— 11	10 13/16	...
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	99 —102	100—103	...	...
400,000	Eastern Telegraph, Nos. 1 to 400,000	10	6½%	6½%	...	16¾— 17¼	17 — 17½	17¼	17
70,000	Do. 6 % Cum. Pref.	10	6	6 %	...	17½— 18½	18 — 19	...	...
89,900	Do. 5 % Debs., repayable August, 1899 ...	100	5 %	5 %	...	100 —103	101 —104	...	...
1,302,615l	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	123 —127	124 —128	124½	...
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	17½— 18	17½— 18	17¾	17½
25,200l	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	5 %	5 %	100 —104	100 —104	...	...
100,500l	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	5 %	5 %	101 —104	101 —104	...	...
320,000l	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	126 —129	126 —129	...	...
35,100l	Eastern and South African Telegraph, 5 % Mort. Deb., 1900 red. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	...	100 —104	100 —104	...	...
46,000l	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	...	101 —104	101 —104	...	...
300,000l	Do. 4 % Mort. Debs., Nos. 1 to 3,000, red. 1909	100	4 %	4 %	...	101 —104	101 —104	...	...
200,000l	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	4 %	4 %	...	105 —108%	105 —108	...	...
180,227	Globe Telegraph and Trust	10	4⅛%	4½%	4½%	11½— 12	11¼— 11¾	11⅞	11⅝
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6 %	16¾— 17¼	16½— 17	17¼	16 15/16
150,000	Great Northern Telegraph, of Copenhagen...	10	10 %	10 %	10 %	28½— 29½	28½— 29½	29⅛	...
160,000l	Do. do. do. do. 5 % Debs. ...	100	5 %	5 %	5 %	100 —103	100 —103	...	...
97,000	Halifax and Bermuda Cable, 4½ % 1st. Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	97 —102	98 —103	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	50 — 53	50 — 53	...	...
100,000l	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	6 %	6 %	107 —110	108 —111	109½	...
28,000	Montevideo Telephone, 6 % Pref., Nos. 1 to 28,000 ...	5	4 %	4 %	4 %	2¼— 2¾	2¼— 2¾	...	...
484,597	National Telephone, 1 to 484,597	5	5½%	5½%	6 %	5½— 5¾	5½— 5¾	5 11/16	5½
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	14 — 16	14 — 16	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5⅜— 5⅝	5⅜— 5⅝	5 9/16	5½
1,329,471l	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	99 —104	101—106	103½	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	⅝— ¾	⅝— ¾	...	...
100,000l	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	4 %	4 %	4 %	105 —108	105 —108	...	...
11,839	Reuter's	8	5 %	5 %	5 %	8 — 9	8 — 9 xd	8	...
3,381	Submarine Cables Trust	Cert.	...	...	...	136 —141	136 —141	...	...
58,000	United River Plate Telephone	5	4 %	5 %	...	4 — 4½	4 — 4½	...	...
146,733l	Do. do. 5 % Debs.	Stock	5 %	...	...	104 —107	104 —107	...	...
15,609	West African Telegraph, 7,501 to 23,109	10	4 %	*nil*	*nil*	3½— 4½	3½— 4½	...	...
213,400l	Do. do. 5 % Debs.	100	5 %	5 %	5 %	99 —102	99 —102	...	...
64,269	Western and Brazilian Telegraph	15	3 %	2 %	3¼%	11½— 12	12 — 12½	11⅞	...
33,129	Do. do. do. 5 % Pref. Ord.	7½	5 %	5 %	5 %	7½— 8	7½— 8	7 13/16	7¾
33,129	Do. do. do. Def. Ord.	7½	1 %	*nil*	½%	4 — 4½	4 — 4½	4 7/16	...
389,521	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	104 —107	104 —107	...	...
88,321	West India and Panama Telegraph	10	⅞%	1 %	¾%	½— ¾	½— ¾	⅝	9/16
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	6 %	6 %	7¼— 7¾	7¼— 7¾	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	6 %	6 %	5 — 7	5 — 7	...	...
80,000l	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	5 %	105 —108	106 —109	...	...
1,163,000$	Western Union of U.S. Telegraph, 7 % 1st Mort. Bonds	$1000	7 %	7 %	7 %	103 —108	103 —108	...	...
160,100l	Do. do. do. 6 % Ster. Bonds ...	100	6 %	6 %	6 %	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

Present Issue.	NAME.	Stock or Share.	1895.	1896.	1897.	Closing Quotation, May 25th.	Closing Quotation, June 1st.	Highest.	Lowest.
30,000	Charing Cross and Strand Electricity Supply	5	5 %	6 %	7 %	12 — 13	12 — 13	12¾	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	...	...
26,000	*Chelsea Electricity Supply, Ord., Nos. 1 to 10,277... ...	5	5 %	5 %	6 %	8½— 9½	8½— 9½	9	...
60,000	Do. do. do. 4½ % Deb. Stock Red....	Stock	4½%	4½%	4½%	115 —117	115 —117	...	...
50,000	City of London Electric Lighting, Ord. 40,001—90,000 ...	10	5 %	7 %	10 %	24½— 25½	24½— 25½	25⅛	24⅞
10,000	Do. Prov. Certs. Nos. 90,001 to 100,000 £5 ...	10	...	...	...	16½— 17½	16½— 17½	...	...
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16½— 17½	16½— 17½	16½	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	129 — 134	129 —134	...	...
30,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—30,000	10	*nil*	*nil*	*nil*	13 — 14	13 — 14	...	...
10,000	Do. do. do. Nos. 30,001 to 40,000 £4 paid.	10	...	...	...	6½— 7½	6½— 7½	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	15 — 16	15 — 16	...	...
17,400	Edmundsons Elec. Corp., Ord. Shares 1—17,400 £4 paid	5	...	...	...	3½— 4½	3½— 4½	...	...
10,000	House-to-House Electric Light Supply, Ord., 101 to 10,100	5	...	...	4 %	9 — 10	9 — 10	...	...
10,000	Do. do. 7 % Cum. Pref. ...	5	7 %	7 %	7 %	11 — 12	11 — 12	...	...
62,400	*Metropolitan Electric Supply, 101 to 62,500	10	4 %	5 %	6 %	16½— 17½	16 — 17	16¾	16½
220,000l	Do. 4½ % First Mortgage Debenture Stock	...	4½%	4½%	4½%	117 —121	117 —121	...	...
6,452	Notting Hill Electric Lighting	10	2 %	4 %	6 %	18½— 19½	18½— 19½	...	...
31,980	*St. James's and Pall Mall Electric Light, Ord.	5	7¼%	10½%	14½%	16 — 17	16 — 17	16¾	16⅝
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	10 — 11	10 — 11	...	...
50,000	Do. do. 4 % Deb. Stock Red. ...	Stock	...	...	4 %	107 —110	107 —110	...	...
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2 — 2½	2 — 2½	2 7/16	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000 ...	5	7 %	9 %	12 %	15½— 16½	16 — 17	16⅜	...

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation May 25th.	Closing Quotation June 1st.	Business done during week ended June 1st, 1898. Highest.	Lowest.
30,000	British Electric Traction	10	...	...	...	$15\frac{1}{2}$— 16	$15\frac{1}{2}$— 16	$15\frac{7}{8}$	...
10,000	{ Do. do. 6 % Cum. Pref. 30,001—40,000 £4 pd. (issued at £2 10s. prem. all pd.) }	10	...	...	...	7 — 8	7 — 8	...	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	3	$2\frac{1}{2}$%	*nil*	*nil*	$1\frac{3}{4}$— 2	$1\frac{3}{4}$— 2	2	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	*nil*	4 %	$2\frac{1}{4}$— $2\frac{1}{2}$	$2\frac{1}{4}$— $2\frac{1}{2}$	...	...
125,000*l*	Do. do. $4\frac{1}{2}$ % Perp. Deb. Stock ...	Stock	...	...	...	110 —114	110 —114	...	...
50,000	Do. do. $4\frac{1}{2}$ % 2nd Deb. Stock Red. ...	Stock	...	...	...	101 —104	101 —104	...	...
19,894	Central London Railway, Ord. Shares	10	...	...	...	10 — $10\frac{1}{2}$	10 — $10\frac{1}{2}$	$10\frac{3}{8}$	$10\frac{1}{4}$
129,179	Do. do. do. £6 paid	10	...	...	...	6 — $6\frac{1}{2}$	6 — $6\frac{1}{2}$	$6\frac{3}{16}$	...
59,254	Do. do. Pref. half-shares £1 paid ...	...	...	...	...	$1\frac{1}{4}$— $1\frac{3}{4}$	$1\frac{1}{4}$— $1\frac{3}{4}$	...	...
67,680	Do. do. Def. do. £5 paid ...	...	...	...	...	$4\frac{1}{4}$— $4\frac{3}{4}$	$4\frac{1}{4}$— $4\frac{3}{4}$	...	...
630,000*l*	City and South London Railway	Stock	$1\frac{3}{16}$%	$1\frac{9}{16}$%	$1\frac{7}{8}$%	67 — 70	68 — 71	$69\frac{7}{8}$	69
28,180	Crompton & Co., 7 % Cum. Pref. Shares, 1 to 28,180 ...	5	*nil*	...	...	2 — $2\frac{1}{2}$	2 — $2\frac{1}{2}$	...	...
99,261	{ Edison & Swan United Elec. Lgt., "A" shares, £3 pd. 1 to 99,261 }	5	5 %	$5\frac{1}{2}$%	...	$2\frac{1}{4}$— $2\frac{3}{4}$	$2\frac{1}{4}$— $2\frac{3}{4}$	...	...
17,139	Do. do. do. "A" Shares, 01—017,139	5	5 %	$5\frac{1}{2}$%	...	4 — 5	4 — 5	...	...
194,023	Do. do. do. 4 % Deb. Stock Red. ...	100	...	...	...	103 —105	103 —105	...	...
110,000	Electric Construction, 1 to 110,000	2	5 %	6 %	...	$2\frac{5}{8}$— $2\frac{7}{8}$	$2\frac{5}{8}$— $2\frac{7}{8}$	$2\frac{3}{4}$	$2\frac{5}{8}$
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 ...	2	7 %	7 %	...	$3\frac{1}{8}$— $3\frac{3}{8}$	$3\frac{1}{8}$— $3\frac{3}{8}$	...	...
111,100	Do. do. 4% Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	106 —108	106 —108	...	...
91,196	Elmore's Patent Copper Depositing, 1 to 70,000	2	...	...	...	$\frac{1}{2}$— $\frac{3}{4}$	$\frac{1}{2}$— $\frac{3}{4}$	...	...
67,275	Elmore's Wire Manufacturing, 1 to 69,385, issued at 1 pm.	2	...	...	...	$\frac{3}{8}$— $\frac{5}{8}$	$\frac{3}{8}$— $\frac{5}{8}$	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	$10\frac{1}{2}$%	7 %	7 %	9 — 11	9 — 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ord.	10	8 %	12 %	10 %	$21\frac{1}{2}$— $22\frac{1}{2}$	$21\frac{1}{2}$— $22\frac{1}{2}$	$22\frac{1}{4}$	...
3,000	Do. do. do. 7 % Pref.	10	7 %	7 %	7 %	$18\frac{1}{2}$— $19\frac{1}{2}$	$18\frac{1}{2}$— $19\frac{1}{2}$	$18\frac{1}{2}$	...
50,000	Do. do. do. $4\frac{1}{2}$ Mort. Deb. Stock...	Stock	$4\frac{1}{2}$%	$4\frac{1}{2}$%	$4\frac{1}{2}$%	110 —115	110 —115	$114\frac{3}{4}$	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	10 %	21 — 22	21 — 22	$21\frac{3}{8}$	$21\frac{1}{4}$
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	102 —106	102 —106	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	$2\frac{7}{8}$%	$2\frac{7}{8}$%	$3\frac{1}{4}$%	$10\frac{5}{8}$— $10\frac{3}{4}$	$10\frac{5}{8}$— $10\frac{3}{4}$	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	$15\frac{3}{4}$— $16\frac{1}{4}$	$15\frac{3}{4}$— $16\frac{1}{4}$	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	34 — 37	34 — 37	$36\frac{1}{2}$	...
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	...	...	133 —136	132 —135	134	$133\frac{1}{4}$

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) $10\frac{1}{2}$.

House-to-House, $4\frac{1}{2}$% Debentures of £100, 107—110.

Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 15—16; 1st Preference Cumulative 6%, £5 (fully paid), 8—$8\frac{1}{2}$. Debentures, 107—110. Dividend, 1897, on Ordinary Shares 10%.

London Electric Supply Corporation, £5 Ordinary, $3\frac{1}{2}$—4.

*T. Parker, £10 (fully paid), $15\frac{1}{2}$.

Yorkshire House-to-House Electricity, £5 Ordinary Shares fully paid, 8—$8\frac{1}{2}$. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount 4 per cent. (April 7th, 1898).

AUSTRALIAN NEWS.

[FROM OUR OWN CORRESPONDENT.]

ELECTRICAL work in New South Wales appears at present to be confined to Government works, the trams being monopolised by the Railway Commissioners, and the only electric lighting contracts settled lately being for the lighting of various Government offices. The George Street electric tramway is beginning to show signs of progress, as work has been commenced on the permanent way at the Harris Street end of the line, and walls are springing up on the spot selected for the power house and car house, which, by the irony of fate, are on the site of the old omnibus stables. In connection with this line further contracts have been awarded to Messrs. Phippard Bros. for erecting the chimney stack for the power house, at a cost of £2,365, and to Messrs. Stewart & Co. for the erection of car house at £12,490. In the case of the former, two sets of tenders were called. On the first specification the prices varied from £5,285 to £6,864, nine tenders being received, on the amended specification ten tenders were sent in varying from £2,365 to £3,750. The car house will be 273 feet by 130 feet, built on hardwood piles, with planking, wailing, &c., with concrete foundation. There will be a suite of offices comprising employers', dining, lavatory, and store rooms; the side walls are brick, with iron principals roofed with nine spans of saw-tooth form. The roof principals, of which there are over 100 of 30 feet span, are rolled iron, supported on rolled iron columns. Front facing roadway is supported on cast-iron columns closed in with revolving shutters; back end wall consists of timber. On floor of car house is an examining pit, 114 feet by 60 feet and 4 feet deep, cars carried over same by strong iron back railbearers, 10 × 8; also a repairing pit constructed of concrete, 173 feet by 14 feet. The chimney shaft is to be of circular form, 235 feet above ground line, with concrete footing and brick base. Mr. C. Keeling's tender of £775 for the trolley wire for this line has also been accepted.

The Rose Bay tramway is also progressing favourably, the generators have been housed at last, the underground feeders laid, and a considerable portion of the permanent way laid and bonded, and the rails of the cable train, of which this line will be an extension, are also bonded with Edison-Brown plastic bonds. Feeders have also been laid, together with those for the tramway, for an electric pumping station for the Double Bay sewerage, and it is probable that the new generators will first be utilised for this purpose, as the pumping plant bids fair to be completed well before the tramway.

The Public Works Department have recently gone in very extensively for electric lighting, amongst those completed being the Hawkesbury Agricultural College, Kenmore Asylum for the Insane, Berrima and Darlinghurst Gaols, and the Government printing office. For the lighting of the Goulburn Gaol 14 tenders were received, ranging from £2,387 to £2,669, Messrs. F. Lasseter & Co.'s tender of £2,450 being accepted for Ransomes, Sims & Jefferies engine and Siemens dynamo. For the Bathurst Gaol nine tenders, varying from £1,986 to £2,616 were received. Specifications are in hand for the electric lighting of other public buildings.

In the matter of the electric lighting of the city of Goulburn, though tenders were only received from two firms, the Council have accepted the tender of Mr. R. Thompson at £7,665, to include a Lancashire boiler, Worthington pump, and three 35-H.P. engines, the system to be three-wire at 440-volts, and mains to be placed underground in the principal thoroughfares. The tender also provides for running the plant for two years at £600 per annum, charging $4\frac{1}{2}$d. per unit for private consumption.

At Tamworth the Municipal Council, after a lengthy discussion, unanimously adopted the report of the Lighting Committee recommending a comprehensive scheme for the utilisation of the surplus water-power at the service reservoir for generating electricity for both the public and private lighting of the town. It is proposed to erect a duplicate set of Pelton wheels and dynamos capable of supplying from 1,200 to 1,400 16-C.P. lamps; using overhead mains, the cost is estimated at about £4,300. Steps will now be taken to secure the passage through Parliament of a Bill empowering the Council to contract with the people for a supply of electric light, also for power to make charges and collect the same. (Needless to say, that, notwithstanding repeated ministerial promises, the N.S.W. General Electric Lighting Act is still hung up indefinitely). The Council confidently anticipate being able to reduce the Tamworth lighting rate from 5d. to 3d. if this scheme is carried out, and give private consumers current at a rate equal to about half the present cost of gas.

At Broken Hill reports on the lighting of the town have been submitted by gas and electrical experts. The prime cost of electric lighting is estimated at £12,500, with an annual maintenance charge of £2,657 10s., while the gasworks, &c., is estimated to cost £8,750 to put down and annual cost of working £1,936 10s. Under these circumstances, and as there is already an electric supply company in Broken Hill, it is hardly probable that the Municipal Council will put down an electric light plant.

The New South Wales Department of Industry recently asked the Crown solicitor to give his opinion as whether, legally considered, electricity can be defined as "goods." The Department wished to know if a place engaged in the generation of electricity was a factory within the meaning of the Factories and Shops Act of 1896. The Crown solicitor has given the opinion that, for the purposes of this Act, the generation of electricity is the manufacture of goods.

In Victoria, the recently passed Electric Lighting Act has generally stirred up the Melbourne electric supply companies. The A. U. Alcock Electric Lighting and Power Company appeared before the Postmaster-General recently to prosecute their application for an extension of the area within which they may operate. They were opposed by the municipalities of Melbourne and Hawthorne, the other corporations interested consenting to the application. It was represented that the A. U. Alcock and Australian Electric Lighting Companies were to be amalgamated, and that the joint business was to be conducted with the aid of a large amount of British capital. The money would be forthcoming as soon as the order sought was obtained, and the united company would be in a position to cater for every possible electric want in Melbourne. A compromise between the City Council and the companies was suggested, but proved fruitless. Since then the Melbourne City Council have made a further move. The Lighting Committee have recommended that the Corporation should exercise its statutory power in buying out the electric lighting companies, and undertake the whole task of supplying the metropolis with electric light. This announcement was made by the Mayor of Melbourne to the Postmaster-General in connection with a further application from the companies. Some months ago the Corporation began to supply private customers with light at a lower rate than that charged by the companies, and it is therefore claimed that the interests of the citizens will be much better served when the business of electric lighting is wholly in the hands of the Corporation. A special meeting of the Council will be called to consider the committee's report. If it be adopted—and of that the Mayor thinks there is no doubt—the necessary steps will be at once taken to determine the sum to be paid to the companies. The Electric Light and Power Act provides that each company shall receive the value of its works, materials, land, and buildings, with 10 per cent. added. The book values of the assets of the two companies amount to nearly £150,000.

In marked contrast to this, the Sydney Municipal Council are not making the slightest attempt to avail themselves of the powers granted to them by Act of Parliament so long ago. In the meantime, a number of small central supply stations are starting up, and supply mains are to be seen stretching in all directions over the house-tops; and by the time the Sydney Council do make up their minds, these will have to be dealt with as the Melbourne Corporation are now doing.

In Brisbane the Municipal Council have given notice of their intention to apply for an order-in-council under the new Act, to supply electricity within the city. Within two years from the date of the order, it is intended to construct electric lines and works in 29 streets. The Brisbane Railway Commissioners are endeavouring to arrange with the tramway company for the lighting of the long railway tunnels with electricity. The company's manager has placed the matter before the directorate to complete arrangements. The tramway company has some 24 miles of track now working.

Sydney, *April 14th*, 1898.

INSTITUTION OF CIVIL ENGINEERS' CONVERSAZIONE.

On Thursday and Friday evenings of last week the Institution of Civil Engineers' conversazione was held at Great George Street. The Civil's conversazione always possesses considerable interest for electrical men, but the 1898 gathering may be safely said to eclipse all others in this respect, the president for the year being Mr. W. H. Preece, C.B., F.R.S., whose position as engineer-in-chief to the General Post Office, and whose popularity among electrical men will, we hope, make the session, to a large extent, an electrical one. We take this opportunity of again congratulating Mr. Preece upon being appointed first electrical president of this time-honoured Institution.

On Thursday night the president, Miss Preece, and the Council, received the guests. As already intimated in our columns, there was brought together by Mr. Killingworth Hedges, in honour of Mr. Preece's election, an exhibition of electrical apparatus of historical interest.

The programme was a very elaborate one, and we quote a few of the items. The string band of the Royal Engineers played in the Hall during the evening; there were exhibitions of views by the biograph; an exhibition by Captain Abney of Dr. Joly's process of photography in natural colours; a demonstration by Mr. Campbell Swinton on some phenomena of the electric discharge in vacuo; a demonstration of wireless telegraphy by Mr. J. Gavey; and various engineering models and scientific apparatus were on exhibition. Mr. Wallis-Jones, of the Electric Welding Company, showed the latest type of automatic electric welder, and samples of recent advances in electric welding; Hon. C. A. Parsons had on view a unipolar dynamo made in 1887, and an 1884 turbo-generator. The Edison & Swan Company's exhibit comprised some of the earliest Ediswan lamps and holders, including the original Swan lamp lent by Mr. Swan. Mr. Crompton showed a Crompton-Pochin projector arc lamp, a 1,000-ampere automatic zero cut-out, a 500-ampere heavy pattern switch, and electric thermometers at work. Mr. James White had a number of Kelvin instruments; Mr. Cowper-Coles had parabolic reflectors; Dick, Kerr & Co., sections of rails and sleepers; Mr. L. B. Atkinson, early types of Swan & Lane-Fox lamps. Mr. Alexander Siemens exhibited an electric drill, a deck driller, a Hughes telegraph transmitter, a Cardew transmitter, a submarine detector and exploders. Mr. Killingworth Hedges, in addition to his collection of apparatus, showed specimens of copper rapidly deposited by electrical currents of high densities. Mr. W. E. Gray (Silvertown) had some cables and electric light apparatus on view, and Messrs. Barnard & Carver showed arc lamps applicable to photo-micrography and other projection apparatus. Messrs. A. Wright & Co. exhibited a 60-inch Letheby-Bunsen standard photometer made by them for the Hinckley Urban Council. Mr. Preece lent a Gaulard and Gibbs transformer. Mr. Lundberg showed a number of his specialities. Edmundson's Electricity Corporation showed some original types of electrical fittings. Mr. Hedges lent a Gramme dynamo made by Mr. W. Blanch Brain about 1878, the original Lane-Fox meter, and system of cut-outs, fuses, and switches invented by Lord Kelvin about 1881. Mr. A. G. Lyster showed some early Serrin lamps.

From the above notes may be gained a general idea of the very varied and interesting character of the exhibition which formed an important feature in the conversazione arrangements.

SOME NOTES ON AN ELECTROLYTIC METHOD FOR THE RECOVERY OF GOLD FROM CYANIDE SOLUTIONS.*

By SHERARD COWPER-COLES, A.M.I.C.E., M.I.E.E.

One of the chief difficulties appertaining to the economical recovery of gold from weak cyanide solutions by electrolysis has been the electrodes. If several sheets are cut superimposed, the strips cling together, and have to be carefully spread out one by one, so that the surface may be exposed to the solution. A clean up is made every seven or eight weeks, when the wood frames carrying the lead strips are withdrawn, the lead strips removed, and new substituted, the auriferous lead being ultimately melted down and conveyed to a central works to be cupelled. This method is both crude and expensive, the labour of fitting the strips into the frames is considerable, and the consumption of lead is a considerable item, having been computed by Mr. Von Gernet, at the Worcester mine, at 1·10 of a penny per ton of ore treated, and Mr. Williams, at the Crown Reef Gold Mining Company, at 1·75.

The cathode should fulfil the following conditions:—

1. The gold must be adherent during the process of deposition.
2. The gold must be capable of being readily stripped after remova from the electrolysing cell.
3. The cathode should be electro-positive to the gold in solution, so that it is coated with gold on immersion.

These conditions are fulfilled, I find, by substituting an aluminium cathode for a lead one, advantage being taken of the fact that a loose film of oxide is very rapidly formed on aluminium, the difficulty in soldering and electro-plating aluminium for this reason being well known. The substitution of aluminium for lead foil, or strip, enables the gold to be obtained as pure gold, and daily returns to be made of the amount of gold recovered; it also has the additional advantage of reducing the cost of labour and economising the amount of cyanide of potassium used, as the solution is not contaminated by any base metal such as zinc. The deposition of gold from a cyanide bath on to an aluminium plate proceeds in a uniform manner, but in such a way that the gold is deposited as a metallic sheet which is easily detachable from the aluminium cathode. This peculiar property of aluminium is made use of in the invention so that the gold deposit can be removed by stripping or peeling or rubbing almost as soon as it is formed, and if as proposed, the aluminium cathode consists of a sheet of the metal fixed to a revolving drum or cylinder, by varying the rate of rotation the film of gold can be brushed or removed from off the cathode continuously, so that the process is an automatic one, resulting in the immediate and continuous recovery of the gold without any subsequent cupellation of the lead as in the older electrolytic process.

The process has therefore in it the elements of economic working, coupled with the quick recovery of the valuable gold. In the Siemens-Halske process, the lead cathodes remain some weeks in the bath, and the gold, which only then amounts to about one-tenth the weight of the cathode, is only recoverable therefrom after a second further operation of smelting and cupellation. In the Siemens-Halske process lead was chosen as the cathode, as it has the property of allowing the gold to adhere to it. In the aluminium process aluminium is used as the cathode, as it permits of the easy removal of the gold film. In the former process the gold has to be won from the lead by a secondary operation; in the latter the gold is directly obtained in the form of a pure foil, without any further expense or trouble. Gold, by this process, has been successfully extracted from cyanide solutions containing only ·01 per cent. of cyanide of potassium, and

* Read before the Institution of Mining and Metallurgy, April 20th, 1898.

2½ dwts. of gold to the ton of solution. The best results are obtained when the solution is raised to a temperature of about 100° F.; it is also found advantageous to use a greater current density with the necessary increased voltage when the aluminium plates have been freshly placed in the solution, so as to ensure their being covered with a film of gold as quickly as possible, otherwise there is a tendency for aluminium hydrate to be formed. In about 10 hours an extraction of 95 per cent. can be obtained by the use of the aluminium cathodes, the amount of gold in solution before electrolysis being 2½ dwts. to the ton of solution, and the strength of cyanide ·01 per cent. and the rate of flow about 15 gallons per 100 hours for every cubic foot of electrolysing cell or three square feet of cathode surface. Gold has been deposited on aluminium cathodes from solutions containing only ·0075 per cent. of cyanide of potassium; the current density per square foot being ·03, and E.M.F. at the poles of the generator 6 volts.

The following are the results obtained from gold cyanide solutions of varying strengths, with aluminium cathodes and iron anodes.

First Experiment.

A cyanide solution containing 3·2 grammes = 2 dwts. gold per gallon and 22·71 grammes per gallon of potassium cyanide or 0·5 per cent. solution was electrolysed. The aluminium cathode had an area of half a square foot, and two similar sized iron plates formed the anodes, placed 1½ inches from each side; the amperage being 1·50 and the voltage 1·40 at the terminals of the electrolysing cell. The gold began at once to deposit on the aluminium cathode as a bright coherent coating, and the deposition was allowed to continue for 15 minutes, when the amperage was found to be 2·0 and the voltage 3·40. The layer of gold could be completely and easily detached by rubbing gently with a piece of india-rubber tubing fixed on a glass rod.

A fresh cathode was then inserted.

Time of immersion ...	1.05 ...	Amps., 3·10 ...	Volts, 4·40
Taken out	1.20 ...	„ 3·20 ...	„ 4·60

The gold was removed from this cathode, and a fresh one inserted, without changing the conditions.

Taken out	1.50 ...	Amps., 2·60 ..	Volts, 4·70

As gold still continued to be deposited the experiment was continued.

Time of immersion ...	2.20 ...	Amps., 2·80 ...	Volts, 4·70
Taken out	2.55 ...	„ 2·60 ...	„ 4·80
Time of immersion ...	3.0 ...	„ 2·30 ...	„ 4·60
Taken out	4.0 ...	„ 2·20 ...	„ 4·90
Time of immersion ...	4.15 ...	„ 2·60 ...	„ 4·90
Taken out	5.15 ...	„ 2·00 ...	„ 4·90

The whole quantity of gold recovered in these six experiments was well washed to remove traces of potassium cyanide, and then weighed—

Gold added ...	3·200	grammes ...	100 per cent.
Gold found ...	2·7108	„ ...	84·70 „

It will thus be seen that 84·70 per cent. of the total gold was recovered from the solution in 3 hours 35 minutes, using an average amperage of 2·51 per plate, or a current density of 5·02 amperes, and an average voltage of 4·63.

Second Experiment.

In this experiment a weaker solution of potassium cyanide containing 11·35 grammes per gallon = 0·25 per cent. solution was employed. The percentage of gold was nearly doubled, viz, 91 grains = 5 = 94 grammes = 3·80 dwts. per gallon.

The experiment was divided into two portions, the yield of gold at each stage being determined.

First stage:—

Time of immersion,	11.15 ...	Amps., 3·00 ...	Volts, 4·75
Taken out	1.05 ...	„ 2·00 ...	„ 5·10

Second stage:—

Time of immersion,	1.20 ...	Amps., 2·10 ...	Volts, 4·90
Taken out	3.40 ...	„ 2·00 ...	„ 4·80

The experiment had to be discontinued at this stage owing to a short-circuit taking place within the cell.

The gold recovered—

First stage, in 1 hour 50 min., 3·005 grammes = 50·59 per cent.
Second stage, in 1 hour 20 min., 0·875 grammes = 14·73 per cent.

A total quantity of gold amounting to 65·32 per cent. was, therefore, recovered in 4 hours and 10 minutes, although it will be noted that the greater part of the gold was deposited in the first two hours.

Third Experiment.

A solution containing 6 dwts. of gold per gallon and 32·71 grammes of potassium cyanide, being a 0·5 per cent. solution, was employed.

The gold was deposited in three stages and weighed separately, as follows:—

First stage—

Time	5.30 ...	Amps., 6·25 ...	Volts, 4·30
Taken out ...	6.00 ...	„ 5·20 ...	„ 4·10

Gold deposited, 2·930 grammes = 32·02 per cent.

Second stage:—

Time	6.12 ...	Amps., 4·80 ...	Volts, 4·10
Taken out ...	6.45 ...	„ 4·20 ...	„ 4·30

Gold deposited, 1·340 grammes = 14·68 per cent.

Third stage:—

Time	6.55 ...	Amps., 2·20 ...	Volts, 2.30
Taken out ...	8.45 ...	„ 2·10 ...	„ 2·30

Gold deposited, 2·055 grammes = 22·46 per cent.

69·13 per cent. of gold was thus recovered in 3 hours 33 minutes, and the greater part was also deposited in the first half hour, viz., 32·02 per cent.

These experiments demonstrate that the process affords a quick method for depositing gold from its cyanide solutions, and also show that it is easy to remove the film of metallic gold from the aluminium cathode by mechanical means.

In another experiment some gold tailings were carefully assayed, and found to yield a button of gold, equivalent to 1·4 grammes gold per 1,000 kilos., or approximately 1 dwt. per ton.

The quantity of tailings used for testing the efficiency of the process was 90 lbs. This quantity was placed in a suitable vat, and treated by the well-known methods for extracting the gold by means of a cyanide solution. The tailings were first leached with a weak caustic soda solution, containing 4 ounces caustic per ton of water, and after its removal, a cyanide solution containing 0·5 per cent. K C N was added. This solution was allowed to leach the tailing for several hours, and was then drawn off into an electrolytic vat. The tailings were then leached dry for some hours in order to ensure the complete solution of the gold, and the double cyanide so formed was leached out with a weak cyanide solution containing 0·18 per cent. K C N. After this solution had been drawn off into the electrolytic tank the last traces of the gold solution was washed into the vat with water. The time occupied for the whole operation was 50 hours, so that it represented the same time as is used in actual practice on a commercial scale. The total amount of liquors obtained in this way and submitted to electrolysis amounted to about 50 litres, or about 11 gallons, or about half the weight of the tailings treated.

From the above assay the theoretical quantity of gold which should be extracted from the above weight of tailings is 0·056 gramme, or $\frac{1}{30}$th of a dwt. On submitting the solution to electrolysis, a current of 0·29—0·31 ampere was employed, at a pressure of between 6 and 7 volts. As the area of the aluminium cathode was approximately 1 square foot, the current density corresponds to the amperes. The electrolysis was allowed to proceed for seven hours, and at the end of that time the gold was seen covering the whole of the cathode as a very bright golden deposit of extreme thinness. Notwithstanding the thinness of the film, it was found possible to detach it mechanically.

THE DIESEL OIL ENGINE.

As considerable attention has of late been directed to the Diesel motor, it may be of interest to compare its operation with other internal combustion engines from which the Diesel motor differs in one rather important principle.

In the standard, or Otto type of engine, worked either by gas or by oil, there are four strokes of the piston in the full power cycle, two out-strokes and two in-strokes in the following sequence: No. 1, an out-stroke drawing in a charge of gas and air. No. 2, an in-stroke compressing this charge, which is ignited by *external means* just at the point of maximum compression. No. 3 is the out-stroke during which the ignited gases do work on the piston, and No. 4 is the in-stroke of exhaust when the products of combustion are expelled. If a good diagram be examined from an ordinary gas engine, it will be observed that the compression line is joined to the expansion line by a vertical line of explosion. This shows that the gas mixture, compressed in the clearance space of the cylinder is burned instantaneously, or to use the physicists' terms, the combustion takes place at constant volume. The volume of the clearance space controls the pressure of compression. Apart from the heating of the charge by compression and from the cylinder walls, the pressure will simply vary with the ratio of the total cylinder volume to the clearance space. Thus if the clearance is 20 per cent. of the total volume, the compression will run up to five atmospheres. Obviously, as explosion takes place at constant volume, it must be accompanied by an increase of temperature.

By compressing a gas its temperature is raised, the work of compression becoming converted into heat. Conversely if a gas be compressed it will ignite more readily than when not compressed. By very high compression it would be found that the charge in a gas engine would explode spontaneously, and ignition might be thus secured without external means. In the oil engine of the Hornsby-Akroyd type ignition would always be premature if it were not that the vaporiser were shut off from the cylinder by the long bottle neck through which the air necessary to explosion has to travel to mix with the oil vapour in the hot vapouriser. In the Diesel motor there are two differences from the foregoing mode of working. In the first place the compression is very great, rising to over 500 lbs. per square inch. At this high compression the combined effect of compression and of the cylinder heat is to raise the temperature of the compressed charge to a very high point, so high, indeed, that if a combustible were present it would ignite. The compressed charge consists of air only, and at the point of maximum compression, fuel is introduced by means of a small pump, and as the piston moves on its outward working stroke the combustion of the injected fuel maintains the temperature so that the expansion line is much fuller than the compression line, the difference being work. By regulating the fuel admission the combustion does not cause, as in the ordinary engine, a sudden and large increase of temperature, but merely as above stated keeps up such temperature as was attained by compression, the endeavour being to secure isothermal expansion. There is, in fact, no sudden explosion in the Diesel engine. The fuel ignites as it enters a vessel of highly compressed air and burns just as an ordinary gas jet burns when it enters the atmosphere from a common burner with a light to give its initial ignition. The large ratio of air present, its high pressure bringing every particle of fuel into close contact with plenty of air, produces a perfect combustion. Obviously with such high pressures the expansion ratio can be great, and it is said that the clearance space is not over 7 per cent. Hence in the larger sizes compound working is resorted to. The compound Diesel motor is made so far with two high pressure cylinders and one low pressure cylinder, the latter having a working stroke every revolution and taking its charge from the high pressure cylinders alternately, these being arranged to alternate their working strokes for this purpose. One end of the low pressure cylinder is used as the first stage air compressor. Air is partially compressed into a reservoir, whence it flows to each of the small cylinders, and is in them compressed to about 500 lbs. The Diesel motor differs from the ordinary gas engine in not having an explosive mixture to compress. It works simply by the heat effect of a flame burning in compressed air.

So far the fuel used in this new motor seems to be oil, but powdered coal has been suggested as a practical fuel, though it seems to us that the dust therefrom would be prejudicial in vertical engines except where the shaft is above the cylinders, so that dust cannot reach the pistons so readily, an arrangement much against the possibility of introducing the coal by gravity. Originally, too, the water jacket was not to have been employed, but has been found necessary.

It is claimed that a fuel efficiency is secured of 28 per cent. as against 18 per cent. for ordinary gas engines. Even half of this saving would mean a very big saving. The doubts that will advance themselves will be in reference to the satisfactory working of an internal combustion engine with such very high pressures. Given this item, and there is no reason why the Diesel motor should not succeed and be economical. But except that it compresses air only and injects its fuel when ignition is required there is not so very much really new about it. It has long been known that increased compression meant an increased economy in the gas engine. Increased compression could not, however, be arranged, or there would be premature explosion, and high compression is thus only possible with the new method of supplying fuel. The Diesel motor is in fact a device for securing high compression, as pointed out by theory, should be secured. The fact that the compressed charge is all air, causes the combustion of the fuel jet to be very perfect, and there is no smoke or smell from this motor.

Generally speaking, the theory seems to be all right. Can the practice be made so? This is, of course, a question for constructive mechanics. The pressure to be employed is one which must tell seriously upon pistons, though against this is to be set the absence of explosive action. The maximum pressure is brought gradually on the parts during the compressive stroke, and the pressure line of the diagram is merely kept above the line of compression by the heat action of the burning jet. Originally the inventor talked of a compression running into hundreds of atmospheres and there was to be no water-jacketting.

The engine experimented with in Germany about 1894 had a compression of 90 atmospheres. As now being made, we believe about 35 atmospheres is the maximum compression; there is a water jacket, and the efficiency, instead of the hoped for 60 to 70 per cent., is less than 30 per cent. The inventor has set himself a difficult task. We should like to see him succeed in a very praiseworthy attempt to secure motor working nearer to thermo-dynamically correct lines. As he himself said, if the very high pressures he proposed could be employed, motors would become mere models compared with our existing steam engines. In Herr Diesel's book, "The Rational Heat Motor," published about four years ago, very high expectations were held as to the possibility of high pressures and the abolition of the water jacket and efficiencies of 70 per cent. were anticipated. Could the water jacket be abolished in the ordinary gas engine, it is a question whether over 60 per cent. efficiency could not be obtained at ordinary pressures. The practical question now is, is it likely to pay to use even the low pressure of 500 lbs. for the sake of getting 28 per cent. efficiency, and is the Diesel motor offering promise of anything more than this after its few years' trial and experience?

THE ECONOMICAL USE OF EXHAUST STEAM.

Writing in the *Electrical World*, Mr. Perkins considers the question of using exhaust steam. He instances a water-power where the driven factory uses so much steam for drying purposes that the firemen cannot tell when the relay engines—used when the water is low—are running or standing, because all the engine exhaust is available for heating purposes. He very properly questions the economy of the water-power in this instance. Another instance is cited where a college is electrically lighted, and is heated also from the exhaust steam, and, owing to certain minor improvements introduced when the light was installed, the fuel bill is less than it was before there was any light. The light really costs nothing, for the heat was previously required.

It would appear, however, that in paper mills the reverse may be the case, and Dr. Louis Bell has protested against the use of exhaust steam for drying purposes, while a case is given by a Mr. Schillit where an engine 13 inches × 21 inches × 175 revolutions per minute drove the mill and heated 13 driers and used 2,868 lbs. of steam per hour with a back pressure of 23 lbs. When exhausting freely, and using live steam for drying, the consumption, all told, was only 2,745 lbs. In each case there were 14 other driers heated, in both cases by live steam. The question seems to resolve itself into one of the increased steam consumption of the engine with 23 lbs. back pressure. To approximate to this, he prepares a diagram showing the percentage of extra steam in an engine 14 inches × 36 inches × 85 revolutions per minute, producing 100 H.P., and he shows that it will not pay to incur 6 lbs. of back pressure for the sake of using the exhaust unless the amount of exhaust used exceeds 20 per cent. of the steam used by the engine under normal conditions. If only 3 lbs. back pressure is needed, then 10 per cent. of the normal steam must be used. These conditions assume that the remainder of the exhaust is blown away at the increased pressure. It appears that the 13 driers did not require so much steam as the engine used normally. Yet a back pressure of 23 lbs. implied that the engine must double its consumption, and obviously the consumption would be greater than if there were a free exhaust and live steam in the driers, and that if the other 14 driers had been available for exhaust heating there would have been economy. The lesson to learn is not that the use of exhaust is not an economy, but that it should be freed from conditions of back pressure, unless the whole of it is needed. Clearly it is poor practice to close up the exhaust of a big engine in order to force steam through long pipes to boil one glue kettle.

ON THE PRODUCTION OF A "DARK CROSS" IN THE FIELD OF ELECTRO-MAGNETIC RADIATION.*

By JAGADIS CHUNDER BOSE, M.A., D.Sc., Professor of Physical Science, Presidency College, Calcutta.

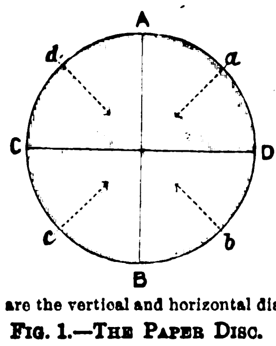
A circular piece of chilled glass when interposed between crossed nicols produces a dark cross. A similar effect is produced by crystals like salicine where there is a radial disposition of the principal planes.

I have been able to detect a similar phenomenon in the field of electric radiation by the interposition of an artificial structure between the crossed polariser and analyser.

I have in a previous communication described the polarisation produced by the leaves of a book. For the following experiment, a long strip of paper was rolled into a disc. A roll of Morse tape serves the purpose very well. The diameter of the disc is 14 cm. and its thickness 2 cm. It will be observed that here we have a single axis passing through the centre, and that all planes passing through the centre are principal planes.

The effect produced by the interposition of the structure may be studied by keeping the disc fixed and exploring the different parts of the field by means of the detector; or the detector may be kept fixed (opposite the analyser) and the disc may be moved about so that the different parts of the field may successively be brought to act on the detector. This latter plan was adopted as being simpler in practice.

The arrangement of the apparatus is the same as in fig. 1 of my



A B, C D, are the vertical and horizontal diameters.

Fig. 1.—The Paper Disc.

paper "On the Rotation of Plane of Polarisation of Electric Waves by a Twisted Structure." The polariser is vertical and the analyser horizontal. The paper disc is interposed between the screens with its plane at right angles to the direction of the ray.

The receiver is fixed on the prolongation of the line (which I shall call *the axis*), joining the centres of the polariser and the analyser.

On the supposition that the interposition of the disc produces a dark cross, the arms of the cross (with the particular arrangement of the polariser and the analyser) will lie in the projections of the vertical and the horizontal diameters of the disc, and will move in space with the movements of the disc. When the centre of the disc is on the axis, the intersection of the cross will be superposed on the receiver, and there should then be no action. If the disc be moved up and down, the centre remaining in the vertical line passing through the axis, the vertical arm of the cross will slide over the

* Communicated to the Royal Society by Lord Rayleigh, F.R.S. Received February 14th, read March 10th, 1898.

receiver. If the disc be moved laterally, with its centre in the horizontal line passing through the axis, the horizontal arm of the cross will slide over the receiver. In this, as in the last case, there should be no action on the receiver. But if the disc be displaced so that the centre does not lie in either the horizontal or the vertical line passing through the axis (the axis now cutting the disc at points such as *a*, *b*, *c*, or *d*), the arms of the cross will not fall on the receiver, and there should be a response in the receiver.

The experiments were now arranged as follows:—The disc was at first placed with its centre on the axis, the plane of the disc being perpendicular to the axis. There was now no action on the receiver; but as soon as the disc was tilted, however slightly, an action was immediately produced on the receiver.

The disc was now mounted on a stand, between the two screens. By means of sliding arrangements the disc could be raised or lowered, or moved laterally.

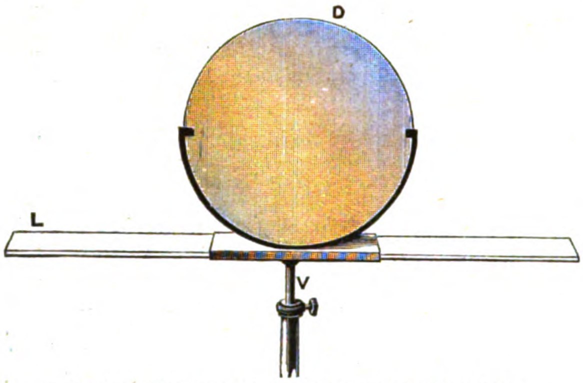
In the next experiment the centre of the disc was first adjusted on the axis, and the disc moved vertically up and down. No effect was produced when this was being done.

The centre of the axis was again adjusted on the axis, and the disc moved laterally on the horizontal slide. In this case, too, there was no action.

By adjusting the vertical sliding rod the centre of the disc was next placed vertically above or below the axis. The disc was then moved laterally either to the right or to the left. In this way the field could be displaced, and the quadrants, *a*, *b*, *c* or *d* (see fig. 1), placed opposite to the receiver. In all these cases, even with small displacements, very strong action was produced on the receiver.

From experiments carried out in the manner described above, the outline of a dark cross projected in space was distinctly made out.

A disc of wood, with *concentric rings*, would probably show the effect equally well. I shall, in a future paper, send an account of the



D, the paper disc; V, L, are the vertical and horizontal slides.

Fig. 2.—The Holder for the Disc.

action of crystals cut perpendicular to the axis placed in convergent or divergent beams of electric radiation.

Some of the investigations on the rotation of the plane of polarisation will, perhaps, be facilitated by an observation of the rotation of the cross. By a modification of this method I am at present trying to detect the rotation produced in a magnetic field.

Addendum, March 16th, 1898.

The production of a dark cross can also be demonstrated by interposing between the crossed polariser and analyser concentric rings of tinfoil mounted on a thin sheet of mica. But greater interest is attached to the exhibition of the phenomenon by double refracting substances, where the axes of elasticity are disposed in radial directions. From the peculiar stresses present, I surmised that woody stems with concentric rings would exhibit the phenomenon above described. Through the kindness of Dr. Prain, I obtained from the Government Botanical Gardens, Sibpore, stems of *Pinus longifolia*, *Swietenia mahogani*, *Araucaria Cunninghamii*, *Mangifera indica*, *Casuarina equisetifolia*, *Cupressus torulosa* and *Dalbergia sissoo*. The ring systems present in some of these were very regular. I was, however, at first disappointed in failing to obtain the results anticipated. But this failure, I subsequently found, was due to the general opacity of the wood, which was freshly cut, and which, though apparently dry, contained large quantities of sap in the interior. I then carefully dried some of the specimens, when the stresses present became quite apparent by numerous cracks starting in radial directions. The results obtained with these dried specimens were quite satisfactory.

I now tried to devise some experiments strictly analogous to the optical experiments with chilled glass. For this purpose I cast a cylinder of paraffin wax in a metallic mould surrounded by a freezing mixture. Owing to the great contraction produced by solidification, a hollow depression was formed in the centre, and this produced a distortion of symmetry. It would, therefore, be better to build up a cylinder by successive dippings, the deposited molten layer contracting on the solid core. I obtained, however, extremely good results with a cylinder of cast ebonite, in which the stresses present are exactly similar to those in a circular piece of unannealed glass.

The next series of experiments were undertaken with mineral specimens. I here acknowledge with thanks the kind help I received from Mr. Hayden, B.A., and Mr. Blyth, of the Geological Department, in obtaining suitable specimens for my experiments. One very interesting specimen obtained from Egypt was formed by ringed concretion of flint round a central nodule. This specimen exhibited the cross with great distinctness. I also obtained fairly satisfactory results with stalactite. The concretion of calcium carbonate formed inside a pipe by deposits from temporarily hard water flowing through it, would also be found to exhibit this phenomenon.

NEW INDUCTION COIL.

Abstract of a paper read before the Röntgen Society by Alfred Apps, *M.I.E.E., and Member of the Röntgen Society, on May 10th, 1898, entitled "Notes on the Description of a 'New' Induction Coil, 'Electrical Review,' February 4th, 1898, page 165."*

The author considers many of the points advanced to be erroneous, and he insists that the members of the Röntgen Society require the most accurate information with a view to the improvement of their X ray appliances. Dealing with the statement that the Ruhmkorff coil is the only one in use, he adduces facts showing that it was, for all practical purposes, superseded some 28 years ago. Ladd greatly improved it, and the author devised a new form both as to coil and accessories which became, with further details, the subjects of a series of patents. These instruments are now known as Apps coils. On the subject of efficiency, it is pointed out that the Ruhmkorff coil, an excellent instrument 30 years ago, weighing about 20 lbs., and giving 1½ inches spark of about the same dimensions as the Apps coil of the present day, giving 8 inches spark. This coil has about 6½ miles of wire as secondary as against the 8½ miles which, by calculation, appears to be coiled on the central bobbin of the "new" coil described in the Electrical Review. The weight there stated, 600 grammes, appearing to be a misprint. It is contended that experience is the best answer as to decay or burning of insulation in the secondary coil, and particulars are given of many coils of the Apps manufacture under the patents referred to, where no decay could be found after nearly 30 years' use, nor diminution of spark length. Cases of extreme damp, immersion in sea water, &c., acid fumes, and direct sunlight impinging on the ebonite exterior are excluded. High power and portability, as in the 8 to 10-inch Apps coils are urged as important for X ray work. The dimensions of secondary bobbins are discussed, and by means of a diagram it was shown that the sectional area of the secondary bobbin of a nominal 4-inch Apps coil working to 7 inches, was practically the same as that of the "new" coil. In answer to the assertion that all coils are defectively insulated, experience is again advanced. The author, however, admits the extreme desirability of high insulation, but points out that other qualities have to be sought, such as portability, strength, freedom from chemical action leading to explosion and ignition. As an example of high efficiency, where a spark of 4½ inches was reached (as long as the bobbin), the coil made by Apps for the late Mr. W. Spottiswoode, F.R.S., is mentioned (see *Phil. Mag.*, Jan., 1877, p. 30). Fluid insulators are discussed at some length; and replying to the proposals in the Electrical Review, the author declines to grant that, all things taken into account, any advantage can be gained by the use of fluid insulators for the secondary of an induction coil. In supporting this view, he refers to the very limited use of oil for the insulation of transformers where the voltage is exceedingly low in comparison with that employed in the induction coil. To show the danger of an accumulation of carbon formed from the oil, he instances the case of a condenser, 20,000 volts only, where there was found to be an accumulation of carbon in the glass cell. In this case resin oil was used. It is further pointed out that authorities differ widely as to the insulating power of oils—that the nature of the electrical discharges affect the percentage or efficiency of oil insulators to an extreme degree, and, further, that the precise nature of the electrical excitation in the secondary of a coil is not satisfactorily known, and that, therefore, the value of oil insulation is uncertain. As there is carbon formed in all oil insulators—certainly when the electrical stress is great. It is produced in the interstices of the secondary winding, thereby destroying all insulation and cannot fall away by gravitation. In 1870 the author, in conjunction with Mr. H. C. Baines, of Pembroke College, Oxford, tested the use of oil in induction coils, and discarded it for similar reasons.

The danger of accumulations of gas in oil insulated coils is discussed at considerable length. The visible bubbles rising to the surface while the coil is working and the possibility of enlarged bubbles being formed in the interior parts and then fired by a minute spark, lead the author to conclude that considerable danger of an explosion is incurred. He has seen such explosions, and refers to Tesla's description of a coil tried when unfinished in a darkened room presenting the appearance of a "mass of fire." The author some 20 years ago was endeavouring to ascertain how small a spark would explode gas. He employed a common medical magneto machine, with a small condenser attached to the rotating contact breaker. Sparks scarcely visible of about $\frac{1}{20}$th inch long thus produced were found sufficient to fire a mixture of coal gas and air

Much has been written as to the proper shape of the secondary coil, and as a contribution to the history of this matter, and to show that the bobbin recommended in the Electrical Review is not the best, reference is made to the experiments of Mr. Ladd about the year 1860. He thoroughly tested the use of various forms, and found no advantage from a large central bobbin. It is contended that the lines of force, within which the secondary wire must be placed, are found in such positions and relative intensities (Kapp lines per square centimetre) that one is led, both by theory and experience, to wind the wire nearly to the whole length of the primary coil, and in depth equal to about one-eighth of the length. The wire recommended, 0·16 cm., is considered too small for a coil designed for 20 cm., or about 8-inch spark.

The author thinks that no good can be gained by undue economy as to secondary wire, and he refers to the use of iron wire now largely employed in very cheap coils which soon rusts asunder, and he humorously says that there are also other devices for constructing coils so as to make them last for a short time. With special reference to X ray work, it is pointed out that unless the secondary coil be of considerable length, the sparks will not be so frequent as to give good results. It is an outpouring of energy that is required, and not a simple disruptive discharge. The great coil made for Mr. Spottiswoode gave a continuous outflow at each discharge for at least half a second when the terminals were separated from 1 to 2 inches, and it is precisely this effect, though necessarily less in degree, that is wanted for the best X ray work.* As an instance of long spark lengths from a small quantity of wire a 3-inch Apps coil is referred to, which, as a maximum, gave 6½ inches. In conclusion, it is stated that induction coils can now be constructed according to specified conditions—it is simply a matter of ordinary electrical engineering practice found to follow very closely the data the author has accumulated during an experience of 33 years. Finally, he expresses his thanks to the authors of the paper in the Electrical Review.

Note on Mr. Apps's Paper on "A New Induction Coil."

Mr. Apps's long experience in the manufacture of induction coils with a deservedly high reputation entitles his opinions to the greatest respect. In some respects, however, we think his criticism of the coil invented by MM. Rochefort-Lucay and Wydts (Electrical Review, 42, p. 165) is unfair. He objects to the statement at the commencement of that article that the Ruhmkorff coil is the only one in general use, but Mr. Apps must know that the term Ruhmkorff coil is in general use for the modern induction coil, and does not mean the coil exactly as it was constructed more than 40 years ago by Ruhmkorff. The first Ruhmkorff coil imported into this country by Groves in 1852 had 10,000 turns in the secondary coil, and gave only a ¼-inch spark in air. But since that time many important improvements have been made in its construction, by which Mr. Apps, as well as other makers, have been enabled to leave far behind the original inventor of the induction coil; for instance, Sinsteden applied the condenser in 1855, Ritchie invented winding the secondary in compartments in 1857, and many improvements were made in the contact breaker by other inventors. Liquid insulators even, were tried with success by Jean in 1858. Mr. Apps makes excellent coils, and no doubt has discovered many important improvements in details in the course of his practice. We quite agree with him that the central coil shown in the illustration of MM. Rochefort-Lucay and Wydts's coil is not the best disposition of the secondary wire. But as we understand it that is not an essential part of their invention, Mr. Apps's remarks on liquid insulators appear also to be beside the question. The French inventors' improvement consisted in the use of *viscous or pasty* insulators, which in many respects have different properties from liquid insulators—for instance, they can stand a longer static strain without allowing the electricity to leak away by convection. The excellent results obtained with the viscous insulators, even though they might not have appeared quite so good if an Apps coil had been used for comparison, indicate that it may be worth while to make further experiments in this direction. Mr. Apps alludes to a series of patents in which his improvements in induction coils have been embodied; we can find only two, one in 1867, and one in 1896. The first patent relates principally to his well-known and excellent contact breaker, and the second principally to matters of detail in the insulation of the primary and secondary coils. In these patents there appear to be no epoch-making steps in the evolution of the induction coil, or at least nothing to justify Mr. Apps in drawing such a hard and fast line between the Apps coil and the Ruhmkorff coil. We readily acknowledge that Mr. Apps makes excellent coils, but all the same, we do not think he has yet reached the *ne plus ultra*. The present low efficiency of the induction coil as a transformer of electric energy leaves plenty of room for improvement.—Eds. Elec. Rev.

BELT DRIVING.

I.

Every species of power transmitting device has its advocates. These advocates often push the virtues of their pet ideas in and out of season and irrespective of surroundings. We can hardly say this of Mr. Tullis who, in his paper on "Belt Driving," read before the West of Scotland Technical College Scientific Society, certainly said all he could for belts, but did not seriously overstate matters. He certainly gave some very useful points to his hearers. For really high class belting the centre of a belt ought to be the centre of the hide, the spine of the ox lying evenly between the two halves of the strip. Such belts should be cemented and stretched, and properly made, will run perfectly true and straight. A safe tension is 50 lbs. per inch of breadth of $\frac{3}{16}$ single leather, and 80 lbs. for double leather. On this item of cementing, the present writer was recently asked to supply a length of the best 4-inch belt to be obtained. He sent the "all cemented joints" of a leading maker, and the engineer rejected the belt as not the best. It is thus clear that belt users are in need of instruction. It is often most difficult when supplying the very best goods in the market to obtain credence for the fact. In regard to the care of belts there should be no dust allowed to cake on a belt, and a belt face should be clammy and should be kept from undue dryness by a reliable dressing. We can understand this, but what is a reliable dressing? A pulley ought not to become bright, this implies slip. A non-slipping belt makes a pulley face dark coloured.

A belt only slips if out of condition or overloaded. Slip implies friction and loss of power and destroys a belt. If overloaded a belt can be compounded. Mr. Tullis is great on compounding. A compound belt is simply one belt running freely on the top of another. An 8-inch belt run on a 12-inch belt is equivalent to a 20-inch belt, the 8-inch belt will do as much work as if on a pulley of its own. When running at over 4,000 feet per minute belts ought to be thin, pliable, and tough, as orange tan or raw hide softened. If compounded they may be run up to 9,000 feet velocity, but we do not see how the author makes out that compounding "deadens and counteracts centrifugal force," and for a 9,000 feet velocity to be economical we consider a belt must have a more than usual working-tenacity per unit weight as 7,000 is usually considered quite an outside velocity taking centrifugal stresses into account.

The flesh side should run next the pulley; it is the stronger, but if overloaded the grain or hair side should be next the pulley, as it will better stand the overheating due to slip. Belt thickness must not exceed a given ratio to the pulley diameter. A 4-inch pulley must not carry a belt above ⅛-inch thick. Up to 8 inches a belt may be $\frac{5}{32}$-inch thick, thin $\frac{3}{16}$-inch up to 12 inches, and $\frac{1}{4}$-inch b are up to 18 inches diameter. Above 18 inches heavy leather can be used. We publish Mr. Tullis's table of belt powers and speeds in full.

Pulley and Belt-Power Table,

showing what horse-power 1 inch in width of single or double leather belt will transmit when running on pulleys from 1 foot diameter to 10 feet diameter:—

Single Leather Belting.

1 in.	width	of single	belt on	pulley 6	in. dia.	at 6,400	ft.	belt	speed	per	min.	1 H.P.
1	"	"	"	12	"	3,200		"	"			"
1	"	"	"	18	"	2,400		"	"			"
1	"	"	"	24	"	1,600		"	"			"
1	"	"	"	30	"	1,340		"	"			"
1	"	"	"	36	"	1,066		"	"			"
1	"	"	"	42	"	950		"	"			"
1	"	"	"	48	"	800		"	"			"
1	"	"	"	60	"	680		"	"			"
1	"	"	"	72	"	533		"	"			"
1	"	"	"	84	"	457		"	"			"
1	"	"	"	96	"	400		"	"			"
1	"	"	"	108	"	355		"	"			"
1	"	"	"	120	"	250		"	"			"

Double Leather Belting.

1 in.	width	of belt	on	pulley 18	in. dia.	at 1,333	ft.	belt	speed	per	min.	1 H.P
1	"	"	"	24	"	1,000		"	"			"
1	"	"	"	30	"	875		"	"			"
1	"	"	"	36	"	730		"	"			"
1	"	"	"	42	"	625		"	"			"
1	"	"	"	48	"	500		"	"			"
1	"	"	"	60	"	400		"	"			"
1	"	"	"	72	"	335		"	"			"
1	"	"	"	84	"	286		"	"			"
1	"	"	"	96	"	250		"	"			"
1	"	"	"	108	"	222		"	"			"
1	"	"	"	120	"	200		"	"			"

The above figures contemplate durability. A belt will do 30 per cent. more than the table without slip, if kept a little tighter and in good condition. Even twice the power can be transmitted at high tension, but a belt ought to do its duty when slack. Its "slack" side ought to be distinctly slack. Mr. Tullis would save pulley cost by using compound belts. Two 20-inch belts will do more than one 40-inch belt on a wide pulley. Superposed belts check surging and air cushioning. The top belt really is working on a leather pulley, and the under belt is being held against its pulley firmly.

Mr. Tullis advances instances of the benefit from compounding insufficiently strong belts. In our own practice we well remember where certain 4-inch belts were continually giving trouble. We changed them for 5-inch belts and the trouble ceased. All Mr. Tullis's examples are to the effect that by means of placing one belt over another, the work done may be increased in fully the ratio of leather used, and such compound belts are altogether satisfactory, and may even be used as shifting belts with strap forks, &c.

In quarter twist drives the ordinary flat belt, especially in a short drive, has one edge of the belt badly strained. This fault is got over by making special belts with one side longer than the other. So made they work perfectly, and may also be compounded. They ought to be of thin leather.

For really heavy work link belting is advised. It ought to have a flexible centre as it will then fit the crowning of the pulleys and do 30 per cent. more than if flat; but here again Mr. Tullis is wrong in saying that on such a belt centrifugal force has no effect. Such belts should not be tightened until they slip, unless the slack side sags down to touch the tight side.

The breaking strain of a link belt ⅞-inch thick is given as 1,400 lbs. per inch of breadth for oak tanned and 1,800 lbs. for orange tanned.

On tapered cones a link belt made to fit the cones will work without trying to climb against the shifter. Some such belts are made for steep pitched cones, which have a cross section varying from ⅝ to 2¼ in a width of 6 inches. Such belts are, of course run half-twisted. If an open drive must be used then a full twist must be put on to both sides of the belt so as to get the correct arrangement of the taper of the belt upon the cones.

A little belt slip may sometimes be desirable, as, for example, when driving a dynamo from a gas engine when a little slip prevents surging and waves in the belt.

(To be continued.)

* This sentence does not occur in the original.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

The Design of Electric Railway Motors for Rapid Acceleration. By Prof. Charles A. Carus-Wilson, Member. Read May 26th, 1898.

The torque on the shaft of a motor may be expressed by the equation,

$$t = 1{\cdot}41\, p\, \text{A}\, \text{C}\, \text{N}\, 10^{-8} \text{ inch-pounds} \quad (1)$$

where N is the number of C.G.S. lines per pole, A is the number of surface conductors, C is the total current passing into the motor, in amperes, and p is a numerical constant depending upon the way in which the armature is wound. This equation may be written,

$$t = 1{\cdot}41\, \text{C}\, \text{M} \quad (2)$$

where M is given by

$$\text{M} = p\, \text{A}\, \text{N}\, 10^{-8} \quad (3)$$

We shall call M the *induction factor* of the motor. Since the tension, e, induced at n revolutions per second is given by

$$e = \text{A}\, \text{N}\, n\, 10^{-8} \text{ volts} \quad (4)$$

the induction factor may be found by dividing the induced tension in volts by the speed in revolutions per second, and the induced tension is given by the product of the induction factor and the speed.

The constant, p, may be defined as the ratio of the number of surface conductors in series between the main terminals to the number of surface conductors lying between two adjacent neutral points, and is unity for a bipolar machine, whether drum-wound or ring-wound.

When a motor is running at n revolutions per second, and taking a current of C amperes, we have the following expression for the speed:—

$$n = \frac{\text{E} - \text{C}\,\text{R}}{\text{M}} \quad (5)$$

where E is the terminal tension in volts, and R is the resistance of the motor in ohms measured between the same points as the tension. Hence, in the case of a railway motor, the speed in feet per second is given by

$$s = 0{\cdot}262\, \frac{d}{\text{M}\, v}\, (\text{E} - \text{C}\,\text{R}) \quad (6)$$

where v is the ratio of the speed of the motor to that of the main axle—afterwards called the velocity ratio—and d is the diameter of the driving wheel in inches.

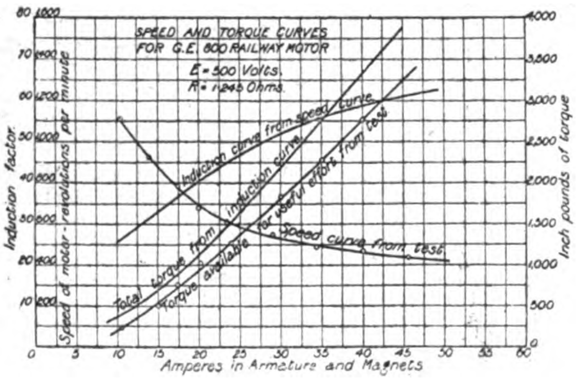


Fig. 1.

If an experiment be made in which the speed, the tension of the line, and the current are observed, we can find from equation 5 the value of the induction factor for different currents, and thus obtain what we shall call the *induction curve*. Such a curve is given in fig. 1, for the "G.E. 800" railway motor made by the General Electric Company.

From the induction curve we can deduce the curve of total torque for different currents. This curve will lie above that obtained by measuring the torque at the rim of the brake-wheel, the difference for any current representing the torque expended in overcoming friction of gearing, hysteresis, &c. The ratio of the two ordinates for any current gives the mechanical efficiency for that current.

If the current passing through the motor at any instant is greater than that required to overcome the frictional and other resistance to motion, the motor will accelerate, and the acceleration in feet per second will be given by

$$a = 405 \times 10^{-4}\, \frac{\text{M}\, v}{d}\, \frac{\text{C}_a}{\text{W}} \quad (7)$$

where C_a is the current in amperes available for acceleration, and W is the whole weight that has to be accelerated, in tons of 2,240 lbs.

As an illustration, we may take the motors used on the Baltimore and Ohio Railroad. The conditions are as follows:—A train weighing 780 tons has to start from rest on a grade of 0·8 per cent. The train is drawn by a locomotive equipped with four motors permanently connected in series. The driving wheels, which are gearless, have a diameter of 62 inches. The maximum current from the line is limited to 1,800 amperes, and the mean value of M while the motors are starting may be taken as 155.

The tractive effort per motor required for the grade is 3,490 lbs., and for friction, allowing 9 lbs. per ton, 1,755 lbs., making altogether 5,245 lbs. If we allow 95 per cent. mechanical efficiency, we find from equation 2 that the current required to overcome friction must

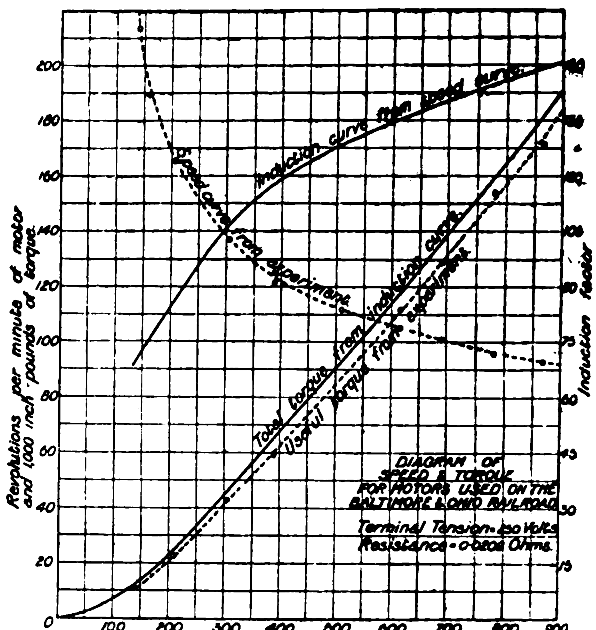


Fig. 2.

be equal to 780 amperes, leaving 1,020 amperes available for acceleration. Under these circumstances the train will start up from rest with an acceleration of 0·53 f.p.s. per second. The induction curve of these motors is given in fig. 2, and the current-curve observed in starting is given in fig. 3.

If a pulley of d centimetres diameter is placed on the shaft of a motor of induction factor M, carrying a current of C amperes, the tangential force at the rim of the pulley is given by

$$\text{T} = \frac{1}{\pi\, d}\, \text{M}\, \text{C}\, 10^{7} \text{ dynes} \quad (8)$$

If $d = \frac{1}{\pi}\, 10^{7}$ centimetres, this may be written,

$$\text{T} = \text{M}\, \text{C} \text{ dynes} \quad (9)$$

The force of a motor may thus be defined as a force of M C dynes at the rim of a pulley 10^{7} centimetres in circumference. We shall call M C the *force factor* of the motor. Thus, in the preceding

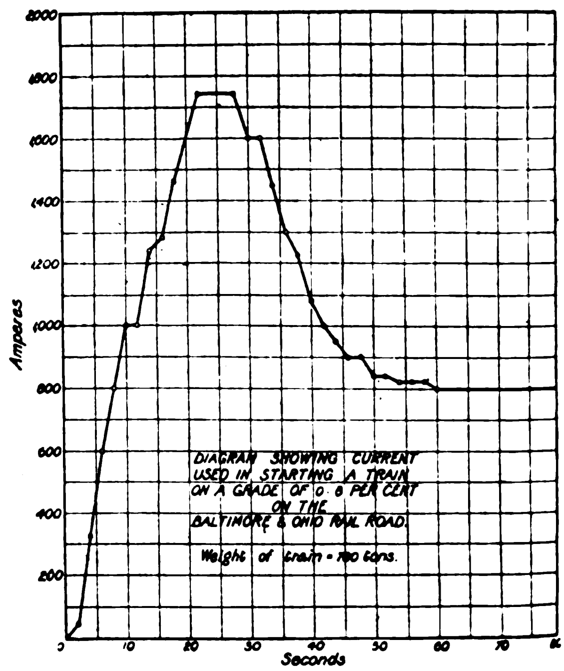


Fig. 3.

example, each of the four motors must have a force factor of 279 kilodynes in order to start up with an acceleration of 0·53 f.p.s. per second.

The rating of a motor in horse-power gives us no indication of its ability to accelerate, though this may be the most important function it is called upon to perform. Thus, in the last example, the horse-power of the motors at the moment of starting is nothing. In the problem that we now propose to discuss we shall find it convenient to be able to define the action of a motor in terms of a force unit instead of a power unit, and for this purpose we shall make use of the force factor. We may note in passing that the power in kilowatts at any moment is given by multiplying the force factor in kilodynes by the number of revolutions per second.

When a given distance has to be covered, we may divide the whole period of motion into two parts—that of acceleration and that of uniform speed. For the present we shall assume that, if there are two or more motors in the locomotive, they are connected in parallel, and that they speed up with uniform acceleration until full speed is reached.

From equations 6 and 7 it appears that, if everything else remains unchanged, the acceleration increases directly, and the final speed inversely, as $\frac{M\,v}{d}$. For example, if we keep M and v the same, we can increase the acceleration by putting on a smaller wheel, but we shall thereby reduce the final speed. The accelerating period will then be small, and most of the distance will be covered at full speed.

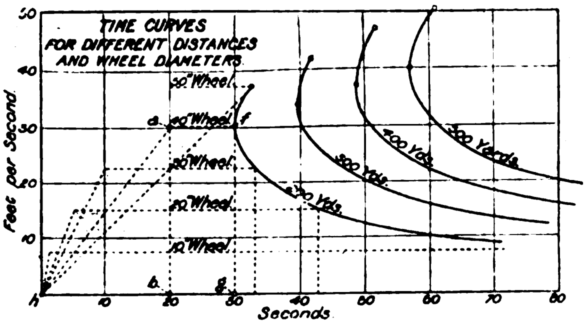


FIG. 4.

On the other hand, if we increase the diameter of the driving wheel, we shall get a small acceleration but a high final speed; most of the distance will then be covered during the process of accelerating, and full speed may not be reached before the given distance has been traversed. Similarly, if we vary the velocity ratio, keeping M and d the same, we shall get the reverse of these results. Or, if we keep v and d fixed and vary M, we shall get the same results as if we varied the velocity ratio.

In fig. 4 the horizontal axis represents seconds, and the vertical axis speed in feet per second. Let us suppose that the conditions are such that with a driving wheel 40 inches in diameter an acceleration of 1·5 f.p.s. per second is obtained, and that the final speed is 30 feet per second. A distance of 200 yards will then be covered in 30 seconds, 20 seconds being occupied in accelerating, during which time 100 yards is covered, the remaining 100 yards being covered in 10 seconds at full speed.

If now we replace the 40-inch wheel by one whose diameter is 30 inches, we increase the acceleration to 2 f.p.s. per second, but reduce the final speed to 22·5 f.p.s., so that it takes 33 seconds to travel 200 yards. If we put on a 50-inch wheel, the acceleration is decreased to 1·2 f.p.s. per second, and full speed is only just reached when the 200 yards has been covered, the time being nearly 33 seconds.

If a line, such as $a\,f$ in the figure, is drawn to a point at which the given distance is covered, the points thus found by using wheels of different diameters will lie on a curve. We shall call this the *time curve*. In the figure, dotted lines such as $h\,a$ represent the accelerating period, and dotted lines such as $a\,f$ the period during which the motors are running at full speed. The area $h\,a\,f\,g$, then, represents the whole distance covered in the time $h\,g$.

Time curves have been drawn for distances of 200, 300, 400, and 500 yards. An increase in the value of M or of v gives the same result as a decrease in the value of d.

It is evident that there is a certain value of $\frac{M\,v}{d}$ for which the time occupied in covering any given distance is a minimum. This value we shall now proceed to find.

We know from equation 7 that the acceleration varies inversely as $\frac{d}{M\,v}$. We may express this fact as follows:—

$$\frac{a\,b}{h\,b} = k_1 \frac{1}{\beta} \qquad (10)$$

where k_1 is a constant, and $\beta = \frac{d}{M\,v}$.

From equation 6 we have

$$a\,b = k_2\,\beta \qquad (11)$$

where k_2 is a constant.

If D is the whole distance in feet that has to be covered, we have

$$D = \tfrac{1}{2}\frac{k_2^{\,2}}{k_1}\beta^3 + k_2\,\beta \times b\,g \qquad (12)$$

hence, by substitution, we get

$$t = \frac{D}{k_2\,\beta} + \tfrac{1}{2}\frac{k_2}{k_1}\beta^2 \qquad (13)$$

where t is the time occupied. To find what value of β makes the time a minimum, differentiate and equate to nothing, and we have

$$\beta^3 = \frac{k_1}{k_2^{\,2}}\,D, \text{ or } b\,g = \tfrac{1}{2}\,b\,h$$

The given distance then is covered in the shortest time, when the equipment is such that the distance travelled during the process of acceleration is equal to that travelled at full speed, the time of accelerating being two-thirds of the whole time.

Substituting for k_1 and k_2 their values as given by equations 7 and 6, we get

$$\left\{\frac{d}{M\,v}\right\}^3 = 0.59\,\frac{D}{W}\,\frac{C_a}{(E - c_f\,R)^2} \qquad (14)$$

It appears, then, that, when a train of weight W tons has to be started from rest and moved through a distance of D feet, the tension of the line being E volts, the accelerating current c_a amperes, and the internal drop when running at full speed $c_f\,R$ volts, the time occupied is least when the ratio $\frac{d}{M\,v}$ is that given by equation 14; and that, if this value of $\frac{d}{M\,v}$ is adopted, half the distance will be covered in the process of accelerating.

Since the equation 14 gives the value of $\frac{d}{M\,v}$ for covering any distance in the least time for a given accelerating current, it follows that, when the time as well as the distance is given, the accelerating current will be least when half the distance is covered during acceleration.

For, if any other ratio of $\frac{d}{M\,v}$ is adopted than that which covers half the distance during acceleration, the time will be prolonged, and consequently a greater accelerating current required.

We have, then, two conditions to fulfil. First, half the distance must be covered at full speed in one-third the time. If we are at liberty, as we generally are, to adjust the value of the resistance so that the drop at full speed is independent of M, v, and d, we then have

$$\frac{M\,v}{d} = 0{\cdot}1747\,\frac{t\,e}{D} \qquad (15)$$

where e is the induced tension at full speed, or the tension of the line minus the heat drop.

It thus appears that the ratio $\frac{M\,v}{d}$, which governs the design of the whole equipment, is given by the consideration that half the distance must be covered at full speed in one-third of the time.

The accelerating current can now be found from equation 7. We know that half the distance has to be covered in two-thirds of the time: this gives us the acceleration. We know also the value of $\frac{M\,v}{d}$, and of W: hence we deduce,

$$C_a = 55.5\,\frac{D\,W}{t^2}\,\frac{d}{M\,v}, \qquad (16)$$

or we may write at once,

$$C_a = 318\,\frac{D^2\,W}{e\,t^3}. \qquad (17)$$

If we know the retarding forces at full speed we can find the current, since $\frac{M\,v}{d}$ is fixed, and hence we can obtain the resistance of the motor.

For example, suppose that we have to design an equipment by which a tramcar weighing 10 tons can be started from rest and moved through 500 feet in 30 seconds. We may suppose, further, that two motors are to be used, connected in parallel throughout; that the tension of the line is 500 volts, and the drop at full speed 9 volts.

From equation 15 we obtain the value of $\frac{M\,v}{d}$, and find it to be 5·15. We may assume for the present that v is limited to 4·78, and that d is 33 inches; hence M = 35·5. The maximum speed is 25 feet per second, or 17 miles per hour. If the frictional and other forces retarding the motion are equal to a torque of 3,580 inch-pounds on each axle, the current at full speed will be 15 amperes, and the resistance of each motor 0·6 ohm.

(*To be continued.*)

PHYSICAL SOCIETY.

MAY 27TH MEETING.

MR. CAMPBELL SWINTON read a paper on "Some Further Experiments on the Circulation of the Residual Gaseous Matter in Crookes Tubes." In the discussion that followed the former paper on this subject, at the Physical Society on March 25th, 1898, Mr. Appleyard had suggested that, in tracing the cause of the rotation of the exploring mill, it would lead to simpler results if the vanes were made of some light conducting substance, for it was probable that mica introduced complications by retaining the charges. Prof. Boys then pointed out that the mica might be gilded. Such a tube has now been made by Mr. Wolff. With the gilded mica vanes so placed as to be outside the cathode stream the mill behaves in a manner similar to the non-conducting insulated mill. It shows a greater tendency to assume a position of stability, due to electrostatic induction, this renders it somewhat troublesome in starting, but, when once under way, the mill rotates always when excited. Occasionally, when starting, a few reverse revolutions are observed, these are probably due to electrostatic influence and momentum, and also possibly to eddy currents in the residual gaseous matter. But it is found, in all cases, that rotation in the direction that indicates a stream of residual gaseous matter from anode to cathode, follows the reversal immediately after one or two oscillations. An electrometer connected to the mill, through the pivot and needle-point, shows the vanes to be always electrified positively. The results are confirmed by a second tube with oblique vanes. The author concludes that at very high exhaustions there exists a molecular or atomic stream from anode to cathode, which carries a positive charge and travels at high velocity outside the opposite cathode stream.

Mr. J. Quick asked what was the minimum degree of exhaustion required to produce these results.

Prof. Boys said that the experiments gave some amount of probability to the truth of Mr. Campbell Swinton's hypothesis, but it did not altogether prove the mechanical theory of rotation to be correct. He was glad that the chance suggestion at the last discussion had led to such interesting experiments being continued.

Prof. Threlfall mentioned that Boettger had devised a method for gilding mica, by a chemical process, that was much to be preferred to ordinary gilding.

Mr. Campbell Swinton said it was necessary to exhaust the tubes as completely as possible, to a point where it was only just possible for any discharge at all to pass through them. If the rotation was due to electrification, there must still be some mechanical process whereby the charges get to the vanes—a stream of residual gas satisfied that condition.

The Vice-President proposed votes of thanks and the meeting adjourned until June 10th.

TRANSATLANTIC CABLES.

Messrs. Siemens Bros. have kindly permitted us to publish the following tabular statement of calculated and actual speeds compiled by them of Atlantic cables. It will be noticed that in the 1894 cables, which are of different lengths, and varying weights of copper and insulation, the advantage would be with the manufacture of Messrs. Siemens, length and weight of core being equal (see cols. 9 and 10).

As the earlier figures may require further notes to explain that the speeds given were by mirror or recorder, or by simplex and duplex, we have preferred to draw attention only to the two results directly comparable, viz., the 1894 cables:—

1	2	3	4	5	6	7	8	9	10	11
Date when laid.	Designation of cable.	Length in nautical miles.	Type of core of deep sea cable. Lbs. per naut. mile	K R. Ohm × Microfarads / 10_6	Calculated speeds taking 1874 cable at 20·2 words per minute.	Calculated speeds taking 1874 cable at 27·6 words per minute.	Speeds actually obtained in regular working.	Calculated speed if lengths 1,850 naut. miles.	Calculated speed if lengths 1,850 naut. miles and core 650/400.	Manufactured by
			Cop. G.P.							
1873	Anglo-American ...	1 876	400/400	3·919	18·11	24 75	...	...	...	Tel. Const. & Mtnc. Co.
1874	Anglo-American ...	1,837	400/400	3·512	20·20	27·6 (*f*)	20·2 (*a*)	19 9	28·2	Tel. Const. & Mtnc. Co.
1875	Direct United States	2,423	400/360	7·558	9·38	12 82	22·6 (*b*)	38·6	70·2	Siemens Bros.
1879	Pouyer-Quertier ...	2,242	350/300	6 600	10·74	14 67	22 (*c*)	32·2	59·8	Siemens Bros.
1866/80	Anglo-American ...	1,852	...	4·632	15 31	20 91	...	...	...	Tel. Const. & Mtnc. Co.
1881	Jay Gould	2,518	350/300	7 834	9 05	12 37	21·5 (*d*)	39·8	69·4	Siemens Bros. & Co.
1882	Jay Gould	2,563	350/300	8 030	8 84	12·08	21 5 (*d*)	41·2	71·2	Siemens Bros. & Co.
1884	Mackay-Bennett (S)	2,353	350/300	6·740	10·52	14·37	26	42·0	72·3	Siemens Bros. & Co.
1884	Mackay-Bennett (N.)	2,346	350/300	6 630	10 71	14 63	26	41·8	71·2	Siemens Bros. & Co.
1894	Mackay-Bennett (3rd)	2,161	500/320	4·671	15·18	20·74	40 (*g*)	54·6	77 2	Siemens Bros. & Co.
1894	Anglo-American ...	1,850	650/400	2 420	29·31	40·04	47·4 (*e*)	47·4	47·4	Tel. Const. & Mtnc. Co.

(*a*) Report of engineers, Messrs. Clark, Forde & Co., to the manager of the Anglo-American Telegraph Company, dated June 25th, 1877.
(*b*) Report of engineers, Messrs. Clark, Forde & Co., to the manager of the Direct United States Cable Company, dated June 25th, 1877.
(*c*) Report of the engineer-in-chief, Mr. von Chauvin, to the Pouyer-Quertier Cable Company, dated June 15th, 1880.
(*d*) Report of Dr. Muirhead to Mr. von Chauvin, representative in London of the Western Union Telegraph Company, dated July 10th, 1883. (i.) Special trial of code words, 18 words per minute; (ii.) Press messages, usual rate, 25 " " " — mean 21·5; (iii.) As many as 135 letters per minute have been observed to pass at times without requiring repetition.
(*e*) *Electrician*, dated October 12th, 1894.
(*f*) Speed specified as basis for column 7 is taken from a letter from the manager of the Anglo-American Telegraph Company, dated September 20th, 1894.
(*g*) From a letter from Mr. G. G. Ward, vice-president and general manager of the Commercial Cable Company, dated May 10th, 1895.

It will be noticed in column 8 that the actual working speed obtained with the cables made and laid by Siemens Bros. & Co., is very much greater than that calculated upon, even allowing for all the progress in manipulation and manufacture. Columns 9 and 10 prove this even more clearly, the figures given there having been calculated (from actual speeds) according to well-established formulæ—column 9 showing what the speed would be if all the cables were only 1,850 nautical miles long, and column 10 if the length and weight of core of all the cables were the same as those of the 1894 Anglo Cable.

THE "FULMEN" ACCUMULATOR.

We know that accumulators intended for electro-mobiles should above all possess a high *specific power* (watts per kilogramme of *total* weight) and a high *specific energy* (watt-hours per kilogramme of *total* weight) in order to reduce as far as possible the dead weight carried, and so to increase the length of the journey that the battery enables us to make without recharging. These figures are now pretty well established for certain types of accumulators, and we find under the signature of one of the best authorities on *automobile locomotion*, M. Ed. Hospitalier, a very competent article on the "Fulmen" accumulator, which is already well known to our readers. This article describes the progress realised in apparatus for the storage of electrical energy during the past 15 years.

The type that we have examined, says M. Ed. Hospitalier, is distinguished by the symbol B_{13} and comprises 13 plates: 6 positive and 7 negative. The plates, which are rectangular, are 18½ centimetres high, 9½ wide and 4 millimetres thick. They form a block consisting of 24 rectangular cells, in which is lodged the active material. Thin sheets of celluloid prevent the plates from coming in contact with one another.

The moist plates cut level with the fastening gave us the following respective weights of the grid and of the active material (in grammes).

	Positive plate.	Negative plate.
Grid	135	135
Active material ...	340	255
Total weight	475	390

The surface of each plate is 1·75 square decimetres of the total surface for the 12 faces of the six position plates.

The celluloid trough and the partitions separating the plates weigh 600 grammes. The total weight of the complete element with the liquid is 7·5 kilogrammes.

M. Brault, administrator and delegate of the Fulmen Accumulator Company, considers the normal *régime* of discharge equivalent to a current of 21 amperes corresponding to a continuous discharge of 5 hours, or a density of current of 1 ampere per square decimetre of surface of the positive plates, but the accumulator can, at the expense of its capacity, supply as much as 50 amperes of continuous discharge and 100 amperes in interrupted discharge, for a special strain, for instance.

With the normal discharge in 5 hours the mean available difference of potential of the element is 1·9 volts, and the capacity 105 ampere-hours. Each element of 7·5 kg. supplies at the normal *régime* 40 available watts and contains an available energy equal to 200 watt-hours.

The specific constants of the element are, therefore, as follows, as compared with the *total* weight:—

Specific output, in amperes, per kg.	3
Available specific power, in watts, per kg. ...	5·3
Specific capacity, in ampere-hours, per kg. ...	14·6
Available specific energy, in watt-hours, per kg.	26
Specific weight in kilogrammes per kilowatt ...	190
Specific weight in kilogrammes per kilowatt-hour	37·5

At the *régime* of 5 watts per kg., the Fulmen accumulator contains, therefore, more than 25 watt-hours per kg. These two figures are sufficient to calculate the weight of accumulators necessary to work an automobile of a given total weight, at a given speed on a given track, the efficiency of the motor and the transmission being known, and also the road to be traversed between two successive charges. If the *régime* of continuous specific discharge be doubled and brought to 10 watts per kilogramme, the specific energy falls to 20 watt-hours per kilogramme. If we do not require more than 100 kilogrammes of accumulators to produce 1 kilowatt, we should require 50 kilogrammes (instead of 40) to store up 1 kilowatt-hour.

If, on the contrary, we reduce by half the specific *régime* of continuous discharge, the available specific energy increases and attains to 30 watt-hours per kilogramme.

In calculating the weight of a battery, therefore, we must not lose sight of the fact that we lose in energy what we gain in power, and *vice versâ*, and that accumulators wear much better when they are subjected to more moderate *régimes* of discharge. In their special application to electro-mobiles, the discharge is not continuous, but, on the contrary, extremely variable, and interrupted by intervals of rest favourable to the diffusion of the liquid, which diffusion is also facilitated by the agitation of the elements during the journey The figures given for the normal *régime* may therefore be accepted as representing the energy actually available, notwithstanding the variations in the output.

As regards the duration of the elements we can give no figures as there is too great a difference between the conditions under which they work in the laboratory and on the road. We shall gain more information on this important point as electro-mobiles become more extensively used.

We had intended to publish the conditions of working of other types of accumulators applied to automobiles, but we found that they were nearly all considerably inferior to those we have just described relating to the "Fulmen" accumulator. As each maker or inventor claims in favour of his apparatus special advantages as to solidity, duration, cheapness, facility of arrangement, &c., which more or less compensate for inferiority in output and capacity, we did not think it expedient to challenge claims and contradictions.

The figures which we have given, and which are deduced from our own experience, represent the maximum of what can be obtained from the *present* accumulators while we are waiting for better, in defiance of the proverb that says "Let well alone."

The accumulator question is attracting universal attention just now, and we would readily believe that the present maximum is merely provisional. But such as it is, it enables us to realise practical electro-mobiles capable of making daily journeys of 50 to 60 kilometres without being recharged.

The competition for electric cabs to be held by the Automobile Club in June, will be a reliable experimental confirmation of our deductions.—*L'Energie Electrique.*

REVIEWS.

Treatise on Chemistry. Vol. II.—The Metals. By Prof. Roscoe and Schorlemmer. London: McMillan & Co., Limited. 1897.

This is the third edition of one of the most important volumes in the great work first issued by the authors in the early part of 1878. During the 19 years which have elapsed since the publication of the first edition of this volume, much important work on the chemistry of the metals and their compounds has been done. So much, indeed, that the time was ripe for a new edition in which the metallic elements and their compounds should be re-arranged and all new matter of importance added. Prof. Roscoe and his assistant have had a large mass of material from which to make their selection, and on the whole, those who are familiar with the first two editions will conclude that they have generally exercised their judgment well, and have not failed to realise the significance of the new discoveries.

The new edition is more bulky, but fortunately, it has been possible to condense much of the old matter and even to reject some, so that the volume before us is not too ponderous. This is a great advantage, for, in the early editions, the metals used to be dealt with in two volumes.

To review this work from the point of view of the metallurgist is scarcely within our province, but we have no doubt whatever that those who are interested in the chemistry of metals will give a whole-hearted verdict in favour of this new edition, which we are sure they will find to be a veritable mine of unusually accurate information.

A treatise on the metals, their chemical and physical properties, would not be complete without alluding in the proper places to the achievements of those who have sought to increase our knowledge of electricity within the past 20 years, and this has been done to some extent. We humbly suggest, however, that the work would have been far more valuable if the editors had drawn more copiously upon these achievements and had made more of them. We even venture to say that the work would have been more valuable if an electrical engineer thoroughly conversant with the researches of the past 20 years had been associated with them in their labours, for the purposes to which the metals are now placed in the electrical industries are so numerous and important that they cannot be overlooked. It is only in this direction that we can detect any serious weakness, otherwise the work is, humanly speaking, complete.

In a treatise on the metals, extending to nearly 12,000 pages, one might surely expect more than a page on the subject of conductivity; this is all that is devoted to it, and the subject is only considered with conductivity for heat under the heading of "Physical Properties in relation to the Periodic System." Actually in describing the physical properties of silver, we are only informed that it is the best conductor of electricity; and under the physical properties of copper, the only statement is that next to silver it is the best conductor of electricity, and that pure copper is very largely employed for electric light mains and subterranean constructions, and that small quantities of impurities lower the conductivity to a large extent. We should have thought that metals possessing this property to such a high degree would have been written about somewhat differently, and that wherever the physical properties of metals were stated, the values of their electrical conductivities would have been given. But we have searched for them in vain. Generally speaking there is a great dearth of physical constants.

Another instance of unbalanced treatment in dealing with electrical matters is to be found on page 319, where the electrolytic preparation of copper is described in 18 lines, yet the electrotyping process, which is surely a matter of less importance, receives more than two pages.

In dealing with the velocity of reaction we miss any reference to recent German researches on the velocity of ions.

Spectrum analysis and the methods of producing emission spectra are very fully dealt with as might be expected from one who has done so much himself in this direction; indeed, this part of the work is very complete.

There is a very good section on the constitution of salts and bases in dilute solution, but, strange to say, no reference to Arrhenius, Nernst, and the other great investigators in this field of research. It seems impossible to have omitted a full explanation of the electrolytic dissociation hypothesis, but such is the case. Indeed, the editors of this edition do not seem to have realised the important progress which has been made in electrolysis, not only as regards theoretical matters, but in practice; and so we look in vain for any reference to recent achievements in the direction of producing chlorates, hypochlorites, &c., in this way.

We should have thought that the work would not have gone to press too soon to have included some reference to Karl Elb's recent research on electro-chemistry. We miss him in common with many others of greater and less rank.

The authors had a great opportunity when writing up aluminium, but they do not call our attention to the phenomenal progress which has been made in the industrial application of this metal during the past 7 or 8 years, and the electrolytic production of aluminium is dismissed in about half a page. Some of the data too are wrong. We might have been favoured with the authority for the statement that the electrical energy required for the production of 1 lb. of aluminium amounts to 3,730 watt-hours. In describing the Héroult process in use at Foyers, the statement is made that the alumina is melted without the addition of a flux, and is then simply electrolysed. But the fact is, that alumina itself is practically infusible, though it dissolves readily in several salts which melt at a reasonably low temperature. In practice cryolite is found to be the most suitable with the Héroult cells, and this is used by the British Aluminium Company. The bath is filled with molten cryolite which is constantly fed with alumina as the aluminium is deposited. If the cryolite is not a flux, it is certainly a solvent for alumina and most, if not all, will imply this if they speak of cryolite as a flux. Loose statements of this kind ought not to have crept into such a work.

Turning to platinum we find as, indeed, we do with nickel and others of the metals which are more interesting to our industry, that data which we may reasonably expect to be present are conspicuous by their absence. The position of platinum in the electrical industries ought certainly to have been defined.

The last chapters in the book deal with the newly discovered elements of helium and argon, and practically constitute abstracts of the more important papers which have appeared, and with which our readers are familiar. We were expecting too much, perhaps, when we looked for some pronouncement on the fact that the existence of these two elements is not in any way indicated in the periodic arrangement of the elements, yet it is probable that their discovery will lead to modifications of that hypothesis.

As a treatise on chemistry, the work will probably satisfy chemists and also metallurgists of the older school, but the up-to-date metallurgist and especially electrical engineers who are interested in electrolysis will find it somewhat disappointing.

The book is executed in Messrs. McMillan's well known style, it is well printed, well illustrated, and suitably bound, and though as a treatise not perfect from our point of view, will, we are quite sure, be welcome wherever the chemistry of the metals is studied.

Alternating Currents of Electricity. By Alfred Still. London: Whittaker & Co. 1898.

This book, says the author, is written less from a scientist's point of view, and more from an engineering standpoint, than is usually the case; and not only for engineering students, but also for those engineers who are but slightly acquainted with alternating current problems.

There are, doubtless, many electrical engineers who, while possessing an extensive practical acquaintance of alternating current machinery, are ignorant of, or, at any rate, have but hazy notions of the principles underlying the design and working of such apparatus. To write a book meeting the requirements of this class of reader demands an author whose knowledge of the subject is good in both theory and practice, and who at the same time possesses the aptitude of expressing his ideas simply and clearly.

As far as we can judge, Mr. Still appears to satisfy all these requirements. His production is undoubtedly one which will appeal to a large class of readers. His preface is a little misleading where he states that the introduction of mathematics has been entirely avoided, since there are instances of the use of differential coefficients to denote rates of change; but such insertions are so carefully explained that no exception can be taken to them.

In the explanation of the various phenomena due to self-induction, capacity, &c., liberal use is made of graphical methods.

In general, the explanations given are scientifically sound and clearly stated. On page 119, however, the explanation of the constancy of the cycle of magnetisation in a transformer core for varying secondary loads is rather loose. We presume Ohm's law has an extended meaning given to it here. Moreover, would Ohm's law necessarily be violated in the primary, if, on increasing the secondary load, the maximum value of the induction varied? This is, however, but one unsatisfactory passage in an otherwise uniformly excellent production. The book is well written, aptly illustrated, clearly printed, and free from typographical slips. We can heartily recommend Mr. Still's book to the class of readers for which he has ostensibly written it.

NEW PATENTS.—1898.

Compiled expressly for this journal by W. P. Thompson & Co., *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.*

11,153. "Improvements in electric arc lamps." Siemens Bros. and Co, Limited. (Siemens & Halske, Aktien-Gesellschaft, Germany.) Dated 16th May. (*Complete.*)

11,154. "Improvements in self-regulating driving pulleys applicable to the driving of a dynamo from a railway carriage axle and for other purposes." E. J. Preston. Dated May 16th.

11,155. "Improvements in secondary batteries or accumulators." F. King. Dated May 16th.

11,157. "Improvements in alternating current motors." W. Langdon-Davies. Dated May 16th.

11,175. "Improvements in switches for electric circuits." C. B. Callow and J. Eck. Dated May 17th.

11,185. "Improvements in starting devices for monophase electric motors." E. B. Wedmore. Dated May 17th.

11,255. "An improved means or apparatus for reducing or extinguishing the electric arc formed on breaking electric circuits." R. H. Fowler, C. J. Hall, and R. Acock. Dated May 17th.

11,278. "Improvements in step-by-step printing telegraphs." W. S. Steljes. Dated May 17th.

11,282. "Improvements in electric check clocks or alarm signal apparatus." H. Reich. Dated May 17th.

11,290. "Improvements in electric arc lamps." P. R. Jackson and Co., Limited, and L. C. H. Mensing. Dated May 17th.

11,292. "A new and improved electrical gas lighter." J. De Meza. Dated May 17th.

11,293. "A new and improved theatrical ticket or check." A. Marsh. Dated May 17th.

11,302. "Improvements in or connected with electrical switches." A. Brier. Dated May 18th.

11,307. "Improvements and modifications in the construction of amperemeters, voltmeters, wall meters, or the like." A. Spark. Dated May 18th.

11,320. "Improvements in electrical ignition apparatus for gas burners." R. J Urquhart. (The Actien-Gesellschaft fur Fabrikation von Broncewaaren und Zinkguss, vorm. J. C. Spinn & Sohn, and S. J. von Romocki, Germany.) Dated May 18th.

11,326. "Improvements in adjustable reels, leads, and other similar purposes." W. H. Sturge. Dated May 18th.

11,340. "Improvements in or connected with electric batteries." E. A. Jahncke. Dated May 18th.

11,353. "Improvements in or connected with commutators for dynamo-electric machines and electric motors." C. J. Ferguson and G. T. Ferrell. Dated May 18th.

11,360. "Improvements in globe holders for enclosed electric arc lamps." K. Weinert. Dated May 18th.

11,396. "Method of producing foot-plates for electrotypes, stereotypes and the like and foot-plates thus produced." V. H. Holm. Dated May 19th.

11,416. "Improved method of and apparatus for signalling or advertising by electricity." A. Ginisty and V. Metz. Dated May 19th.

11,426. "Improvements in electrically propelled vehicles." The Hon R. T. D. Brougham and W. C. Bersey. Dated May 19th.

11,429. "Improvements in electrically propelled road vehicles." O. Patin. Dated May 19th.

11,433. "Improvements in prepayment electricity meters." F. F. Yeatman. Dated May 19th.

11,438. "Improvements in electrical furnaces." Siemens Bros and Co., Ltd. (Siemens and Halske Actien-Gesellschaft, Germany.) Dated May 19th. (*Complete.*)

11,440. "Improvements in dynamos." G. Unterberg. Dated May 19th. (*Complete.*)

11,455. "An improvement in automatic electric circuit breakers and restorers." G. E. Fletcher. Dated May 20th.

11,498. "An improvement in holders for electric glow lamps." H. C. Gover and C. F. Proctor. Dated May 20th.

11,499. "Improvements in resistance switches." H. C. Gover and C. F. Proctor and A. H. Bate. Dated May 20th.

11,506. "Improvements in or connected with telephones." J. E. O. Kumberg. Dated May 20th.

11,518. "Improvements in electrical lighting devices for kerosene and other burners." S. M. Meyer. Dated May 20th. (*Complete.*)

11,519. "Improvements in electric brakes." H. P. Davis. Dated May 20th. (Date applied for under Patents, &c., Act, 1883, Section 103, October 22nd, 1897, being date of application in United States)

11,525. "Improvements in and connected with electrical switches." E. J. Wade and the Electric Motive Power Company. Dated May 20th.

ELECTRICAL PATENTS OF 1884, EXPIRING IN JUNE, 1898.

We are informed by Messrs. W. P. Thompson & Co. that about 80 applications for electrical patents were filed in the month of June, 1884. Out of these applications some were never completed, and of those that were, not one has been maintained to run its full length of term, viz, 14 years, but became void after a period of a few years.

THE

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CONTENTS:

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DYNAMO DESIGN IN THE UNITED STATES.

AT the Electrical Exhibition, which was recently opened in New York, a large number of machines by different makers are on view, and our contemporary, the *Electrical World*, has taken this opportunity of comparing the several designs, and has drawn therefrom certain conclusions as to the direction in which modern practice is moving. These conclusions are published in a recent editorial, and as the subject will probably be of interest to many of our readers, we propose to briefly enumerate some of the leading features mentioned. First, we learn that multipolar machines steadily grow in favour as compared with two-pole machines, and that slow speed machines are now made multipolar for as small an output as one-half horse-power. Steel is not so much used as formerly, a common construction now being to use cast-iron yokes with cores or pole tips of wrought-iron plates from one-eighth to one-quarter inch thick. The yokes are generally circular in form, and wide enough to entirely cover the magnet bobbins; these latter being often further protected from possible mechanical injury by arranging an inward flange at each side of the yoke, so that the bobbins lie in a sort of trough. With regard to the magnet winding, it is stated that edgewise tape winding is beginning to be used for the series coils. Smooth core armatures, we are told, have practically disappeared from up-to-date design, deep parallel-sided slots about half the width of the teeth being most frequently used, although some makers prefer an overhanging tooth with a very small gap between the tips of adjacent teeth. In this case no bands are used, and even with the parallel slot bands are often replaced by the insertion of long strips of wood running the whole length of the armature, and held in place by being fitted into notches just beneath the tips of the teeth. A notable feature of modern design is the increased induction in the air-gap, the use of enlarged pole pieces to increase the area of the air-gap having been largely abandoned; whilst in some cases this increasing of the magnetic density is carried to the point of bevelling the magnet cores at the poles so as to reduce the area of the air-gap below that of the magnet limb. The object of this design is to reduce as much as possible the distortion of the field under load, and this practice has arisen owing to the demand for a machine that will run sparklessly without changing the position of the brushes from no load to 25 or 50 per cent. overload. The carbon brush is almost universally used, even for 100-volt machines, and is invariably arranged radially or nearly so; the brush-holders being of various designs, very generally carried on two rings, one positive and one negative, which serve both for mechanical support and electrical connection of the brushes at the same potential. With regard to commutators no great changes are noticed, except a tendency to increase the area of brush contact per ampere, this being done by increasing the diameter of the commutator whilst keeping the length unaltered. Although the exhibition does not include any examples of the very big output machines now made for traction and power transmission, it is, says our contemporary, of very great technical interest, and besides many examples of moderate-sized machinery of various designs, it contains a very good collection of dynamo and motor accessories, arc lamps, switchboards, and other apparatus.

Overcoming High Resistance in Crookes Tubes.

IN the *American X Ray Journal*, April, 1898, Dr. Graves makes some very interesting remarks on methods of restoring X ray tubes which have become "dead" by increase of resistance in use. He considers that by proper treatment any "dead" tube may be made to work again, without re-exhaustion, or without the use of restoratives, such as vapour emitters in side pockets. Dr. Graves's treatment consists in a rational combination of certain artifices already known and applied separately. The principal artifices employed by Dr. Graves to resuscitate "dead" tubes are reversal, spark-gaps, and tinfoil on the cathode end of the tube. He finds that in tubes of an ordinary resistance, the direct resistance is about three times the reversed resistance. When, therefore, the current refuses to pass in the proper direction, the chances are that it will be able to pass when it is sent in the reverse direction through the tube. If it is found impossible to send the current through the tube even in the reverse direction (when the leads are connected directly to the tube), then success will usually be attained by introducing a spark-gap between the tube and the negative terminal of the generator. Dr. Graves has repeatedly observed that a spark-gap at the negative pole reduces the resistance of a tube, while a spark-gap at the positive pole increases it. The reversed current is sent through the tube till the phenomena observed are the same as when an ordinary tube is reversed. Dr. Graves maintains that tubes that have been resuscitated in this way are far more efficient than new tubes which have not yet become "dead" by continued use. Dr. Graves's paper is well worth the study of those engaged in practical X ray work.

Some Notes on Boiler Trials.

IN making boiler tests, it is rightly observed by Mr. Schweder in his paper to the South African Association of Engineers, that complete trials are lengthy. He advises means whereby the action of a plant can be followed continuously. For this he would analyse flue gases frequently, so as to approximate the ideal of 15 per cent. of carbonic acid in the gases. Average analyses only showed 10·8 per cent., and once only had he found 15 per cent. The Arndt econometer is recommended as giving, with a fair degree of accuracy, the ratio of CO_2 in furnace gases, and it will justify its title if the fireman can be induced to fire to its indications, either by pride or by a bonus on results. We drew attention to this instrument when it first came out, and advised its employment as a means of paying firemen by the piece, so to speak—that is, by the proportion of CO_2 they manufacture. Furnace temperatures are computed by means of a piece of copper held in a piece of gas pipe a few inches above the fire. The copper is quenched in water, and the temperature computed from the final temperature and specific heat. Mr. Schweder has had made a new instrument for measuring the velocity of the furnace gases for the purpose of showing the amount of air that is being used for a certain amount of coal. It is not clearly described, but appears to record by means of a nearly horizontal water-gauge tube such that a little difference of head gives a long range of reading. The instrument is the design of Prof. Buknagel, and should Mr. Schweder read this, we hope he will send us a drawing and full description for our columns.

The Magnet and the Spectrum.—Mr. F. Charles, of Bristol, writes the following very interesting letter to the *Engineer* as follows:—"At a time when so much attention is being paid to X rays and new developments of the theory of light, it will not be inappropriate to direct attention to a passage in the *British Cyclopædia*, published by Orr and Smith, Amen Corner, in 1835. The passage in the article on 'Spectrum' runs as follows:—'One of the most extraordinary effects which has resulted from the action of coloured rays is the communication of magnetic powers to metallic bars. Dr. Morichini, of Rome, was the first person who discovered the properties which he considered were confined to the violet rays. At that season of the year when the light of the sun is most powerful, he admitted it into his chambers, and having formed a coloured spectrum by means of a prism, he collected the violet rays in the focus of a convex lens, and by moving the lens parallel to a steel needle, he made the focus of the violet rays pass from the middle of one extremity of the needle to the other, and always in the same direction, without touching the other half. By continuing this operation for nearly an hour, the needle was found to be completely magnetised. . . . . The same result was obtained by Dr. Carpi at Rome, and Mr. Cosimo Redolfi at Florence. . . . When the violet light was passed through the thick smoke of burning sugar, the needle showed only a very slight degree of magnetism.' Further on it is explicitly stated that in 1817, when Dr. Playfair was in Rome, he saw the same experiment carried out with perfect success. Perhaps some of your readers can tell me whether these statements are true or not."

The Ameer and the Dynamo.—In the whole annals of the engineer in the East, probably no man has achieved in so short a time as honourable a record of difficulties overcome and conspicuous success attained from the smallest beginnings as Sir Thomas Salter Pyne, C.S.I., M.Inst.M.E., and C.E. The extent of confidence reposed in his ability by H.H. the Ameer of Afghanistan has been more than justified by the varied and far-reaching industrial developments which, under the enlightened patronage of the Afghan ruler, Sir Salter has created in the midst of an unsympathetic and fanatical population. The story of Sir Salter Pyne's rapid success is a testimony to his solid worth of character and indomitable energy in a position from which a predecessor, after a short inspection of Kabul amenities, hastily retired dismayed. To enter a country in which the worst traditions of the East prevail, his only guarantee the somewhat filmy protection of a ruler suddenly become interested in mechanics, as a child might be in watching wheels go round, to retain that interest and form it in the direction of serious work, to erect and equip workshops, foundries, mills, and to establish a dozen or more useful industries, and, above all, to make 3,500 skilled mechanics out of the typical Oriental material before him—all this is surely an achievement which can only be described as grand. The solid fact of this industrial activity set going in a land amongst a people whose energies knew no other outlet than that of warring against their neighbours, is sufficient to place Sir Thomas Salter Pyne in the front rank of the pioneers of civilisation. Great things often originate in small beginnings, and this great enlightenment of the Afghan people may be traced to a dynamo which one day the Ameer, when on a visit to India, lingered to watch at Rawal Pindi. It is from this incident that the great interest in applied mechanics which the Ameer now possesses may be dated, and which has given the subject of our note the opportunity of which he has so well availed himself. The Ameer retained the services of the engineer in charge of the plant, who happened to be a Frenchman, but that gentleman, after a brief experience of Kabul, took an early opportunity of returning to his beloved boulevards. He was succeeded by Mr. Pyne, and from that date Sir Salter's career has been one of uninterrupted success, not only in his own professional lines of activity as a civil and mechanical engineer, but also in the more exacting domain of confidential agent to the Afghan ruler.

APPLICATIONS OF ELECTRICITY ON A MODERN WARSHIP.

There is little doubt that the Americans are far ahead of us in their applications of electricity on board ship, and if only Admiral Sampson can force the Spanish fleet, now said to be "bottled" up in Santiago de Cuba, to a pitched battle, it is possible that the lessons which electrical engineers will learn from the fight will be as important in their way as those which will be gathered by students of naval strategy, and of armour *v.* gun.

Even the most sanguine of electrical engineers do not look forward to the use of electricity in propelling warships: at any rate, they do not expect that this method will be adopted in the near future; but they are without doubt right in claiming that electricity is by far the best source of power for driving the auxiliary machinery of the modern man-of-war. The American naval authorities, more than those of any other country, have realised the importance of this, and should a really serious action take place between the hostile fleets, we shall eagerly watch for official reports on the behaviour of electrical systems in actual warfare.

The presence of steam and exhaust pipes anywhere outside of the main engine and boiler compartments is undesirable, especially in the crews' living quarters, where the heat that they produce in confined spaces densely inhabited is particularly bad. In addition, the presence of complicated steam appliances in various parts of the ship adds to the work of keeping the vessel clean. These, however, are minor disadvantages. A greater one is the obvious danger in action from steam pipes placed above the protective deck. This is met by placing below the protective deck all auxiliaries whose use would certainly be necessary in battle, and by shutting off steam from all the rest below the protective deck when the ship is cleared for action; but the capstan and the winches must be on deck, and their use may become imperatively necessary in action. The cutting of the steam pipe, above the protective deck, to any of the machinery, would render some of the ammunition-passing rooms entirely untenable until steam could be shut off from below, to say nothing of the probable loss of life and disastrous moral effect.

By far the most serious objection to these auxiliaries, however, is their lack of economy. Everybody knows they are wasteful, but just how wasteful it is difficult to say, because of the rarity of tests under service conditions. About a year ago, however, engineer W. W. White made a series of very careful experiments on the auxiliaries of the *Minneapolis* (U.S. Navy). In these experiments the condensed exhaust was measured and indicator cards were taken from 13 different auxiliaries, beside the dynamo engines, including main and auxiliary air and circulating pumps, pumps for feed, fire, bilge, flushing, and water service, one forced-draft blower, and the ice machine. The mean result from these 13 was 99·522 lbs. of feed-water per I.H.P. per hour. The greatest economy was shown by the middle circulating pump engine, a simple, vertical, two-cylinder, inverted, direct-acting engine, with slide valves, actuating two centrifugal pumps. At the time of test the pump was working under its full load. The consumption was 55·06 lbs. of feed-water per I.H.P. per hour. The least economy was shown by a horizontal duplex pump, 12 inches × 8½ × 10. At the time of test it was making an average of 12·7 double strokes per minute on a very light load. Its consumption was 318·68 lbs. of feed-water per I.H.P. per hour.

These results are certainly startling. We have, of course, always known that the auxiliaries were very extravagant in the use of steam, but who supposed that there were engines to-day using from 100 to 300 lbs. of steam per I.H.P.? In an official summary of tests to determine the consumption of steam of the main and auxiliary engines, we find there are 34 auxiliaries having in all 52 steam cylinders. Thirty-one of these engines were indicated, giving an aggregate of 471 H.P. developed, using collectively 56,049 lbs. of water per hour, or an average of 119 lbs. per I.H.P. Were these auxiliaries as economical as the main engines, 9,891 lbs. of steam would have developed the same power. 46,158 lbs. of steam or water being used *more than is necessary* if the best conditions of economy prevailed. In other words, the data show that at 8 lbs. of water evaporated per 1 lb. of coal, 5,769 lbs. of coal can be saved per hour.

It must, of course, be borne in mind that it is impracticable to realise this gain because of the complications which would follow the introduction on board ship of high-expansion engines for these numerous purposes, but the question is, shall these numerous engines for so many purposes be replaced by fewer engines of higher character and have a few central-power plants capable of meeting similar wants with greater economy; or shall we design more economic engines for each individual condition, even at the cost of a slightly increased number of parts; or shall we have one more economical central steam-plant developing power to be distributed by electricity to the varied requirements in different parts of the vessel?

Wastefulness is inseparable from any system requiring the development of power in numerous independent engines of small power situated at a distance from the boilers. Under such circumstances the losses by radiation and condensation must necessarily be greatly increased. Then, too, the use of numerous small engines causes a great increase of the friction load. Worst of all, each of such small engines must be large enough to do its maximum work; hence, under service conditions, it must often work at low power with great waste of steam.

These troubles can be avoided by the use of one power plant for all the auxiliaries. Such a plant for a large man-of-war could be divided into a sufficient number of units, so that the generators in use could always be working at nearly their full load; and at the same time the units would be so powerful that compound engines could be used with consequent economy. In addition there would be the gain from the substitution of a few large engines for many small ones. The plant, of course, would be placed near the main boilers, avoiding much steampipe drop and condensation, would be below the water-line and well protected, and would keep its heat, dirt, and noise in the machinery space.

In the *Engineering Magazine*, Mr. George H. Shepard discusses the applications of electricity on modern warships, and indicates the direction in which it may be most usefully employed. He is a great advocate for central power plant. In order to run this to the best advantage by keeping its load as nearly uniform as possible, the distribution to the auxiliaries should be by electricity; the dynamos for electric lighting being continued to run by steam. By this means, when the night's lighting load goes off, the day's motor load could be put upon the same generators, instead of running two sets of generators, each at light load and heavy load alternately—a necessity under any system of distribution. There would, of course, be variations in the load; but electric light and power stations equipped with several units, operated by condensing engines, can run under wide variations of the total load, without greatly changing their steam consumption per I.H.P.

Electricity is very adapted to the conditions existing on board ship. The wires can be carried through water-tight bulkheads with less damage to the latter than that caused by the pipes necessary for any other system of distribution. For the short distances existing on board ship the transmission losses are negligible. In starting machinery electricity can be applied with a quickness, certainty, and safety attainable with no other power, except possibly compressed air, whilst distant motors can be controlled from the central station.

It must be admitted that most naval officers regard electric machinery on board with distrust, so that at present it is chiefly used only for illumination, search lights, communication, and to some extent for signalling. Perhaps the dislike for electric machinery arises from the fact that electric call-bells and telephones on board ship frequently get out of order, whilst a fault in the electric mains is hard to locate, but such disadvantages as have been experienced are probably due in most cases to the restrictions and interferences which electrical engineers have to contend with when putting in installations on board a man-of-war, for it cannot be said that electric machinery deserves a bad reputation, although the conditions on board ship are very trying to electrical appliances.

Naval architects should try and meet electrical engineers more leniently, for the advantages to be gained by giving electrical appliances a fair field are enormous.

Mr. Shepard carefully examines the advantages and disadvantages of replacing steam auxiliaries by electric auxiliaries, and puts his finger upon the chief difficulties in using complete installations of this kind. He concludes that although electric auxiliaries offer many advantages, their great cost and the amount of space they would occupy render a complete installation of them of doubtful benefit, while their great weight makes it absolutely out of the question under present conditions. It is to be expected, therefore, that the present mixed system of power distribution will continue aboard ship, possibly as long as the steam engine remains the prime mover, but that electric appliances will never occupy a much more important place there so long as present ideas obtain. However, there is every reason to hope that, with continued progress, both amongst makers and users of electric machinery, it will gradually become more and more adopted aboard ship for those purposes for which it is peculiarly fitted. The necessary power will probably be furnished by a gradual expansion of the present electric light plant to meet the new demands. What the limit will be depends upon the future improvement in electrical appliances, especially in the matter of weight, and upon an increased disposition among naval constructors to design their plans in such a way that whilst the efficiency of a man-of-war as a fighting machine shall not be impaired but enhanced, more scope shall be allowed and more opportunity given to the electrical engineer for the practical solution of those difficult problems connected with the distribution of power to auxiliary engines.

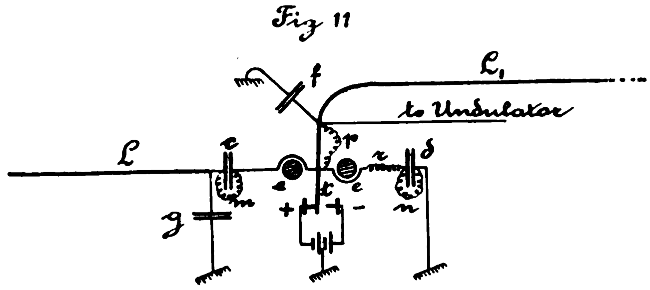
VIBRATING CABLE RELAY.

By K. GULSTAD.

(*Concluded from page* 752.)

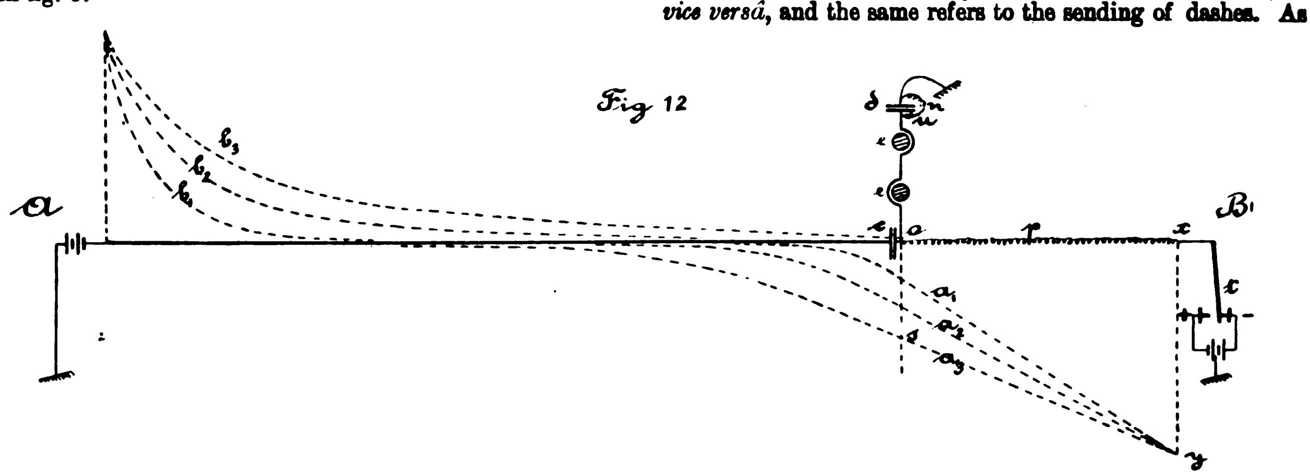
It is not always necessary to employ special windings for the vibrating current; some advantage might possibly be gained by an arrangement, as in fig. 11, or in principle as sketched out in diagram, fig. 12, where the tongue, for the

Fig 11



sake of clearness, is placed apart from the electro-magnets, and where the resistance, p, for the same reason, is joined up as in fig. 5.

Fig 12



To limit the subject, I shall try to explain the working of the relay arranged in this manner only.

Let us suppose that the vibrating apparatus is put into action by switching the resistance, p, fig. 12, on to the cable at point o, while the transmitter at the sending station, A, sends a series of dots into the cable, p being chosen so that the rate of relay impulses is the same as the rate of dots.

Considering the instant, when the armature has been moved against, say, the right-hand contact, a negative current is sent through p into the cable end at the relay station, B, thereby decreasing the potential throughout the line. In fig. 12 this decrease at different periods of time is roughly illustrated by the potential curves, a_1, a_2, a_3, the ordinates at any point representing the potential, which, at the tongue, is $x\ y$. This fall will evidently continue till the potential at point o has dropped to, say, $o\ s$—*i.e.*, so far, that the negative current through the relay windings is sufficiently strong to move the armature and press the tongue against the left-hand contact, whence a positive current is then sent into the cable, &c. The time elapsing from making till breaking contact thus depends upon the potential at o due to the relay battery, and it is further evident that the time also will be influenced by the sending current, that tends to increase or decrease the potential, as the case may be. In fig. 12 the potential curves for a positive sending current are indicated as b_1, b_2, b_3. If a positive sending current increases the potential at o a little just before it has fallen to $o\ s$, the time for the reversal of the tongue will be prolonged. If the sending current, on the other hand, is negative, the time will be shortened. In general, the interference of the sending currents will therefore, after a little while, bring the vibrations of the relay tongue into unison, and practically into synchronism with the reversals of the transmitter, and in such a way that, while the transmitter sends a positive current into the cable, the relay will send a negative current into the cable at the other end, as well as into the line L_1, fig. 11, or *vice versâ*.

How soon this synchronism is established depends, of course, upon the strength of the line current; suffice it to say that a relatively weak current will soon be able to control the motion of the relay armature, even if the resistance, p, is not exactly corresponding to the rate of dots. In case the action of the dots is quite negligible, sufficient synchronism would, however, be established as soon as the action of the dashes commences; all that is wanted is that the influence of these signals of longer duration are strong enough.

From this it will be seen that only positive and negative dashes at certain intervals are necessary for signalling, it being of minor importance whether the dots penetrate or not, as the relay itself will fill up the intervals between the dashes and spaces with the number of dots needed. Obviously the very circumstance that this Morse code signalling can be practised by means of dashes and spaces, involves the possibility of increasing the working speed of cables or long landlines, where vibrating relays are employed.

When I have mentioned the arrangement, fig. 11, as probably being preferable to that shown, fig. 10, it is not only for the sake of convenience, but also because a partial diminution of the effect of the charge appears to be attainable.

Referring again to fig. 12, it has been pointed out that whenever positive dots are sent into the line from A, a negative current is simultaneously forced into the cable at B, or *vice versâ*, and the same refers to the sending of dashes. As the current direction through the cable is the same, a portion of it nearest B will be charged oppositely to the length of cable nearest A, the two charges being separated at a point of zero potential. Whenever reversals take place, a portion of these opposite charges will tend to neutralise each other, thereby diminishing the time for the succeeding re-charge from both cable ends. On account of the sensitiveness of the relay—even with pole-pieces quite up to the armature—a feeble charge only can be sent into the cable from B, in case p is placed as is fig. 5, and it is partly to try the effect of increasing the charge due to the relay current that I have applied p as described (fig. 6, &c.).

It has been mentioned that the effect of distortion will be diminished by making the relay vibrate in a proper manner (*vide* fig. 8). Going further into the matter it will be found that the diminution can be effected to a greater extent than might appear possible at the outset. The question of dots being of minor importance for high speed work, the formation of the dashes is the only one to be considered as regards the speed of signalling. To make up for the distortion of the dashes, the tongue must leave the contact on which it rests as soon as the time for the dash is elapsed. The decrease of the negative potential due to the relay current at o, fig. 12, must, for instance, correspond to the increase of the potential due to the sending current, or *vice versâ*, in such a manner that the differences between the resultant potential at o, and the equally varying potential at u, will cause the tongue to be reversed, whenever the relative strength of the cable current diminishes. Up to this moment the tongue will be kept against the contact by the attraction of the armature, which action will continue as long as the flow of electricity from B can be neutralised by the flux of opposite signed electricity from A.

In order to ensure a satisfactory working of the vibrating relay, it is therefore not sufficient that it vibrates at a certain rate; this can be attained in different ways, but it must vibrate so that the relay current through the windings also increases in a special manner. This can be accomplished by proper variation of the condenser capacity, or of the resistance r, of course, at the same time altering p for maintaining the rate of vibration. For the sake of extending this variation, a condenser, g, fig. 11, may sometimes be added with very good result.

The manner in which the variation of the condenser capacity affects the working of the relay is illustrated by the record of signals upon undulator slips marked figs. 13, 14, 15.

As to the regulation, the same holds good as for duplex working, it is chiefly a matter of experience, patience, and perseverance, although certain rules can be given. When, however, the right "balance" is found for the maximum speed, it is likely to be steady from day to day, and only to need small corrections. When the speed is lowered a new delicate adjustment of the condensers is not required, as it is generally sufficient to alter the resistances, p, and sometimes r.

Referring to fig. 8, it may be said that the regulation is intended to prevent the top of the dash or the space from extending much above or below lines m_1 and n_1 respectively. This is possible even with a series of dashes sent, from the fact that the vibrating relay also sends an equal series of negative dashes into the cable, thereby producing corresponding phenomena of charge.

The above regulation is dealt with as if it was undertaken from the receiving end only. It is, however, clear that the same thing can be done to some degree from the sending end, all the effects of variation of current—by altering the battery power, by compensation, by employment of sending condensers, &c.—being at once noticeable on a suitable recording instrument, such as the undulator. The manipulations at the sending end must at the same time only be looked upon as a means of facilitating the adjustment at the relay station.

By the use of the vibrating relay, the distortion of signals on undisturbed lines may be compensated for and eliminated to a considerable extent in conformity with the "balancing" applied in duplex working. The arrangement, fig. 11, is the same in several respects as the one employed in the differential duplex. "Bridge" connections may also be employed with good results—see fig. 16, where h, i are resistances.

The *modus operandi* for "balancing" is comparatively simple in principle. Let the transmitter station send a series of signals, including a certain number of dots previously agreed upon. The relay station, which switches on the vibrating current as soon as the signalling commences, regulates at first the resistance, p, fig. 11, till the right number of dots is obtained, and subsequently the condenser capacities and resistance, r, for correcting the dashes, then re-adjusting p, and so on.

The slip, fig. 17, records the effects of the transmitter

Fig 13


Fig 14


Fig 15

Fig 16

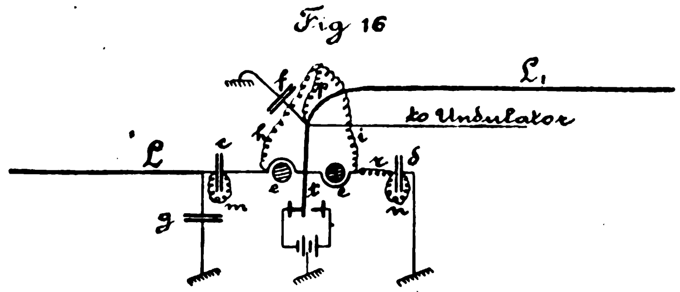


Fig 18

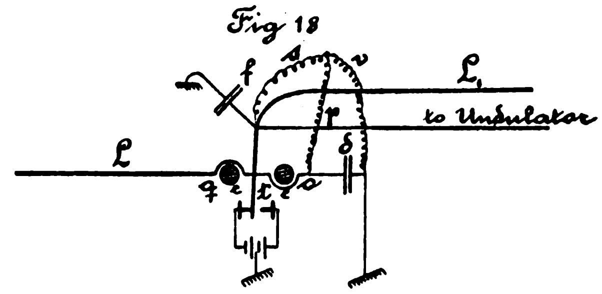
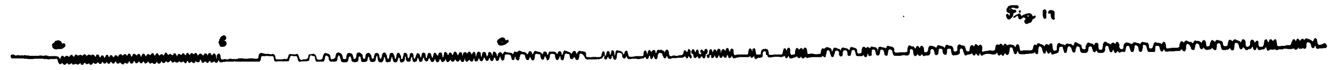


Fig 17



current when signalling begins. The vibrating current is put into action at a, the interference of transmitter currents commences at b, and the proper signalling at c.

The details of construction and the adjustment of the relay may influence the results obtainable considerably. The conditions of the line, L_1, may likewise affect the same, and I consider it, therefore, preferable sometimes not to connect L_1 directly to the vibrating relay, but to the tongue of another ordinary relay, worked by the former.

Regularity of the transmitter motion and constancy of the sending battery are also essential points to be observed, when the system is to be fully utilised.

The records in fig. 13 are very readable, yet it will be seen that the dashes are unproportionally large, and would possibly run together when the speed is increased. In order to increase the influence of the relay current, I may then reduce the capacity of d and likewise the resistance p, fig. 11, the result being as in fig. 14, that the signals become more distributed. Reducing the capacity much more would, however, not do—see fig. 15—as the relay current would then rise or fall too quickly (preponderate) and break the dashes, making the signals unreadable. In all three cases it will be seen from the 12 dots that the rate of vibration is the proper one.

B

It seems evident that the application of the vibrating relay is not limited to cables, but may be employed on long landlines also. The regulation for dashes and dots requires not be so very exact in the latter case, neither is this necessary on short cables nor when working long cables at low speed. The arrangement, fig. 10, would perhaps be convenient on landlines.* As to duplex working in connection with the vibrating relay, I don't see any objection for employing the same arrangement (fig. 10).

So much for the theory of the vibrating relay. By means of this a very considerable increase of speed on cables or on long circuits, undisturbed by induction, &c., may be looked for, when compared with ordinary relay work. I shall, however, not here suggest to what extent this is possible, the matter being new, and no doubt open to improvements in different respects. I have myself obtained a speed of 80 to 90 words per minute on an artificial line composed of resistances and artificial cables representing something like 700,000 K.R. The system has also been tried practically upon the Great Northern Telegraph Company's cables and landlines from Newcastle-on-Tyne to Gothenburg, *i.e.*, a circuit of about 580,000 K.R., with the result that upwards of 100 to 110 words per minute can be sent from Newcastle and translated at Gothenburg to Nystad in Finland, whenever the landlines are free from external disturbances; if such is not the case, the speed as a matter of course is considerably lower.

It should be mentioned that a modification of the vibrating relay arrangement as described above has been in use on this very cable for many years, and with a very satisfactory result. This modified arrangement—shown in fig. 18—is due to Mr. Falck, the Great Northern Telegraph Company's Superintendent at Gothenburg, who introduced it in order to facilitate the reversal of the relay armature, and who has since improved upon it in several ways. The speed attainable is 65 words per minute. It will be understood from fig. 18 that the direction of the marking current is the same here for the sending as for the relay current, and the diminution of the distortion is consequently caused by the proper variation of potential at the points o and q, both being of the same sign.

called variable zero. An increase of battery power will also to some degree be found advantageous for such instruments, when the condensers are diminished at the same time.

With regard to battery power, it is certainly a capital thing to be cautious, but when speaking of faultless cables, as made nowadays, with a thick insulating coating, occasionally tested with several thousands of volts, a much higher E.M.F. than is generally in use on cables, may doubtless be employed without risk.

Copenhagen, *May*, 1898.

CONSULTING ENGINEERS.

The company promoter is inclined to the belief that he is at liberty to ask an engineer to carry out tests on lines to be laid down by the promoter. It is possible to carry out a so-called test on promoter's lines and obtain results which, while representative of facts obtained under the given conditions, are by no means fair facts to place before a lay investing public.

Recently it appears that the British Hydraulic Jointing Company called in Sir Frederick Bramwell to report upon the invention to be worked or exploited by the company. Sir Frederick's report was lengthy and apparently not so favourable to the promoters as to make them afford space for it in the prospectus. The condition laid down by the author of it was that it must be published *in extenso* or not at all, and the prospectus simply stated that Sir Frederick had reported on the invention and his report could be seen at the office of the company. Of course, not one in a hundred investors would go to see it: they would conclude it to be favourable. But Sir Frederick wrote to the *Times* asking the public to read his report before investing. Many experts really do little else than follow out the instructions of promoters, and they prepare reports of no real value but very seriously misleading, while at the same time they write

Fig. 19

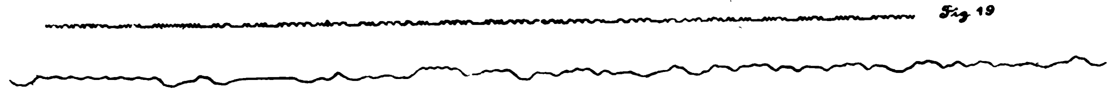


Fig. 20

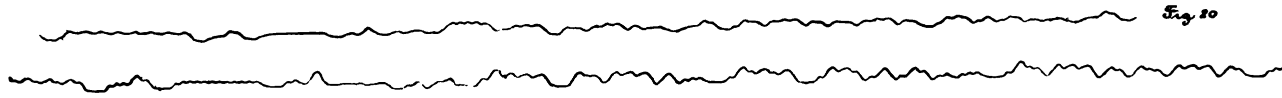


Fig. 21

To illustrate in some way what the influence of the distortion means, I may refer to the undulator records, figs. 19, 20, 21. Fig. 19 shows signals translated through the mentioned artificial line at a speed of 90 words per minute by means of the vibrating relay. Fig. 20 gives the signals sent through the line direct to the undulator at a speed of 80 words, and fig. 21 the same thing at a speed of 50 words per minute, the conditions being the same in all three cases as far as practicable. When the relay was worked in the ordinary fashion a signalling speed of only 21 words could be attained (impulses to be used).

In conclusion, I beg to remark that when I have limited the speed on the artificial line to 80 or 90 words per minute, it should be understood that this is effected by rather a moderate E.M.F. By increase of the battery power a somewhat higher speed would no doubt be obtainable according to previous trials.

The limit of speed appears, indeed, principally determined by the attenuation of the sending current, and not so much by the distortion of the signals, which can be neutralised, to a great extent, in the way shown. The attenuation can of course be counteracted by augmentation of the E.M.F. till the same has reached the limit which is considered safe for the cable.

The vibrating arrangement may, according to its mode of action, be looked upon as a contrivance for transforming the distortion into an attenuation of the current, *i.e.*, the very same thing which partly is done by condensers in circuit with receiving instruments working with the so-

* If arrangement fig. 11 is used, condenser c and resistance m may be dispensed with.

nothing which is not true. A bicyclist might run along a rut in a road and would be able truthfully to report he had had a smooth journey.

This would read well in a report, but it would not make the whole road surface good. Where an engineers' report is to be employed as a means of floating a company, we think he ought to report on everything he may find concerning the idea or project. Indeed, it is the consulting engineers' right to assume that no matter by whom he is called in, his client's object is to obtain the whole truth. As often as not, however, promoters merely want favourable reports, and are very apt to think they are badly treated when an engineer refuses to carry out a test on misleading lines. We do not think that an engineer called in to report on an invention purely as a piece of mechanism is bound to say that in his opinion it is a non-patentable invention; he naturally leaves such questions to the patent expert, and has a right to assume his employers to be honest enough not to ask the public for money until they have satisfied themselves that the patent is good. It appears from Lord Crawford's letter in reply to Sir Frederick that the report dealt with the question of validity of patents on which Sir Frederick had not been called on to advise, but on which he apparently felt bound to say something. We think in such a case if an engineer doubts the validity of a patent he might simply say, "as regards the patent I would advise you to obtain the opinion of some expert." We have known would-be promoters very strenuous in asking consultants to give them facts when they hoped or expected such facts to be favourable, and to be exceedingly annoyed when the facts were unfavourable. Whatever extent may be covered by an engineer's report, there can be no question that on the points he does deal with he should refuse to admit any course of action which makes for results that cannot be obtained commercially. A hard and fast rule to cover every case it is not possible to lay down. Every case must be its own law, and an engineer must necessarily be guided by what he finds in each case. He will find out for himself whether the intention of his employers be really honest or otherwise, and act accordingly.

PREPAYMENT METERS.

The popularity of a prepayment system in connection with artificial illumination is undoubted. It has strengthened the unsecure tenure of the gas companies by creating a handsome revenue from a section of the public which is commonly reputed to be beyond the civilising influences of quarterly accounts. Light is a necessity even to the submerged tenth, and the essential principles of prepayment were quickly grasped by it.

It was discovered that a pennyworth of gas went further than oil, and was immeasurably more convenient. The fact that it was infinitely safer than the devastating oil lamp may

Fig. 1.

not have counted for much, but no doubt the prepayment gas meter has operated very effectually in this direction. The prepayment system, however, has extended beyond the poorer classes of the community, and is not uncommon in the flats and domiciles of the well-to-do. With the success achieved by the gas companies so prominently displayed, it was not surprising that attempts should be made to apply the principle to electric lighting, and Mr. C. O. Bastian, whose electrolytic meter has been discussed a good deal of late, has been working on the subject for some two or three years. The prepayment electric meter devised by Mr. Bastian has gone through quite an evolutionary process before arriving at its present form, the chief modifications tending towards a simplification of the instrument.

This prepayment arrangement does not imply a special form of meter, for the device can be attached] to any of the well-known types of meter. The illustrations by which we shall strive to explain the working of the instrument show the prepayment mechanism applied to a Thomson watt-meter. The operation of the instrument, by means of a coin, is an interesting and ingenious one. Until a coin is inserted, the handle which projects from the cover is free to move; a coin, when pressed through the slot, falls into a groove, and forms a rigid connection between the handle and the interior mechanism, and a turn of the handle switches on the current. The arrangement of the meter will be better appreciated by referring to the detailed parts. Fig. 1 shows the meter and prepayment attachment entirely enclosed, which is the form in which the mechanism will be usually sold. Fig. 2 is front view of the meter, the only features to be noticed here being the coin receiver or shoot shown at O, and the pointers N, N, the exact function of which will be referred to subsequently. Fig. 3 gives a detailed view of the prepayment mechanism seen from the

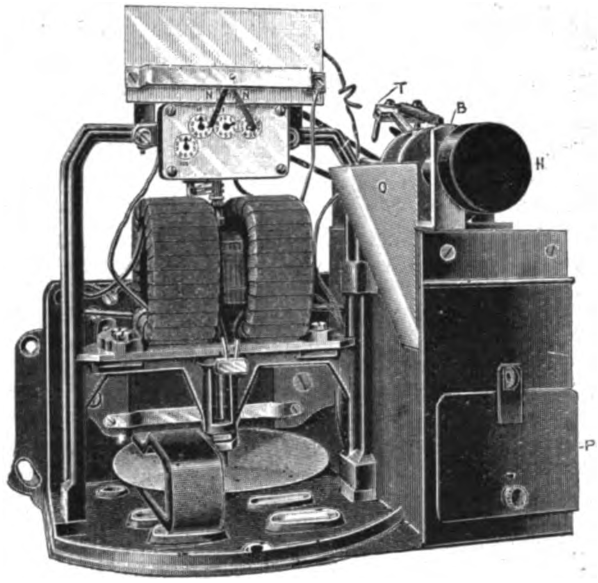


Fig. 2.

back of the meter. We will now follow the action of the apparatus. Upon the insertion of the coin at B, which makes a mechanical connection, the handle, H, is turned. One result of this is to operate on the pivoted end of the switch, T, which is depressed into the mercury cups, M, thus completing the circuit through the meter. The switch is held in the mercury cups, against the tension of a spring, by

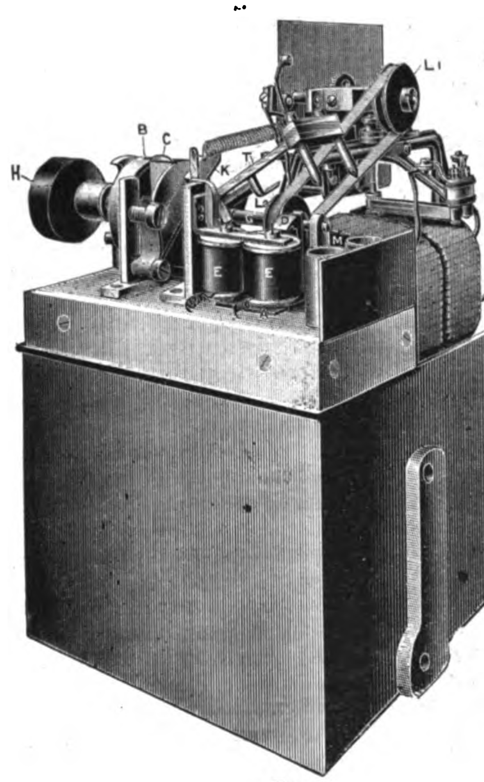


Fig. 3.

means of a clutch, D. The turning of the handle does more than merely put the switch on. In fact, the operation that we are about to describe is probably the most important in the complete action of the mechanism. Above the dials of the meter (fig. 2) will be observed two pointers, and the relation of these to one another is very important. The handle H, being in connection with a rod, G, its movement will cause a partial revolution of the pulleys, L_1 and L_2. These pulleys are connected together by means of a miniature raw hide belt; pulley L_1 is mounted on an axle, which carries one of the pointers already alluded to. It will be seen, therefore, that when the handle is turned, one of the needles, through the medium of the pulleys, is moved away from the other pointer, the exact distance of its movement being predetermined. The second pointer is geared to the train wheels of the meter, and when the switch has been put on by the agency of a coin, the meter commences to run, and the second pointer travels slowly after the first one. The exact distance it has to traverse before it overtakes the first pointer is a measure of the current consumed; in fact, the first pointer is caught up by the second pointer in a time inversely proportionate to the amount of current flowing through the meter. The distance that the first is separated from the second is determined by the gear wheels, which are proportioned according to the price per unit and the value of the coin with which the mechanism is intended to be operated.

The more coins that are dropped in, up to a certain limit, the further the first pointer will be separated from the second, and they will be a proportionately longer time in coming together. One side of the first pointer is insulated so that it can come in contact with one side of the second pointer with impunity. The other side, however, carries a platinum contact, and when the second overtakes it and comes in actual contact, a current of electricity at once flows round the electromagnet, E, whose armature is immediately raised, and pulls the clutch, D, away from the switch, F, which immediately flies into the off position.

From observations we have made the action of the meter seems to be certain, and the instrument ought to meet with considerable success.

THE YARMOUTH BREAKDOWN.

The report of Mr. Preece upon the recent breakdown at Yarmouth is a little curious for two reasons. He does not advise the use of separators for the prevention or, rather, dealing with priming water. One reason is the heavy expenditure, £250, that would be involved. Granting that the expense would be so much, is the sum an extravagant one as an insurance against such a breakdown as occurred? which must have involved an expense directly and indirectly very much greater than £250. Then, again, if separators are what they profess to be, can it be held that a station is complete without them and, their omission having proved so provocative of disaster, ought not such omission to be remedied at once. Further, the wasteful effect of wet steam is such that if separators do their duty the economy in fuel which they bring about must be such as to very amply repay the expenditure upon them. Every pound of water separated from the steam represents the destruction in the cylinder of steam probably equal or nearly equal in amount to the water. Separators are not merely to be regarded as such for safety but also for economy.

But Mr. Preece did not stop at one reason. As a rule separators are provided with a water-gauge and are blown out periodically by the attendant when a given amount of water has been collected, and any neglect to do this may lead to the very disaster intended to be averted. This is correct, but it ought not to be. Separators ought to be drained automatically. The ordinary steam trap which, of necessity, discharges water at a temperature above the atmospheric boiling point, is looked upon as a nuisance, for it practically discharges steam. What is wanted is a good steam trap of large opening discharging into a closed pipe which may be carried to the suction side of the feed-pump whereby all water is returned to the boilers. Where the arrangements are suitable steam separators may be drained direct to the boilers, but not below water-level, and they should have discharge pipes as large and direct as possible.

In a station recently inspected by us there were separators not merely to each engine, but also on the main steam pipe, which we regret to say was a ring main, an appliance far more likely to cause trouble and breakdown than to prevent it or safeguard against its occurrence.

METROPOLITAN RAILWAYS.

The problem of fitting the Metropolitan Railway with electrical traction offers considerable difficulty in the opinion of the *Engineer*. Many of these difficulties come in with the numerous junctions of other railways, as the Great Western, Midland, Great Northern, which, running upon the Metropolitan, make it an open question whether—at least at first—there should not be both steam and electrical working. This in itself does not seem very terrible. With only half the trains worked by steam, there would be considerable improvement in the atmosphere. The directors of the line are, of course, greatly pleased with the antiseptic nature of their tunnel atmosphere. We prefer it ourselves to the unchanged foulness of the unventilated buried electrical railway. While the electrical lines are bound to keep their tunnels little worse than the outside atmosphere, we would tell the Metropolitan directors that they are not bound to maintain their shallow tunnels in better condition than the atmosphere. The philanthropic provision of an antiseptic atmosphere is doubtless kindly meant, but the public are willing to forego the boon. Our contemporary calls on the Metropolitan Company to provide lifts at the stations, facilities for some amount of personal luggage, clean stations, and generally such comforts as would remove the line from the stage of barbarism from which it never seems able to emerge. We think if the Metropolitan Company really set itself to the task of electrical working that the difficulties anticipated would disappear as they came to be grappled with. That it would involve an enormous capital expenditure to put in electrical equipment is undoubted, but we have previously shown that a comparatively small addition to traffic would find an income to pay interest on such outlay, and there can be no doubt that if properly managed the dirty underground might become a clean and paying undertaking. As our contemporary implies, the line has been so brutally managed in the way of dirt and roughing it, that the "system has never had a fair chance yet," and while electricity would be valuable, it is doubtful wisdom to introduce it except in company with other much needed improvements. American experience in electric traction is sufficient to show us that the mere factor of working expenses is not of much moment. Grant that the train mile cost is increased, this can matter little, so long as the receipts more than proportionately grow. It is to this end that electric traction will tend.

MANAGEMENT OF ELECTRICAL UNDERTAKINGS.

The paper on the above subject by Councillor Hesford, read before the Municipal Electrical Association, is not remarkable for its originality. He begins by stating that electrical undertakings can be efficiently administered and profitably managed by local authorities, but he omits to say that such undertakings can be, and sometimes are, inefficiently administered and badly and unprofitably managed by local authorities, particularly when the gas interests of the authorities are interfered with, when individual members of Committees have their own irons to warm, or when political parties fight their battles without regard to anything but the final supremacy of their particular party. After referring to the well-known apathy of local authorities respecting electric lighting, the author proceeds to enumerate the difficulties to be met by those Corporations who decide to take up the electric lighting business.

We are glad to learn from Councillor Hesford that "Every Committee know what they want," and according to him, "It is a station and system of distribution that shall be second to none. It must be planned for utility and convenience, and meet the unknown wants of futurity. Its machinery should be designed to adapt itself with precision and success to all the varying requirements; work at a cost that shall top the record and be obtained from the lowest tenderer. These are the ideals, and the question is how to get them." Exactly; and the writer does not go very far towards trying to perform the obviously impossible task of explaining how it may be done, but contents himself with dwelling upon the idiosyncrasies of the consulting engineer, and the troubles of the Committee, who find that everything is wrong in their station after it has been running for a time. Bad design, buildings too narrow or too short, day plant too small, are amongst the discoveries made, and a scrap heap becomes necessary. Start a reserve fund, says Councillor Hesford, in order to provide for these contingencies. Very good advice, but not original, as we fancy the Local Government Board will sooner or later point out to those Corporations who omit such an obvious precaution.

The author is of opinion that "the primary and foremost duty" of a Committee is to break the record of low costs, and plainly states that the comparative cost-tables published by a contemporary show up the failings of undertakings. Here we must disagree with the worthy Councillor, for however valuable such comparative tables may be, a low works' cost does not of necessity mean good design or management, nor does a high cost mean bad management or design, and before any fair comparison can be made, a deal of further information would be required.

A station in which the staff are paid fair and proper salaries and wages cannot compete in the question of costs with another station worked largely by premium pupils. To endeavour to work a station economically is laudable and an obvious duty, but the attempts of some committees to cut down salaries and wages and to generally starve their works is little short of a scandal, to which we fear the electrical engineer is sometimes a party. The writer complains of the cost of distribution, and looks forward to the time when its reduction will bring the light within reach of the poor man, but we are afraid the poor man will have to wait a long time if cheap light necessitates much cheaper distribution. He considers that street lighting by electricity must wait until the cost is materially reduced, "as corporate gas committees are tough, thick-skinned gentlemen." We are afraid we are uncomplimentary enough to consider them thick-headed also; surely one way of reducing the cost would be to go in for it on a big scale. But do they desire it at any price?

A few remarks on charging, in which he suggests that the lowest price per unit should be aimed at consistent with covering all charges, and a general lamentation that the breakdown of steam plant prophesied does not occur, while faults on mains not foreshadowed are frequent, brings the paper to a close. Councillor Hesford's advice is—Start a reserve fund, break the record for low costs—anyhow—but break the record, and reduce the cost of distribution.

Apparently good management does not include the giving of an efficient supply, as this is not mentioned.

SWITCHBOARD APPARATUS.

Mr. J. R. Blaikie's M.E.A. paper under this heading, is of the type to excite discussion, and switch-gear has not yet reached the stage when engineers feel that there is little more to be done than maintain what is in use. Low tension supply may be fairly secure on this point, as only in individual stations is the switchboard unsatisfactory, but one cannot believe that the largely varying types, forms and sizes, are necessary or desirable. For complication, it is admitted that three-wire boards easily beat those employed in alternating distribution, and this is to be expected. The use of batteries, motor-boosters, and such like auxiliary apparatus, complicate the switch-gear without making it unmanageable.

Mr. Blaikie, however, principally deals with alternating boards, as might be anticipated. It is with this class that the greatest divergency of detail and arrangement is to be found. Frequently the combination is unnecessarily intricate, but we would not care to go as far as the author in attributing it to ignorance or vanity. After all, what is wanted is a reliable and well-designed set of details, switches, fuses, and regulators, and the board as a combination of these should be the result of the responsible engineer's requirements, and adapted to suit the local conditions. This seems to be rather overlooked in the paper, for, take a modern station, arc lighting is gradually extending, and we have separate plant, rectifiers, parallel alternating arcs, and series alternating arcs. Each of these will require an appropriate board, and sometimes more than one of these methods is at work in an alternating station. Auxiliary batteries, feeders, boosters, synchronising gear, dead-load, traction supply, and exciting arrangements, may all have to be provided for, and it would be rash to urge uniformity throughout the business. Nevertheless the fact is that the details are still lamentably weak, and engineers too frequently design or call for a tender for a "switchboard," when what should be asked for is a combination to their own ideas of switches, fuses, instruments, &c. It is upon these lines that American manufacturers have been working for years with success, although their designs do not fulfil English requirements generally, owing to the wide divergence in generation and distribution practice in this country and on the other side of the Atlantic.

Taking the details, everyone will allow that the plug switch has done, and continues to do, good work for currents up to 80 or 100 amperes, so long as double-pole breaking is required. We are rapidly passing to something beyond this, and the difficulty then arises: What switch is thoroughly satisfactory for currents of 150 to 300 amperes at 2,000 volts alternating? This question is not answered in the paper, nor does it seem easy to give a reply. Large numbers of the Ferranti lever pattern are coming into use; but this is a "switchboard," and will not harmonise with any other arrangement. The choice therefore remains with one or two makers, whose apparatus has not yet been in use long enough to make it prudent to speak too definitely upon its merits. Then comes the disputed point—are fuses desirable in the alternator circuits? We think not, and the reasons are ably and clearly expressed in Mr. Andrews's recent Institution Electrical Engineers' paper. A *good* non-return device does everything that is wanted, but it must be of a universal pattern, and generally adaptable. Circuits must have switches and fuses, but there should be no great difficulty in selecting them, because the currents are not generally large, and the switches need not be operated at full load. It is too often forgotten, and is not mentioned in the paper, that alternator switches and fuses may have to break many times the normal current at considerably over the generated pressure. Thus, if one machine is taken off the bus bars when just motoring the pressure across the break of the switch or fuse may be something approaching the sum of the bus bar and machine pressures, due to the change in speed of the machine throwing the phases into opposite sign. For similar reasoning, we think Mr. Blaikie's table of breaking distances of little use, and likely to lead to trouble if adopted, for a switch or fuse of *n* ampere carrying capacity (or rated value) may have to break a current of many times *n* amperes, should the circuit it controls develop a short circuit, or the machine in whose connection it is break down and the current come back from the bus bars. In fine, a switch or fuse *must* be capable of dealing with the abnormal conditions due to a fault so far as breaking goes, although it may only be called upon to *carry* its rated current without heating. Again, with continuous currents the inductance effect may be considerable, and this is usually allowed for, but too often it is ignored that capacity on an alternating system may be quite as vicious in its tendency to carry over, to say nothing of the unavoidable risk of opening the circuit at the instant when the peak of the pressure curve is reached.

Oil-pot and protected fuses—such as the Ferranti, Cowan-Still, and Bates patterns—have proved themselves to be thoroughly reliable in careful hands, and are on the whole better designed than most switches. It is a very curious fact that the automatic cut-outs used on continuous current boards should have given so much trouble; one would have thought their design such a simple matter that no fault would be found with them. Yet they have an unhappy knack of flying "off" when a rush of current takes place—a thing that ought only to hold them on more securely. We venture to hazard the suggestion that lamination of the cores and pole-pieces will cure this evil propensity.

With the latter part of the paper there is little need to deal. Everyone will agree with the strictures passed upon ammeters which don't read current, and voltmeters whose behaviour is erratic to the last degree. The instrument maker, unfettered as regards price, and not limited by "minimum loss of power" clauses, can do fairly well in the matter of instruments, and no one, whose laboratory training has included a course of research work or absolute measurements, need be in a difficulty regarding pressure or current, for the behaviour of instruments reflects the treatment to which they are subjected. In like manner, regulating, and other subsidiary switches, if thoroughly mechanical, give no trouble, but in these days of expensive labour, good fitting, and finish is not ensured by accepting the lowest tender.

One or two points still await ample discussion; foremost amongst these is the best means of providing interchangeability of circuits and machines, commonly known as "hospital barring" or "jack-carding." Within this subject falls "boosting," or individual regulation of high tension feeders. No longer can it be said that the sweet simplicity of the alternating system from pressure-raising devices on feeders is its strong recommendation; either feeder boosters or separate busses at different pressures have to be installed, but no one seems quite settled in his own mind what should be done, or to be able to agree with his neighbour what manufacturers should be called upon to turn out for the purpose.

In closing this review of a useful paper, we would like to strongly urge the claims of all switchboards to be treated in the same manner as other parts of the plant. Frequent inspection, cleaning, trivial adjustments, and small repairs are as necessary as anywhere else, and there is no reserve of x per cent. on the board. Either each detail works, or it does not; yet how often is the board neglected, while boilers, engines, and generators are kept up to the very pink of perfection.

SINGLE v. MULTIPLE GENERATING STATIONS.

The paper on the above subject, prepared by Mr. Snell for the meeting of the Municipal Electrical Association, and reprinted in this issue, is intended, as we learn from the author, merely to serve as a basis for thrashing out the arguments for and against supplying any district with current from one or from several generating stations. The question upon which discussion is invited is one of considerable importance, in view of the steady growth of the supply business, and it is one which the engineers of several of the larger towns have already been called on to decide, and which will, in the near future, have to be examined in connection with the extensions which are in progress in many districts.

The author is in favour of multiple stations, and deals with his subject under the various headings of capital cost, economic generation and distribution, load factor, and possible creation of nuisance.

With regard to what Mr. Snell calls the critical limit of horse-power installed, the opinion of Dr. Kennedy is quoted, that, when one has reached an aggregate power of between 3,000 and 5,000 horse-power, it is as cheap to build a second station as to go on increasing the capacity of the existing one. This statement was made by Dr. Kennedy at a time when the largest generating units in use were, we believe, generally of 300 to 400 horse-power, and it would be interesting to know to what extent this limit would be increased now that much larger units are being used, as, for instance, at Manchester, Deptford, and Bankside, where units of as much as 2,500 H.P. have been adopted. The exact fixing of this limit is, however, not a matter of prime importance, as we believe that in many towns the question of single or multiple stations will have to be answered before even the lower limit of 3,000 H.P. is reached, as a large number of stations are in existence where it would be difficult to erect anything like this capacity of plant, and where, owing to the surroundings of the site, it would not be possible to sufficiently extend the station buildings without going to very great expense in the purchase of neighbouring property.

The question then arises as to whether it is preferable to commence operations on a new site on a much larger scale, and eventually do away with the original small generating station, or whether this first station should be maintained, and a second one erected and worked in conjunction with it. The answer to such a question depends so much on local conditions, such as the relative positions of the old station, of the possible sites for a new one, and of what we may call the centre of gravity of the demand, that we do not see how it can be settled otherwise than by examining each separate case on its merits. In this connection we would draw attention to the assumption made by Mr. Snell throughout his paper, that the one large station will be extra-mural, and the several smaller ones intra-mural. We do not think that this assumption is justifiable, as, in our opinion, the advantages of the multiple station system may often be greatest when these stations are extra-mural, or near the boundary of the town; as in such a case it will frequently be possible to get all, or almost all, the advantages which can be claimed for a single large extra-mural station, and yet be able to supply current on a direct system without undue expenditure on mains; because, if the stations are placed on opposite sides of the town, it is possible to halve the length of the feeders, which only have to come from one side to the centre, instead of having to traverse the town from one side to the other.

The same conditions hold good when we consider the question from the point of view of economy in generation and distribution, as if the station or stations are in the central parts of the town, or, to use Mr. Snell's words, are erected on the mains they are to supply, so that the distribution losses are small, there will almost certainly be compensating disadvantages in the extra cost of carting coal and ashes, in getting condensing water, and in the increased chances of trouble from the nuisance question. On the other hand, if the station or stations are out of the town or near its boundaries, it will often be possible to find two sites which will permit of moderate distribution losses, whilst at the same time offering facilities for dealing with coal and ashes and for condensing. Of course, there will be cases when one large station will give the best results; but on this point it is, as we have already said, difficult to generalise, and our remarks are made rather to draw attention to the fact that even when several stations are used to serve a town, it may be better to erect them practically outside the boundaries, rather than on the mains they are to supply.

We cannot quite understand Mr. Snell's remarks about the load factor, and do not see how he can expect a better one with several stations than with one. If the term load factor is used in the ordinary sense of the ratio of the actual average output per hour to the maximum output of any hour during the year, it will not be changed whether there be one or more stations; and if the factor referred to be a plant factor, we should expect the advantage, if there be any, to be on the side of the single station.

With regard to the nuisance question, a station situated centrally is always at a disadvantage, and we do not agree with the author of the paper that vibration and smoke nuisance can so easily be dealt with in a satisfactory manner. It is wonderful how keenly sensitive to vibrations the neighbours of a central station become, if they think there is the slightest chance of getting anything out of a supply company; and with regard to the smoke nuisance, we have for some time past had convincing evidence in London that Mr. Snell is somewhat optimistic when he says: "One may confidently say that in these days there are few of us who would care to admit that our stations would be complained of from this point, and with careful stoking and management, the smoke nuisance is more visionary than real."

The question of how best to extend, so as to be able to supply current in greater quantities, and over a larger area, is one which gives plenty of scope for discussion, and we hope that some of the municipal engineers who have lately carried out such extensions, or have reported on the best way of doing so, will communicate to the meeting their reasons for adopting the methods they have recommended; as, notwithstanding the local differences which must exist between one district and another, all such information must be of great use to their fellow engineers who may have to consider this question.

Presentation.—Mr. F. T. Paynter, shift engineer at the Windsor electrical installation works, has been presented with a marble timepiece and a pair of ormolu ornaments by the directors and staff on the occasion of his marriage.

REVIEWS.

A Text-Book of Applied Mechanics. Vol. II. By ANDREW JAMIESON. London: Griffin & Co. 1897.

This is one of a growing family of books whose origin is based on the idea religiously held by every engineering professor, that he must protect the morals of his own flock by specially preparing a text-book for their use. Anyone who has had the misfortune to pay school bills knows how the pedagogues at one school play into the hands of those of other schools, by discovering virtues in new grammars. Curious, is it not, that a dead language like Latin is so much alive that new grammars can be poured forth about it, whereas there is no grammar at all of Anglo-Saxon slang, so very much alive? Some such thoughts as these attack one on the appearance of a new book of mechanics. We have paid for so many improved grammars and English histories, that we feel sorry for those who have got to buy all the mechanical text-books. But having said this, we don't propose to say much more against Prof. Jamieson's book. We can forgive a good deal to a man who, being a professor, resolutely refuses to use the word poundal in his pages. We have searched diligently, and lo! we have not found it.

We would also desire to compliment the author on the choice and method of the examples he has employed, notably where he shows how the tension in a rope is so much greater than the weight it is lifting when acceleration is in progress. We incline to think that rope tensions are often treated entirely from a static standpoint, with perhaps liberal margins, a very undesirable thing to do in face of the rapid accelerations in deep pit work and high buildings' elevators.

The first part of the book concludes with a description of many varieties of engine governors and other examples of centrifugal force and machine balancing. Part IV. deals first with the graphic statics of framed structures, and is about as clear an exposition of this art as we have seen. Part V. deals with the stresses in shafts and beams and their deflections, and Part VI. with hydraulics and hydraulic machinery and refrigerating machines, which seem to be a little out of place and more suitable for special treatises.

Altogether, however, this is a very common-sense sort of book. It is intended for students advanced beyond the elementary stage who may or ought to be supposed to know that, strictly speaking, the term *cold* is intended to convey the idea of more or less deprivation of heat. Cold is simply a relative form of heat, and were we a professor with an abnormally developed sense of the supreme importance of definition we should *lodge* a complaint against our author for some of his language. On page 360, speaking of refrigerating machinery, he has the temerity to speak of brine as acting as a transmitter of cold. Of course, everyone will perfectly understand what is meant, and we think no one will even be led astray, but there be many will have his blood for speaking of cold as an entity. Our complaint of the account of refrigeration is that it is a mere description, there are no figures or dimensions to enable a student to make a calculation of what can be done with a machine, nothing as to the physical properties of the materials employed in refrigeration and what can be accomplished with them. We do not see why this mere descriptive section has been added to the book.

Electric Wiring and Fittings Details Book. By W. PERREN MAYCOCK. London: Whittaker & Co.

This book is intended for firms connected with the electric wiring business, its object being to afford an expeditious, convenient, and methodical means for noting down particulars concerning both the wiring and fittings of any electrical installation, on any wiring system. It consists of little more than a mass of sheets set out with columns, for the purpose of taking proper note of the required positions of lights and other fittings, the description of fittings to be put up, and general remarks regarding same. We observe the sheets are perforated for tearing out; this is perhaps as well, for the book is rather bulky. The idea of the author is a good one, and the book may be of service to some engineers and wiring contractors. There are two pages of directions for use, so that the user may understand what he is about.

THE MUNICIPAL ELECTRICAL ASSOCIATION.

THE third annual Convention was opened on Wednesday morning at the Royal United Service Institution. The programme, which we published in our issue of May 27th, showed that the public proceedings were to last three days. Of the importance of the papers to be presented there can scarcely be a diversity of opinion. The range of subjects is probably not so wide, and they are probably more specialised in their treatment than was the case at the last Convention in London. They mainly deal with the essential features of municipal electricity supply from the engineering point of view, and were naturally expected to evoke considerable discussion.

A large number of municipal engineers and a moderate sprinkling of other members of the electrical engineering profession were present when Mr. A. H. Gibbings, the President, rose to deliver his Presidential Address. It is scarcely necessary here to dwell in detail upon the points raised by the President. He referred with some amount of pride to the educational and the stimulating effect that their former conventions had created, and he considered that the rapid progress that had been made by municipalities in electrical undertakings during the past two years was due, in a great measure, to the work of the Municipal Electrical Association. He dwelt at some length upon the constitution of electricity committees, and suggested a divided responsibility, by forming electricity sub-committees. The future developments of electricity supply were noted, and the address concluded by some suggestive remarks on the subject of standardisation of plant. He pointed out that while many were agreed that some form of standardising was necessary, there was a diversity of opinion as to what the respective standards should be. The co-operation with other and kindred societies for the purpose of dealing with some of the special subjects he had raised was insisted upon with some force.

The next business of the meeting was to hear a paper read by Mr. Councillor Hesford, chairman of the Electricity Committee of the Southport Committee, on "The Management of Electrical Undertakings." The paper is published in full in another part of this issue, and it is not proposed to do more than give the principal points raised in the discussion. Mr. Faraday Proctor (Bristol) raised some interesting points, the chief of which were, that it was always advisable to engage an engineer, who was to run a station, from the the commencement of building operations. In the case of a small station, he thought it best to employ a consulting engineer, because it would not be possible to pay an adequate salary to a resident engineer who was capable of laying down plant; at the same time he urged that a resident engineer should be there all the time. The question of dividing the engineering and secretarial work was next brought forward. Mr. Proctor's view seems to be that the mere account work should be done by a separate department, but that the secretarial work should be done by the engineer. Mr. Councillor Skinner, of Hull, referred to the practice relating to accounts in that town, and said they all passed through the hands of the treasurer. Mr. Bromley Holmes (Liverpool) thought the engineer's duties should cease when the units were certified in the consumers' books. Mr. Jackson (Newcastle) asked if it would not be possible to get municipalities to make their accounts more in accord with the Board of Trade form, so that it would be possible to compare the accounts with those of companies. He referred to the practice in some Continental stations of employing a mechanical engineer, an electrical engineer, and an outside engineer. Generally speaking, the outside man in this country was not paid well enough. Mr. Wordingham (Manchester) thought that the paper dealt with the policy rather than the management of stations. His views on the employment of a consulting engineer were almost similar to those of Mr. Proctor. In his opinion it was unnecessary to duplicate generating plant; it would be difficult to duplicate distributing network, but feeders could more easily be duplicated. He considered that the accountant's portion of an undertaking should be entirely separate from the engineering part. The engineer should have a voice in the financial management, but actual account work should be entirely separate. Mr. Boot (Tunbridge Wells) raised an interesting point about the reserve fund, and Mr. Robert Hammond having addressed the meeting, mainly on the reserve fund question, Mr. Hesford briefly replied.

The meeting then proceeded to discuss Mr. Blaikie's paper on "Switchboard Apparatus," the paper being taken as read. Mr. Wordingham thought there ought to be no inflammable material in connection with a switchboard, and did not admit the difficulty of making it decent looking under such circumstances. It was impossible to lay down any definite length of break in a switch according to current, because a good deal depended on the design of the switch, and the speed of the break. Fuses were necessary in high pressure stations, but in low pressure works they did more harm than good. He thought there was room for some convenient and cheap means of signalling between the switchboard and the engines. Mr. Andrews (Hastings) after referring to automatic cut-outs, and pointing out that electrical engineers did not like them, because they were unreliable, said that a fuse on an alternator was useless, and a great source of danger. Mr. Robert Hammond expressed his surprise that wooden switchboards abounded in Germany. He pointed out that it was important not to put an inflammable board on a flammable floor, and he advocated a space of at least 4 feet between the back of the board and the wall. Mr. Rider (Plymouth) spoke of the danger of the field switch being on the dynamo instead of on the board. With regard to the space at the back of the switchboard, he thought the best arrangement was to have no back at all. Mr. Quin (Blackpool) and Mr. Evershed made some remarks, and the meeting passed on to rapidly discuss Mr. Jeckell's paper.

CORRESPONDENCE.

Prof. Carus-Wilson's Paper.

As it would appear, judging from to-day's issue of a contemporary, that I did not make my meaning plain—even to the author of the paper—at the discussion on Prof. Carus-Wilson's paper on the 26th ult., I beg leave to supplement it by a few remarks, which will, I hope, explain more clearly my reasons for disagreeing from Prof. Carus-Wilson's figure No. 5.

I may say at the outset that I quite understood that Prof. Carus-Wilson's remarks related only to the shunt motor, but in view of the diagrams in fig. 4 and the conclusions deduced on page 8, the inference may have been drawn by some that the error was equally negligible with the series motor; and the curves in fig. 5, which show the series motor covering the distance in *less* time than the shunt motor, may strengthen this wrong impression.

It only needs pointing out for it to be seen that fig. 5 is not a practical case; for, if we have a locomotive to draw our train, we cut down its weight to nothing more than that necessary for the requisite power; while, if we have motors on the bogies, we cut down their number to the minimum consistent with the necessary power and space available, *i.e.*, if we at all value our peace of mind. In either case the limiting value of the initial acceleration is determined solely by *adhesion*; and in comparing the shunt and series motors Prof. Carus-Wilson has departed from this assumption.

Imagine the initial slope of the series curve (fig. 5) made the same as that of the shunt curve, so that the series curve falls away from the straight line, *o a*, on reaching a speed of about 10 feet per second, and it will be evident that the current for the series motor would be required much longer at its maximum value, and much longer at its final value, than shown; also that the time required to cover the 500 feet would then be much greater for the series than for the shunt motor.

Imagine, further, that the level part of the shunt curve (representing constant acceleration) was lowered, so that the distance was covered in each case in the *same* time, and I think we shall find there is not much difference between the energy required in the two cases.

The example I cited from Mr. Short, as well as that which had occurred in my own work, and my deductions therefrom, were based on an equal initial acceleration in the two curves compared. In the latter case both curves were for the same final speed and, in departing from this, Mr. Short has, I venture to think, rather given his case away so far as energy consumption is concerned.

My remarks were intended to show—not that Mr. Short's apparatus for effecting it was perfect—but that the principle of carrying the acceleration at its full value right up to the point when the maximum speed of the train is reached, is a good one, and this, I venture to think, has yet to be disproved.

Prof. Carus-Wilson's own conclusions and his curves in fig. 4 are, in fact, based on this assumption, though he does not explain how he proposes to obtain it with a series motor.

Hoping I have made this clear, and that you will be able to find space to insert this letter.

A. M. Taylor.

Electricity (?) direct from Water Power.

If Herr Josef Popper has had the notion referred to in your note on page 731 of your issue of May 27th, on his mind since 1895; it must have been a heavy burden to it. A normally vigorous one would have tossed it off long ago. Why, in all that time, hasn't he put the idea to a practical test? Or, stranger still, why, at least, hasn't he put it through the mathematical grinding mill—the mill that grinds bright ideas so exceeding small—and, as others have before him, seen it puff away in thin air? *That* wouldn't require three long years of patient meditation; in fact, it is a more simple process than putting pen to paper to describe the grand idea.

The same brilliant inspiration visited the writer some years previous to 1895 in much the same way no doubt as it has lighted round on many others before and since. But sad to relate, it did not behave so congenially to him as it has to Herr Popper. In fact, after the first joyful welcome of what appeared so charming a guest; want of confidence in his credentials, or his claims to be all he seemed, grew up with such alarming rapidity, that a few short hours terminated the intercourse.

He is fortunate, at last, to have found such a staunch friend as Herr Popper, for really, his character, so fair-seeming at first acquaintance, has such an uncomfortable habit of falling to pieces upon closer investigation, that his friendships, if many, are all too brief. Clearly Herr Popper must be one of those delightful but erratic souls, who, hospitable to a fault, would scorn to harbour a suspicion of an agreeable guest.

The crux of the difficulty in realising the promise of this idea, lies in the implacable fact that 100 million magnetic lines of force must be cut through per second by a conductor to generate at its ends a potential difference of 1 volt. We come against the same old boundary fence that limits our aspirations in so many other ways. For the greatest practical value of the magnetic induction attainable falls short of 20,000 lines per sq. cms. Therefore, to generate 1 volt per centimetre length of conductor, the velocity of the conductor across the magnetic field of such strength must be 5,000 cms. per second, equivalent to about 170 feet per second. To obtain this velocity, in a jet of water for instance, would require a head of over 400 feet.

The transverse resistance of a jet of water 1 centimetre through depends mostly upon the area of the contacts. It is very considerable at the best; and there is only 1 volt pressure available both for this and the external circuit. Current is likely to be a wanting quantity under these circumstances. Suppose we increase the velocity, and leap with vaunting ambition to, say, 1,000 feet per second, needing a water head of 15,000 feet, or pressure of over 3 tons per square inch, and therefore quite outside the bounds of practice. It gives us a meagre 6 volts for a centimetre jet, which, by the way, would be passing an enormous quantity of water, and could scarcely be constructed to stand the wear and tear.

There is no question of multiplying the jets and placing them in series, for the internal resistance increases them in the same proportion as the volts. Further, there are practical difficulties in the way of insulating the jets which are insurmountable. It would be a sufficiently onerous business to insulate one jet; in which there would in any case be considerable leakage up and down the stream, and thence across it outside the influence of the magnetic field. To insulate many jets, many pipes, many reservoirs, many mountain lakes and river sources—well, no thanks! the idea is a little too appalling!

All the above applies with even greater force to the proposal to use gases. At most 20 volts might be obtained across a jet 1 centimetre through, and a resistance inexpressible in megohms! May our quondam guest have a long and contented residence in Germany!

James Whitcher.

Nottingham, *June 3rd.*

Honour to whom Honour is Due.

I have read with interest your article "Honour to whom Honour is Due," at p. 685 of your esteemed journal. I may be allowed to add in connection with this subject that Prof. Holtz has proved up to the hilt at p. 686 (A.D. 1883) of my "Centralblatt für Elektrotechnik" that he invented at a much earlier date the machine now ascribed to Mr. James Wimshurst. If the Council of the Royal Society propose to distinguish Mr. Wimshurst on account of his machine, the ignorance of the history of science displayed by that eminent body is to be deplored.

Uppenborn.

May 31st, 1898.

[Mr. Rollo Appleyard in his letter in the ELECTRICAL REVIEW. May 27th, considers that we have been scarcely fair to James Wimshurst in our article dealing with the question of priority of invention of the Wimshurst influence machine. The above letter shows that we are at least in agreement with so high an authority on the history of electricity as Uppenborn. We may also quote from Prof. Schaffers, of Louvain, in his recently-published work, "Essai sur la theorie des Machines Electriques a Influence," where he says, "De fait, en 1876, Holtz avait clairement decrit le dispositif particulier aux machines Wimshurst secteurs radiaux et conducteurs à balais." Speaking of the machine illustrated in our figure, p. 685, Holtz said in 1876 (*Nachrichten von der kön Ges. der Wissenschaft Göttingen*) that the before-mentioned machine may be made self-exciting by covering the plates with small radial strips of tinfoil and replacing the combs with brushes or springs. Mr. Rollo Appleyard in his letter carefully avoids pointing out in what respect the Wimshurst machine differs from the machine invented long before by Holtz. The evidence we have cited appears to show that there is no difference in any essential electrical detail. No one thoroughly acquainted with the subject will venture to say that machines of Varley, Tœpler, or Kelvin come into the same category. It is useless for Mr. Appleyard to say the machine of Holtz did not possess the five "simultaneous characteristics" of the Wimshurst machine. The machines, being identical, must both possess five or any greater number of "simultaneous characteristics." Mr. Wimshurst deserves the credit of having introduced to physicists in this country a very valuable electrical machine, which otherwise would probably have long lain buried in obscure German publications. It is his misfortune that, without his knowledge, he had been anticipated, but such misfortunes are not usually considered a justification for depriving the first inventor of the credit which is his due.—EDS. ELEC. REV.]

The Chelmsford Fatality.

Another victim to the use of high tension alternating currents!

Everyone connected with the electric light industry must be sincerely sorry at the sad calamity.

As a rule, sooner or later, fatal accidents occur at most stations where such a dangerous system to employés is in use.

Recognising the dangers connected with it, you would naturally expect that in planning and arranging for the safety of the workmen, some common-sense means would be adopted to prevent the possibility of fatal accidents.

What are the actual facts? Instead of placing transformers in a special building, with plenty of room and ample daylight—which are an absolute necessity—they are generally fixed under the pavement in limited space, and to get to them the workmen have to grope their way down iron ladders or iron projections to a dark chamber.

I consider erecting small dark sub-transformer stations under the public pavements leads to accidents, and should be discontinued.

If not, as time goes on, more shocking fatalities will occur, with the usual verdict of accidental death to follow.

I know, from practical experiments made over 14 years ago, during wet weather, and while wearing wet boots, how quickly you can get shocks, but I naturally took care that the experiments I made were with continuous currents of about 400 volts pressure.

A transforming sub-station should not be built without having easy access to it, plenty of daylight, a good dry wood floor, and over it vulcanised rubber sheets of substantial thickness.

I recollect a few years ago explosions in electric light conduits were rather frequent in London, and I noticed about that time you had a short article in the ELECTRICAL REVIEW referring to them, and asked if anyone, from their experience, could suggest a cure. On that invitation I related my early experiences, and suggested (having laid the first underground mains for electric light under the London streets) that in the absence of good ventilation in the conduits of the companies affected, if they would remove the lids of the service connections every morning, the explosions would cease.

The hint I saw was very quickly acted on, and the explosions—well, you never hear of them now.

I hope my suggestions *re* transformer sub-stations will also be acted upon. If so, I am quite certain it will, in the future, be one of the means of assisting to stop the cause of recent fatal electric shocks, where high tension alternating currents are used.

A. L. Fyfe.

The Parliamentary Committee on Electricity Supply.

In the revised report of the Joint Committee on Electrical Energy (Generating Stations and Supply) just issued there appears two clauses which were not in the proof which was handed out just before Whitsuntide, but which are of such great importance that I venture to ask you to call attention to the fact in your next issue.

The clauses to which I refer are as follows:—"In connection with this question of purchase under section 2 of the Act of 1888, evidence has been given to the effect that with a view to secure in London one and the same time for execution of the powers, the Board of Trade have in some cases imposed upon undertakers a less term than 42 years within which they are liable to be purchased."

"The Committee suggest that if the full period of 42 years is not granted, and if a substantially shorter period is imposed by the Board of Trade, the terms of purchase should in each case be reconsidered."

Syd. Morse.

The Electrical Engineers Volunteers.

A friend of mine on hearing that the uniform of the Electrical Engineers Volunteers was to be the same as that of the volunteer battalions of the Royal Engineers, at once gave up all idea of joining the corps, although he was very keen on being a member when he first heard that such a regiment was to be enrolled. He is now making arrangements to join the Yeomanry Cavalry, as, to use his own words, he "will then be able to walk through the public streets in uniform without being insulted and his friends will not be ashamed to speak to him."

Whether his views are right or no, there is no doubt that the great majority of the British public always associate the red coat with that useful but much maligned body of men, viz., the Militia, and I have known many young fellows join the Artillery, although the work is harder than that of a rifle corps, for the simple reason that the latter have such a prominent uniform.

Thinking that probably my friend's case is not a solitary one, I would beg to suggest to the proper authorities that an alteration might be made to the uniform, and as no doubt it is now too late to do away with the red tunic, might not the facings be such as to be entirely different from any other regiment.

There is no doubt that the Electrical Engineers will be one of the crack corps of our volunteer army; the men no doubt mean to be, and the profession expects them to be, and such being the case the War Office might give them a uniform that would proclaim to all and sundry the regiment to which they are proud to belong.

Raw Recruit.

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending June 7th, 1897.

	£	s.
Adelaide	11	0
Amsterdam	75	0
Antwerp. Elec. fuses	43	0
Baltimore. Teleph. mat.	22	0
Buenos Ayres	83	0
Calcutta	690	0
Colombo	20	0
Durban	341	0
Kobe	381	0
Madras	26	0
Melbourne	44	0
Perth	116	0
Rotterdam	31	0
St. Petersburg	28	0
St. Pierre, N.F. Teleg. cable	19,050	0
Shanghai	143	0
Sydney	55	0
Yokohama	381	0
Total ...	£21,540	0

Week Ending June 7th, 1898.

	£	s.
Aden. Teleg. mat. ...	600	0
Alexandria. Teleph. mat.	305	0
Amsterdam	200	0
Auckland	126	0
Bangkok	405	0
Bombay...	584	0
" Teleg. mat. ...	61	0
Buenos Ayres	264	0
Calcutta...	233	0
Cape Town	70	0
Copenhagen	52	0
" Teleg. cable	5,600	0
Durban	2,609	0
East London	98	0
Flushing	60	0
Genoa	637	0
Gibraltar	60	0
Gothenburg	44	0
Hamburg	42	0
Launceston	10	0
Lisbon	793	0
Lyttleton	245	0
Mauritius	35	0
Melbourne	98	0
Monte Video	157	0
Ostend	36	0
Perth	152	0
Stockholm. Teleg. wire	1,343	0
Sydney	85	0
Wellington	732	0
Yokohama	23	0
Total ...	£15,759	0

Foreign Goods Transhipped.

	£	s.
Lisbon	2,000	0
New York	83	0
Total	£2,083	0

Bankruptcy Proceedings.—On 3rd inst., at the offices of Mr. J. C. Clegg, Official Receiver, a meeting was held of the creditors of John Henry Dewhurst and George Longden, who traded as John Dewhurst & Son, electrical engineers, 68, 70, and 72, Attercliffe Road, Sheffield. Mr. J. E. Wing represented the debtors. The Official Receiver stated that the receiving order was made on May 12th on a creditor's petition. The statement of affairs showed £1,938 2s. 10d. owing to unsecured creditors, and £205 10s. 11d. liabilities on accommodation bills, making the total liabilities £2,143 13s. 9d. The only assets were some doubtful and bad debts which were estimated at £100. Some time prior to October last the debtors carried on business in Attercliffe Road as partners, though originally neither of them took any capital into the concern. In October the business was converted into a limited company, an agreement being made between the parties that the company were to take to the business and to pay £5,000—£4,000 in shares, and £1,000 in cash on October 4th, 1902. The company were to be entitled to possession as from October 1st, and in accordance with the agreement the concern was transferred to them a few days later. The shares had not been issued to the vendors, and he believed there had been some subsidiary agreement in relation to the £1,000 under which certain payments had been made, or were alleged to have been made on behalf of the vendors to enable them to meet some of their outstanding liabilities. He did not thoroughly understand this matter yet, and could not get a proper explanation from the debtors. The agreement provided that the liabilities of the vendors should be paid by the company, but certain of the liabilities in respect of money-lending transactions were not taken over by the company. The matter would, of course, require further looking into. Perhaps there might not be any great advantage in following it up, because he understood that there had been no further capital brought into the company except a sum of £1,000, part of which was applied in payment of the expenses of the formation of the company. One thing was pretty clear that by the agreement the debtors transferred all their assets to the company, and left themselves with outstanding liabilities to the amount of something like £2,000, and no means of meeting these debts. That was the position they were left in under the agreement, and, of course, the debtors soon began to realise the difficulty of their position. After struggling on for some time they executed a deed of arrangement, but one of the creditors who did not consent to the arrangement presented a petition, and the receiving order was made. As far as the separate estates of the debtors were concerned the only asset in each case was household furniture. It was clear that the debtors were largely insolvent in October last. They said they were not aware of this, but subsequent investigation proved such to be the fact. Mr. Wing said with regard to the £1,000 cash, the debtors were owing the Birmingham District and Counties Bank about £2,500 when the company was formed, and they also owed money to moneylenders. It was arranged that the £1,000 should be advanced by the bank for the purpose of providing means for the bills of the moneylenders to be met—for the purpose of warding them off a bit. When the bank stopped payment the the company was wound up, and the debtors made bankrupt. The company was only in existence about four months, from October to February. The question of the appointment of a trustee was considered, and the estate will be dealt with by the Official Receiver. Mr. Wing explained that he was acting for some of the creditors of the company, and the whole matter would be most thoroughly investigated.

Business Sold.—The business of Kerby Bowen, Limited, electrical launch builders at St. Helen's and Cowes, Isle of Wight, was disposed of by auction on Wednesday last week, by Messrs. Perkins & Sons, by order of the High Court of Justice (Chancery Division), and realised £700.

Campbell v. Benjamin Jacobs.—This action, heard last week at the Glasgow Appeal Court, was for recovery of the contract price for fitting up an installation of electric light. The contract controlled the price so far as workmanship was concerned, but the price of the material was not included, although an estimate was appended to the offer. The defender challenged certain items as excessive. The Sheriff Substitute (Strachan) allowed a proof, and on appeal the Sheriff adhered.

Clayton Air Compressors.—During the months of February, March, and April, the Clayton Air Compressor Works, of New York, sold 19 air compressors for operating pneumatic stone tools, chipping and calking tools, air hoists, &c.; nine air compressors for moving and elevating acid and chemical solutions; four air lift pumping plants were installed and placed in operation; three air compressors were furnished to rubber works for removing hose from mandrels, testing hose and inflating tyres; one compressor was supplied for the pneumatic transmission of messages; two for oil burning plants; three for racking off beer in breweries; one for spraying brick in the process of manufacture; and six for unusual applications of compressed air power. In addition to a number of air compressors furnished for domestic use, four were exported to Europe for operating pneumatic shops plants. The above notes show the wide range of applications of the Clayton compressor.

Dermatine.—A pamphlet giving a short account of the discovery and manufacture of India-rubber and gutta-percha, and a description of the "special characteristics and qualities of dermatine as superior to either," has been issued by the Dermatine Company, Limited, of 95, Neate Street, S.E. Prices and particulars are given of the patent dermatine machine belting, circulating valves, sheet and insertion, mats, and dermatine is recommended as an insulator in electrical work.

Dissolution of Partnership.—Messrs. F. M. Prockter, A. Turner, and H. F. Clough, carrying on business as electrical and general engineers, at 10A, Virginia Street, Southport, under the style of Prockter & Co., have dissolved partnership by mutual consent.

Electric Power for South African Mines.—A South African correspondent of the *Financial News* says that it has been suggested that certain mines which find themselves short of water should avail themselves of the electric power supplied from Brakpan. Thus they would be enabled to close down their steam plant and to do with very little water. The May Consolidated Gold Mining Company is already in negotiation with the Rand Central Electrical Supply Company, and it is likely that arrangements will be shortly made by which the May's mill shall be driven by electric power.

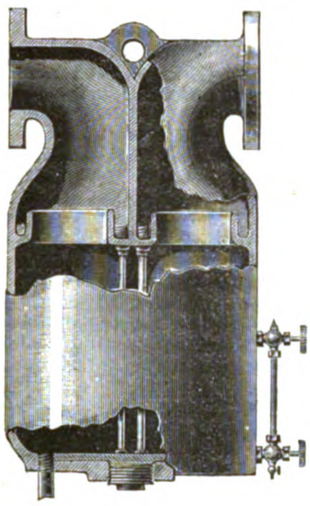
Electric Tramways.—The Brush Electrical Engineering Company has issued two pamphlets reprinting in first class manner descriptions which have appeared in some of the technical papers of the Kidderminster and Stourport electric tramways and the Dover municipal electric tramways. It is well known that both of these are lines for the equipment of which the Brush Company has been mainly or largely responsible.

Exhibitions.—Messrs. W. H. Willcox & Co., are exhibiting a general collection of engineers' tools and engineers' stores, also lubricating oils, at the various agricultural shows which are being held at Portsmouth, Birmingham, and King's Lynn, during this month; and at Lincoln, Leeds, and Tunbridge Wells during July.

Fined.—On Monday at the Wolverhampton (County) Petty Sessions, E. J. Pennington was fined £2 10s. and costs for driving a motor car at a furious rate. Three grooms who gave evidence, respectively stated that the car was proceeding at 20, 25, and 30 miles an hour. The bench commented upon the public danger. On the previous Friday the same defendant was, in another Court, fined £3 and costs for each of various breaches of the Light Locomotives Act (total £18 15s. 8d.) committed on April 23rd.

Forthcoming Book.—Messrs. Seeley & Co. will shortly publish a brief popular account of "Wireless Telegraphy," by Mr. Richard Kerr. The methods devised by Mr. Preece, Signor Marconi, Dr. Oliver Lodge, and others who have worked in this direction will be explained in popular style.

The Hoppes Steam Separators.—The drying of steam by discharging it of water has lately been attracting a good deal of attention. The annexed illustration represents a simple form of separator made by the Hoppes Manufacturing Company, of Springfield, Ohio, which affords a very considerable volume for the collection of water, and will, therefore, provide for a considerable flush of water, and at the same time it provides a cross section about ten times the steam pipe area. Suitable water channels are provided to catch the drip and flow of water down the sides of the vessel and prevent its re-entrainment. A glass gauge shows the amount of accumulation,



and a trap provides for final discharge. It is important that steam traps to separators should be of good size in order to allow the rapid discharge of sudden flushes. The Hoppes separator is symmetrical, and no mistake can be made in fixing it, as steam can enter either side indifferently. Its construction, while sufficient, is simple, and it should give a minimum of obstruction to the flow of steam, an item apt to be overlooked in the construction of separators, on what may be termed the steam worrying system. A somewhat similar apparatus is provided for fixing in vertical lengths of pipe.

Lists.—We have received from Messrs. Parvillee Frères, 29, Rue Gauthey, Paris, an illustrated list of their manufactures of electrical porcelain. The list deals more particularly with insulators for telegraphic, telephonic, and overhead traction work.

Messrs. C. E. Billin & Co., of Marquette Buildings, Chicago, send us a pamphlet (March, 1898) on their machinery and supplies for mines and mills. The firm are engineers, purchasing and forwarding agents, and the list contains special lines of a large number of American manufacturers.

McDonald v. Clement.—At the Glasgow Court of Sessions last week the settlement was intimated of an action by Robert M. M'Donald, electrician, Davos House, Strathtay, against Hugh Sprott Clement, manager of the British Patents Company, 121, West Regent Street, Glasgow. The pursuer sought reduction of a letter written by him to the defender in July, 1893, in which he assigned to the defender one twenty-fourth part of his interest in an invention relating to primary electric batteries. The pursuer said that the letter was written in consideration of the defender having found a purchaser for the patent, but that the defender failed to carry through the sale. The defender raised two actions against the pursuer, in which he sued for payment of the value of his interest. All the actions have now been settled extra judicially.

Newport Electric Light Association.—This association has opened premises at 55, Commercial Road, Newport, as electricians and mechanical engineers. Mr. J. L. Davies, who has had a varied experience in electrical work, is the manager. He was for two years in the employ of the Brush Electric Light Company, and three years at the Edison Central Depôt, New York, U.S.A., and has had three years local experience in wiring and other work.

Parliamentary Bills.—In the House of Commons on Monday, the following Bill received from the Lords was read a second time:—Blackpool and Fleetwood Tramroad (Tramway Extensions). The Great Northern and City Railway Bill was also read a second time. It is stated that the Royal assent has now been given to the Eastern Telegraph Company's Act, 1898, which has been promoted by that company in Parliament for the conversion of the existing 6 per cent. preference shares into 3½ per cent. preference stock, and for other purposes. The final dividend on the 6 per cent. preference shares for the quarter ended June 30th will be paid on or about July 1st next. The dividend on the new 3½ per cent. preference stock will accrue as from July 1st next, and will be paid quarterly on the same dates as those on which the dividend on the 6 per cent. preference shares has hitherto been paid. The existing transfer books are to be closed on June 15th, and the transfer books for the new stock will be opened as from July 1st next.

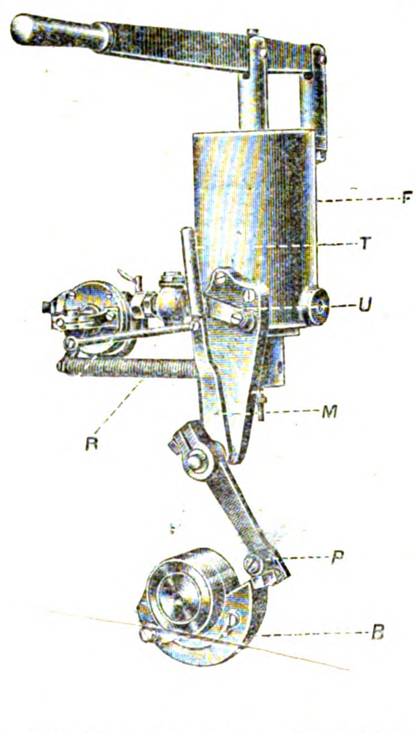
Partnership.—Mr. J. T. Niblett having resigned his position as general manager to the Lithanode Electric Storage Company, announces that he has entered into partnership with Mr. Malcolm Sutherland, and in future the firm will trade under the name of Niblett & Sutherland, electrical engineers, 61, Chandos Street, Strand, W.C.

Personal.—We understand that Mr. H. H. Hall, A.I.E.E., has voluntarily resigned his position as engineer to the Electric Lighting and Fittings Corporation, Limited (late John Haynes Lighting Company, Limited), in order to join the Walsall Electrical Company, Limited, which firm he now represents at 6, Central Chambers, 17a, South Castle Street, Liverpool.

Smoke Nuisance.—On Wednesday last week the London Electric Supply Corporation, Limited, of Stowage Wharf, Deptford, were summoned at Greenwich, at the instance of the Greenwich District Board, for having allowed black smoke to issue from a chimney on two successive days, in such a quantity as to be a nuisance. Mr. J. Spencer, clerk to the Board, prosecuted, and a representative of the Company having pleaded guilty, the magistrate imposed a fine of £10 and 2s. costs in each case.

South African Electrical News.—The *British and South African Export Gazette* has the following items of electrical interest in its June issue:—A shipment of electrical material and machinery, valued at £3,000, has been consigned to Port Elizabeth by a New York firm. The electrical installation supplied to the Angelo and Driefontein mines is a three-phase plant, including engines of 450 H.P., and was manufactured by Messrs. Brown, Boveri & Co., Switzerland. The Town Council of Kingwilliamstown is considering a scheme for the electric lighting of the borough. The Queenstown (Cape Colony) Municipality has also an electric light scheme under consideration. The Durban Town Council has recently ordered two additional miles of cable and a condenser. A telephone installation has been ordered for Bulawayo. The Natal Government estimates for the year ending June, 1899, make provision for additional telephone plant to the extent of £4,900. Electrical lifts for the new premises of Messrs. Thorne, Stuttaford and Co., Johannesburg, are on order with Messrs. R. Waygood and Co., Limited. An electric elevator, manufactured by Messrs. Easton, Anderson & Goolden, has been supplied to the Luipaardsvlei gold mine. The present air compressor pumping plant, which was manufactured by Messrs. J. Cameron for the Langlaagte Deep gold mine, is shortly to be replaced by an electrical pumping installation manufactured by Messrs. Riedler & Co.

Starters for Gas Engines.—In Mr. W. H. Booth's recent article in our columns on "Starters for Gas Engines" he advocated the use of a small starting engine for the purpose. Mr. Joseph



Edmondson, of Bradford, claims to have effected this in another way, namely, by means of the Edmondson & Dawson patent starter. This is claimed to give an initial impulse, automatically proportioned to the requirements of the engine at the time. The advantages claimed for this starter arise from three features, viz.:—(1) The initial impulse being delivered on a piston *already set in motion* (by the compression of the charge by the pump) is cumulative in its effect. In other words, the primary inertia of the piston having already been overcome, the influence of the initial explosion upon it is much greater than it otherwise would be; (2) The initial charge being compressed by the pump, the initial explosion is proportionately more powerful than in any starter working at atmospheric pressure. Owing to these two features, the initial impulse carries the running well over the first cycle, and the piston is moving steadily when it receives the *second* impulse. (3) At the slow speed of starting by any self-starter the proportions of gas and air in the charge drawn into the cylinder is frequently not ignitable by the tube; hence the extreme difficulty of starting an engine by a single initial impulse. In the Edmondson-Dawson starter this difficulty is said to be entirely removed. It injects a flame into the midst of the charge and will therefore ignite a mixture so badly proportioned that the tube would fail to fire. Hence by this starter ignition is certain, and successive impulses are given to the piston—the engine runs in spite of the temporary failure of the tube to fire the charge—and thus the speed is gradually but surely got up to point at which the tube takes up the firing and the starter may be put out of gear. The action is as follows:—The engine being set on the "explosion stroke" with the gas cock turned on, and with the crank a little behind the top centre, the starting cam, B, having the square stud, Q, resting on its nose; the exhaust valve of the engine being set open; a charge of explosive mixture (gas and air) is pumped into the cylinder by the pump F. When the cylinder is filled with explosive mixture the exhaust valve is closed. The pumping being continued, the charge is slightly compressed till it propels the piston slowly and moves the cam, B, forward (clockwise) till it drops the roller, P, into the gap of the cam and releases the lever, M, the spring, R, rotating the plug of the ignition valve, towards the right, ignites the charge in the cylinder and propels the engine. If the pumping be still continued so as to keep the connections between the pump and the cylinder full of explosive mixture, the revolution of the cam, B, by opening and closing the ignition valve and exploding the charge at the proper times, will give successive impulses to the piston, increasing its speed until the ordinary igniting apparatus takes up the firing and the engine is effectually started. The starter is then thrown out of gear by pushing the handle, T, of the lever, M, to the left, when the catch, U, falls down and holds the lever, so that the roller, P, stands free of the cam, B, and the action of the starter ceases. The pumping into the cylinder of a full charge of explosive mixture is only necessary when the cylinder is filled with a spent charge or with gas. When filled with air (as is always the case if the engine when stopping has made a few revolutions after the gas was turned off) it is sufficient to pump a few strokes of gas only, and follow on with explosive mixture. In this case the exhaust valve must be left closed.

Water-Power.—Messrs. P. C. Middleton & Co., Aberdeen, who recently completed the large water-power installation at Braemar for Mr. A. H. Farquharson, of Invercauld, have been entrusted with the electric lighting of Invercauld House. Water-power will be used, and 300 lights will be installed.

Werner Cadmium Accumulator Syndicate, Limited.—We are informed that a meeting of the directors of the Werner Cadmium Accumulator Syndicate, Limited, was held at 41, Devonshire Chambers, Bishopsgate Street Without, on Saturday, Mr. Alexis Werner, D.Sc., in the chair, when a satisfactory report was made as to the progress of the company. It was stated that important tests have been made and several orders have been booked for train lighting and traction. The chairman reported that progress was being made with the arrangement for floating a company in Paris, where the use of accumulators for traction is very extensive, and a letter from Belgium was read, with a proposal for the purchase of the patent rights for that country.

ELECTRIC LIGHTING NOTES.

Aberdeen.—At a recent Council meeting, Mr. Blackman's resignation from the post of electrical engineer was discussed. It was generally regretted that a greater effort had not been made to retain good engineers at higher salaries. Mr. Blackman is coming to London, and Aberdeen is to engage another engineer at the same salary as it paid him, £225. The Council passed a resolution thanking Mr. Blackman for his services.

Ambleside.—The electric lighting question has been before the District Council at a special meeting this week.

Barking.—The Council has received the sanction of the Local Government Board to borrow £15,000 for electric lighting.

Barnes.—The Board of Trade has issued a provisional order to the Urban District Council empowering them to supply electricity throughout the whole of the area within their jurisdiction, but excluding Hammersmith Bridge.

Bedford.—The Town Council, having applied for a loan of £5,400 for electric light extensions, Mr. H. H. Law will hold a Local Government Board inquiry on June 15th.

Belfast.—The Council has resolved to make a charge of 7d. per unit for the current supplied for lighting purposes for the first hour and a half, and 2d. per unit afterwards; 4d. per unit for current supplied for motor and heating purposes for the first hour and a half, and 1½d. per unit afterwards; and 5d. per unit for church lighting.

Belgium.—Five firms sent in tenders for the supply and erection of the plant for the electric lighting of the railway station at Ghent for the Belgian State Railway authorities, the lowest being that of Messrs. Dierman & Co., of Liege.

Bermondsey.—At Monday's Vestry meeting, Mr. Cox, chairman of the Electric Lighting Committee, brought up a report of the proceedings of a meeting of the Committee held that afternoon. He stated that the Vestry would be aware that the Board of Trade had granted a provisional order, and that the Bill to confirm the order had already been read a first time in the House of Commons. The speaker read a letter from Sir Courtenay Boyle, stating that it was not without hesitation that the Board decided to grant the order in view of the objections put forward by the London Electric Supply Corporation and the County of London and Brush Electric Lighting Company. The Board of Trade, the letter proceeded, had granted the provisional order with a view to giving Parliament an opportunity of expressing its opinion on the subject, and the Board intimated that should the order be opposed in Parliament, it would be necessary for the Vestry to take steps to support the Bill. Mr. Cox went on to say that the electric light companies had only laid mains in the parish for the purpose of supplying other districts, and that they were liable to penalties for not fulfilling their obligations. With regard to the confirmatory Bill, which was down for second reading this week, Mr. Cripps had given notice of motion that the Bill should be read "that day six months." Should the Bill pass its second reading, it would be referred to a committee, and it would then be necessary to secure the services of counsel in the event of opposition at that stage. The Electric Lighting Committee accordingly recommended, and the Vestry decided to give them permission to engage counsel to promote the interests of the Bill. With reference to the forthcoming telephone conference convened by the County Council, the General Purposes Committee reported having received a letter from the London County Council, stating that since sending out invitations for the conference, the report of the Joint Select Committee of both Houses of Parliament on the supply of electrical energy in bulk had been issued. The report raised some important questions affecting London, especially as regards the erection and subsequent purchase by local authorities of generating stations for the supply of electrical energy. The letter further stated that it had been decided to bring these matters forward for discussion at the conference to be held on June 14th, after the matters relative to the telephone service had been disposed of.

Bethnal Green.—The Board of Guardians Finance Committee has had under consideration a demand from the contractor, whose tender for the laying of an electric lighting plant at the new infirmary had been accepted, for an additional sum of money in order to carry out the work, so that the amount of that tender now reached £5,394. The committee offered Messrs. Calvert & Co. the sum of £5,000 to do the work, but they refused. It was decided to again advertise for tenders.

In anticipation of the Vestry carrying out the electric lighting of the parish, an electricity committee has been appointed to have all matters in regard thereto under its control. The committee is as follows:—Messrs. Hales, Mundy, Brooks, Kippins, E. Jones, W. H. Clark, Goodwin, White, H. Jones, Pitt, and Styles.

Bexhill.—The Local Government Board have sanctioned the proposal of the Council to borrow £20,000 for electric lighting purposes.

Birmingham.—In regard to the question of municipal purchase of the electricity undertaking, it is announced that at the City Council meeting on 14th inst. the report of the General Purposes Committee will be presented. The report is stated to show the great increase in the business and profits of the company since 1895, and recommends that the undertaking should be purchased if it can be obtained upon fair and reasonable terms. The Committee admit the necessity of taking market price as the basis for fixing the purchase money, and they offered, subject to certain conditions, to give the company £10 10s. per share (or £420,000), taking over the undertaking as a going concern, with all its assets and liabilities, as from January 1st last. The directors have expressed their willingness to recommend the acceptance of this offer to their shareholders. The Committee have received a report from engineers whom they instructed to examine the company's works and mains, showing that the whole of the buildings, plant, and machinery have been well designed, and so arranged as to be capable of easy, and therefore economical, extension as the business increases, and that they are in good condition, and in every respect suitable for the work they have to do. It will be necessary for the Corporation to obtain Parliamentary sanction for the purchase and the borrowing of the necessary capital. The total sum required to be borrowed will have to be repaid within such period as may be fixed by the Act. Upon a 42 years' period the annual charge to the Corporation for interest and sinking fund will be £16,275, on a 2½ per cent. basis, or £17,000 on a 2¾ per cent. basis, against which the Corporation will have an undertaking which for 1897 produced a gross profit of nearly £13,000, which it is safe to assume from the growth of supply in the last few years, will in a short time be not only sufficient to meet loan charges but to give an increasing margin on revenue account. The Committee therefore recommend the Council to purchase the undertaking on the terms now reported, and to authorise the Committee to take all necessary steps for promoting a Bill in Parliament during the next ensuing session for giving effect thereto.

Bognor.—The Urban Council have decided to appoint a committee to consider a public and private electric lighting scheme.

Brighton.—The Council last week adopted the report of the Lighting Committee, showing for what purposes it is proposed to borrow a further sum of £56,300 for the development of the electric light undertaking. In view of the congestion in the engineering and manufacturing trades, the Committee had been advised to apply for borrowing powers for at least two years' requirements, so as to avoid, as much as possible, a recurrence of the serious state of overload the works were in at the commencement of last winter, owing to growth of the business having been exceptionally rapid. The estimate for the two years' requirements is as follows:—

Four steam dynamos	£21,980
Additional 10-ton traveller	300
Two new feeders	6,300
Additional distributing mains	12,600
House services and meters	15,120
	£56,300

The total expenditure and liabilities up to the end of 1897 stands at £229,375. Application will be made to the Local Government Board for power to borrow the money.

Buckley.—The Lighting Sub-committee have under consideration an electric lighting scheme, and will shortly lay a report before the Council.

Bury.—At the Town Council meeting on Thursday week, the salary of the electrical engineer (Mr. Watson) was advanced from £200 to £250 per annum. The chairman of the Electric Lighting Committee (Mr. Pickup) explained why they had recommended the increase, and submitted a number of statistics showing that, although in its electric lighting scheme Bury was very similar to Oldham, Bolton, Dewsbury, Burnley, and Lancaster, they did not pay as much in salaries as those boroughs. He said that Bury paid £76 per annum more than the five towns named for sinking fund and interest, and the loss was only £46 more. Their income at Bury was £1,318 on the year, as against an average of £1,730 in the other places. The average salary paid to the electrical engineer in the five boroughs was £275 per annum, and in Bury only £200 had been given. Mr. Pickup also submitted figures to show that Bury produced electricity cheaper than the average of the five towns named, and on all these points being considered, the advance of £50 to their engineer was, in his opinion, well deserved. The vote for the increase was unanimous

Cardiff.—Mr. Applebee, the electrical engineer, has reported to the Lighting Committee on the lighting of a portion of Newport Road by electricity. It would require, he says, 15 arc lamps of the same power as those in use for the centre of the town. The standards should be fitted with brackets for glow lamps to be lighted after midnight. Capital outlay £470. If this system were adopted, the lamps would be lighted directly from the current in the service mains by men employed for the purpose. This would greatly reduce the capital cost, because rectifiers, which now have to be supplied in the centre of the town, would be avoided. The committee adopted the report.

Colchester. — Representatives of the Electric Light Works Committee have had interviews with Mr. Massey and Messrs. Siemens, respecting the supply of fittings and wiring of consumers' premises, and reported the views of Mr. Massey and Messrs. Siemens on the subject. The Committee has resolved that further consideration be adjourned.

Colwyn Bay.—A Local Government Board inquiry was held on 2nd inst. in regard to the District Council's application for sanction to borrow £2,000 for the electric lighting of the promenade. Mr. Clirehugh gave evidence as to the details of the scheme, stating that the plant would not be in duplicate for reasons stated in the scheme. There will be 24 arc lamps placed on 21-feet columns along the promenade. The scheme was opposed by Councillor Wm. Davies, who was in favour of an installation which had been proposed for supplying the whole town rather than confining it to the promenade.

Crewe.—On 1st inst. the Town Council considered communications from Dr. John Hopkinson regarding his fees for reporting upon electric lighting and supervising the carrying out of a scheme. In one of his letters Dr. Hopkinson said that if his partner, Mr. C. Hopkinson, took charge of the refuse destructor matter, his fee would be 50 guineas. The Council accepted Dr. Hopkinson's terms of 100 guineas for a report on an electric lighting scheme for the borough, including one visit to Crewe, and a detailed estimate of capital outlay.

Devonport.—After visiting the town, Prof. Kennedy advises that the site adjoining the Corporation property at Pottery Quay is suitable for the electricity station.

Dover.—The Dover Electricity Supply Company intends on July 1st to reduce the charges for current.

East Grinstead.—Several would-be promoters of electric lighting schemes have been informed by the General Purposes Committee that any discussion discussing the matter are at present premature. It will be remembered that the Council is considering the question.

Glasgow.—Mr. W. A. Chamen, the borough electrical engineer, has reported on the lighting of St. Andrew's Halls. He says that arc lighting for a hall of this kind will never be made pleasing to the public. After going into the matter, he finds that two rows of seven electroliers, containing 17 16-C.P. lamps each, will be sufficient to light the main body of the hall, whilst the orchestra can be lighted by two more similar electroliers, supplemented by some brackets at the back. The present incandescent lighting of the back gallery will need to be increased by the addition of eight more 16-candle-power lamps fixed in the ceiling. The amount of electric energy consumed by the incandescent lighting now recommended will be double what is at present used for arc lighting. For the Berkeley and Kent Halls similar electroliers, with about 10 lights each, will be required. The cost of making the alterations would not be great, as the arc lamps would probably be transferred for use in other buildings belonging to the Corporation which are about to be lighted, or made use of in some other way. New electroliers would have to be purchased, together with a few brackets. The whole cost, including slight alterations to the wiring, and substitution of short pendant fittings under the galleries in the large hall, in place of the ship's fittings at present in use, would not exceed £300. The committee recommends that Mr. Chamen be authorised to proceed with the work, but meanwhile only in the large hall.

Guildford.—The Council has accepted the offer of Mr. J. M. V. Money Kent, on behalf of the Guildford Electricity Supply Company, to pay the sum of £30 in satisfaction of the claim made by the Council for damage to the paving.

Hackney.—The new Vestry had a long discussion on 1st inst. on the electric lighting question. Some members are clearly pledged to do their level best to prevent the scheme being carried out The Electric Lighting Committee is made up as follows:— T. Barnett, W. L. Beurle, E. Errington, W. Hammer, F. W. Hart, G. Hassmer, W. H. Netting, G. A. Ogan, J. W. Sandwell, J. Sheehan, A. Walmsley, and L. Whitemore. There is now every reason for believing that the Vestry will soon get to work upon an installation.

Hastings.—The Local Government Board have asked the Hastings Town Council to obtain the report of a competent engineer upon the question of the Council's application to borrow £58,000 for the purchase of the Electric Light Company's undertaking.

Islington.—Our readers have heard Mr. Lambert's name mentioned over and over again in connection with the electric lighting undertaking; in fact, the success of the works might safely be called the success of Mr. Lambert. We therefore notice with regret that the progressive majority on the Vestry proposes to oust him from the chairmanship of the Electric Lighting Committee. The difficulty is to see any good reason for this move. The local press is expressing itself in strong terms on the matter.

Lancaster.—The Corporation Gas Department is feeling the opposition of electricity. Last year the amount sold to private consumers was £249 3s. 1d. less than the previous year, or £1,799 6s. 7d. less than the year ending March, 1895, which was the high water mark in the sale of gas. The increase in the amount for electricity last year was £699 12s. 2d. In the last three years the increase has amounted to £1,146 16s. 4d. The Lighting Committee's altered expenditure has affected the Gas Department, for whereas in 1894-5 the outlay on gas lighting was £1,934, and on electricity £133, these items cost in 1897-8, gas £1,726, and electricity £505. In the other Corporation departments there are increases in the consumption of both gas and electricity.

Leeds.—The Leeds Corporation and House-to-House Electricity Provisional Powers have been granted to the Leeds Corporation for the purchase of the electrical system and plant of the Yorkshire House-to-House Electricity Company.

Lewes.—The Town Council has resolved that the question of opening up negotiations with a company with a view to taking up the provisional order for electric lighting be referred to the Finance and General Purposes Committee, with authority to negotiate terms for an agreement to be entered into, and to be hereafter submitted to the Council.

Lombardy.—As the use of electricity, both for lighting purposes and as a motive power, in Lombardy is constantly extending, says the *Financial Times*, there is consequently an ever-increasing demand for all kinds of electrical appliances connected with its development. At present Switzerland and Germany would appear to have the lion's share of the business in supplying the machinery, and our Consul points out that British engineering firms do not seem to be making any effort to secure a share of it. In 1899 the centenary of Volta's discovery of the electric pile is to be celebrated in Como, his native town, by an International exhibition of electrical appliances, and in due time our Consul promises to send full particulars of the conditions on which firms are to be invited to exhibit. In the meantime British manufacturers of electrical machinery might find it to their interest to give the matter their attention.

Londonderry.—The Corporation last week held a special meeting to consider the offer of the New General Traction Company, Limited, to take over the entire electrical plant of the city, to light the streets as at present, and to supply private light and power to all applicants. Dr. Todd, solicitor, said that the company were prepared to take over the plant at a valuation. They bound themselves to give light to the public lamps at £15 10s. per lamp, to give private lighting at 4d. per unit, and power at 2½d. per unit. The company owned 11 miles of tramways in Coventry, 20 miles in Norwich, and four miles in the Isle of Man. It had an invested capital of half a million. Councillor Thompson asked what guarantee there was that the company would carry out what they offered. Dr. Todd said the best guarantee was, that they would spend about £100,000 in laying down plant. They had in view the working of the Strand tramway by electricity. He estimated that there would be a saving of £1,360 on the public lighting. In that, of course, he included £1,000 for depreciation at the rate of 5 per cent. Alderman O'Doherty said the danger was, that when they came to make up the valuation they might be told that their plant was antiquated, and not worth much. The better way would be for the company to mention a lump sum of the basis of the negotiations. Eventually the Corporation appointed a small committee to confer with Dr. Todd and report.

Ludlow.—The Town Council will hold a special meeting on July 7th to consider whether an electric lighting order shall be applied for.

Northampton.—The Town Council, which is desirous of erecting refuse destructors in the town at once, has temporarily postponed all questions of details until the result is known of the negotiations with the Northampton Electric Light and Power Company for the purchase of the company by the town, and with the Northampton Tramways Company for the purchase of their system by the municipality. In the event of both purchases being made, the town will combine refuse destruction with the generation of electricity, which, amongst other things, will be employed for tramcar traction.

Oldham.—At a meeting of the Electric Lighting Committee on Wednesday, Mr. Newington, electrical engineer, presented a return of the electricity works. The works were commenced in 1894, and the total cost for fourth year (1897-8) has been £2,345, against 1896-7 of £2,533. The number of units sold during the year was 322,203, against 227,932 in the previous year. The average price obtained was from private consumers 4·28d., and from public 3d., against 5·7d. and 4d. last year. The gross profit made before setting aside instalments for interest and sinking funds, was £3,492 against £2,946. The total cost per unit was 1·746d., the decrease being 0·921d. The producing of supply at such a low price is considered very satisfactory. Mr. Newington said that the output was nearly as much as the plant could meet, although extensions had been made recently.

Pembroke.—Last Saturday a Local Government Board inquiry was held with reference to the Town Commissioners' application for a £33,000 loan for electric lighting. Mr. Robert Hammond gave evidence regarding the scheme. He stated that the tenders received, including boiler house, engine house, switchboard, accumulators, all the underground work and the meters, amounted to £19,354, against the engineer's estimate of £19,850. The cost of the condensing plant was estimated at £1,500. They proposed to use a triple concentric cable, which would be thoroughly insulated, lead covered, and steel armoured, and not at high tension. They were laying down two dynamos of very first-class make, which could do 5,000 lights, which would be capable of supplying 12,000 lights on consumers' premises. The distribution was to be on the three-wire system, the total length of the cables being 14,100 yards. The cost of the buildings is put at £6,000, with the exception of the destructor works.

Penarth.—The Board of Trade has issued a provisional order to the Penarth Electric Lighting Company, Limited.

Peterborough.—The Town Council had a discussion last week regarding the salary to be paid to the newly-appointed electrical engineer, Mr. Gill. The Lighting Committee had resolved to pay £100 a year, but last week the Council reversed this decision by nine votes to eight, and made the salary £50.

Reading.—A deputation recently waited upon the Board of Trade upon the matter of the amended description of the systems of supply to be adopted by the Reading Electric Supply Company. The Board wrote to the company, stating that they are not satisfied that the reasons urged on behalf of the Corporation are such as would justify them in withholding their consent to the proposed change of system, and they propose to approve the amended description. The Reading Electric Light Company recently wrote to the Council asking them to adopt electricity for street lighting, but the Lighting Committee has recommended the Council that the company be informed that if the Council determine to light the public streets by electricity, they will probably provide works for the supply of energy for that and other purposes. The Reading Electric Supply Company intend to alter the standard pressure of their supply at consumers' terminals from 100 to 200 volts.

Rhodesia.—We understand that the electric light is being installed at the B.S.A. Police Camp, Government House, which is four miles from Buluwayo.

Shoreditch.—At the first Vestry meeting after the election, held on Tuesday night, Mr. S. G. Porter was unanimously selected as chairman for the ensuing year. The Lighting Committee recommended and the Vestry decided to insure the economiser at the electricity works with Messrs. Green & Sons, Limited, of Manchester, for the sum of £500, at an annual premium of £3 10s., the rate to include periodical inspection of the economiser. The same Committee announced that it had been agreed that Mr. Russell, the chief electrical engineer, should supervise the arrangements for supplying steam to the baths and wash houses.

Tipton.—The Midland Electric Corporation has intimated to the District Council that it will accept a maximum of 3d. instead of 3½d. per unit. These terms the Council considered satisfactory.

Walthamstow.—A Local Government Board inquiry was held recently into an application by the District Council for sanction to borrow £5,200 for about two acres of land as a site for an electric lighting station and a stone yard. Mr. Enright, the electrical engineer, spoke strongly in favour of the site, and said the saving on the cartage of coals would alone pay the interest on the money. The whole district could be lighted from this station at the lowest possible cost.

Watford.—A Local Government Board inquiry was held on 31st ult. in regard to the Council's proposal to borrow £21,000 for electric lighting. Mr. Hawtayne, consulting electrical engineer, explained the scheme. He calculated an immediate demand for 8,000 lights. 130,000 Board of Trade units would be required for lighting the streets, and the present lamp standards could be utilised. He had some idea of putting arc lamps in the High Street and part of Queen's Road. For private lighting there would be 4,000 lights of 8 C.P.; public lighting, 363 of 16 C.P.; and 100 of 32 C.P., making 5,126 lamps of 8 C.P. He had considered several sites, and had come to the conclusion that the best was the one adjoining the sewage works. The estimated cost of the building was £3,000, and it would be handy for coal delivery. There was no opposition.

Wednesbury.—At Monday's Council meeting the General Purposes Committee recommended the Council to withdraw its opposition to the application of the Midland Electric Corporation upon the terms that the Corporation supply electricity to the Council for lighting and power purposes within an area agreed upon the same terms and conditions (if any) as may hereafter be agreed upon with the local authorities of West Bromwich, Oldbury, and Smethwick; that the Corporation will not oppose the application of the Town Council for an electric lighting order at any future date. On Monday, when the matter was discussed, Alderman Williams said he believed the whole thing was intended to put a stop to the action of the Midland Electric Corporation. They ought rather to be glad that people were prepared to bring electricity to them for the benefit of the town. Alderman Lloyd also argued that encouragement should be given to schemes for the development of new industries in the borough. The above proposals were adopted.

Whitechapel.—It is stated that the District Board of Works is asking the Brighton Corporation electrical engineer (Mr. Wright) to advise upon the electric lighting of the district.

Wigan.—At the Council meeting on 1st inst., Mr. Alderman Holmes, in moving the confirmation of the minutes of the Gas and Electric Lighting Committee, said that the question of electric lighting, which was brought forward at the last meeting and deferred, was again deferred by the Committee until after an expression of opinion had been given by the Council. The Committee felt that that was one of those matters that must be connected with a loss to the town for some years to come, if adopted. They therefore wished to have the full sanction of the Council behind them before proceeding any further. Mr. Worthington said, with regard to the electric lighting, although that matter had gone back to the Gas Committee, it had come back again to them in the same form. Since then he had acquainted himself more with the subject, and he would be prepared now to endorse the resolution that was previously sent back, with regard to the appointment of a sub-committee. He found that so far back as 1890 there was an electric lighting order which had received the Royal assent in favour of Wigan, and which only applied for two years, or during such a period as the Local Government Board might consent to extend it, and he believed that it was open to a company or syndicate to apply to the Local Government Board for the transference of the power of the order to them in order that they might supply electric light to the town. It seemed that they were in a rather difficult position. They had a gas works with a capital of £350,000 on the one hand, and they were loth to interfere in any way that would reduce the assistance that the rate got from that very important undertaking. On the other hand, it might be that some company might be disposed to supply the town with electric light. And let them suppose that after a loss for a little time that company eventually turned to a profit, then they would have the same competition from an outside company that they were supposed to have from themselves if they adopted electric light. If the outside company went on making a profit, and if the Corporation wanted to turn the electric light to themselves, they would be in the same dilemma as when they bought the gasworks, and would have to purchase them at far more than the original cost. Electric lighting had made important strides since the the last committee met, and he believed in the appointment of a small committee of the Council, apart from the Gas Committee. After discussion, the Council appointed a sub-committee to make inquiries, and with the powers to employ experts to advise them, so that they would be able to recommend to the Council something definite upon which they could act, and which would prevent the electric lighting going into other hands.

Winchester.—Last week the City Council had before it tenders from the Winchester Electric Lighting Company and the Water and Gas Company for lighting the streets. The Gas Company's tender was accepted.

York.—The Local Government Board has sanctioned the borrowing of £20,000 for electric lighting purposes. At Monday's Council meeting it was stated that Prof. Kennedy reported that Messrs. Crompton & Co. now found that they could not recommend the lowest priced engines accepted by the Corporation. The Electric Light Committee, therefore, had decided to instruct Messrs. Crompton to obtain the better class engines mentioned in the tender, and the cost of the plant would therefore be increased from £8,176 to £8,654. It was stated that the Committee would now push the matter forward as fast as they could, and they hoped that some time within the next 12 months they might be able to see the electric light established in the city.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Barnsley.—The Streets, Buildings, and Improvement Committee of the Town Council have been considering the question of tramways for the town, and have now expressed the opinion that it is desirable such tramways should be established and worked by a company and not by the Corporation. Their recommendation that the Council invite companies to submit schemes of tramways for the town, and give consent to an application for the necessary Parliamentary powers to construct tramways in the borough, was before the Council on Tuesday. The Lighting Committee recommend that instructions be given to Mr. Miller to prepare plans and details of the proposed electric lighting scheme (see ELECTRICAL REVIEW, May 20th), and that application to borrow £23,322 to pay for such works be made.

Belfast.—The Tramway Company has written to a Corporation Committee saying that the directors have again been going into the matter of electric traction, and as there was a rapidly growing feeling among the public, they are willing to make another effort to come to terms with the Corporation for its introduction in Belfast. The Corporation has accordingly appointed a small committee to meet the directors to go into the matter.

Birmingham.—The Lord Mayor has sent to the *Birmingham Daily Post* copies of the letters which have recently passed between the City of Birmingham Tramways Company and the Corporation in regard to the proposed introduction of the overhead wire on a section of the lines.

The City Council had a lengthy discussion on the tramway question on Tuesday, the end of which was that it was decided by 28 votes to 27 (six neutrals) not to re-open negotiations with the Tramway Company, as the company has failed to carry out their arrangement with the Public Works Committee, and Mr. Ross, the chairman of the company, has made statements, which were incorrect, *re* authority to use the overhead trolley.

Brighton.—In the House of Commons on Monday, Mr. Ritchie informed Mr. Bowles that the electric railway from the Aquarium to Preston Place Groyne, Brighton, was constructed on land belonging to the Corporation, without Act of Parliament. As it was above high-water mark, the sanction of the Board of Trade was not necessary, and he had no jurisdiction over the railway. With regard to the Brighton and Rottingdean Sea Shore Electric Tramroad, the provisions of the private Act were not binding on the company, unless otherwise agreed between the company and the Corporation, who were the owners of the foreshore on which the line was constructed. The consent of the Board of Trade was given to the construction of the works below high-water mark, including the poles for the overhead wires. He was not aware that the public and boatmen were exposed to any danger, but as to the possibility of depriving them of their right to use the foreshore, he would make inquiries, though he did not think the Board of Trade had any power in the matter.

Bristol.—The following figures show the popularity of the electric tramway service on Whit Monday:—Last year on Whit Monday 104 cars were run and 127,387 passengers carried. This year 121 cars were run and 130,851 passengers carried, being an increase of 3,464 passengers. Of the above number this year no fewer than 50,817 were carried on the Staple Hill and Kingswood electric lines.

Chatham and Gillingham.—During last week both the Chatham Corporation and the Gillingham Urban District Council had under discussion a scheme for the introduction of an electric tramway in certain parts of the district. A special feature is the provision of workmen's cars. The Light Railways Commissioners, at their recent inquiry, cut out what is known as the High Street route, considering that the street was too narrow to admit of the proper working of trams, but there is very little doubt now that the trams will be introduced in this district, and will run from the Dockyard to Gillingham and Luton. The great question now under discussion is the conditions to be carried out by the company as to providing workmen's carriages. The promoters of the scheme have put forward their views as to providing workmen's cars, and the company will agree to contribute £6,000 towards the cost of widening the street, and £1,500 towards the erection of a new bridge across Railway Street. Some of the Council are in favour of the Corporation having the trams in their own hands, while others wish the company to take the matter up at once, considering they would be a benefit to the towns and the trade generally.

The Light Railways Commissioners concluded their inquiry on on Monday at the Sun Hotel, Chatham, for determining the expediency of granting the application made to them by the Rochester, Chatham, Gillingham and District Electric Railways Company, Limited, for an order to authorise the construction of an electric railway through the district. The Commissioners have decided to recommend that the order be made, and tramlines will be laid to and from the dockyard gates to the Brook and Military Road, and from thence along the Brook to Luton, and also from the upper and lower dockyard gates to Old Brompton and New Brompton, and also Gillingham. This will be a great boon to the district.

Dover.—Our local correspondent informs us that so successful have been the Dover Municipal electric trolley trams during the six months they have been running, that the Corporation were, as a consequence, able to reduce the town rates by 2d. in the £. There are four miles of tramways, and the fare 1d. any distance. More new cars are on order, and as soon as these arrive, a five minutes regular service is to be established.

The electric trams did well on Whit Monday. £56 18s. being taken. This is over £1 more than on Easter Monday, and it is stated to be £39 18s. more than is necessary to cover the day's capital and working expenses.

Dudley and Stourbridge.—On 3rd inst., Sir Francis Marindin, inspector to the Board of Trade, made an inspection of the Dudley and Stourbridge tram line, in consequence of the formal application of the owners for a seven years' steam power license, the existing license terminating in the near future. Mr. S. Sellon (engineer to the British Electric Traction Company) was one of the party. During the inspection of the whole of the line it was stated that the application was merely a formal one, but that it was necessary; also that electric cars would be running in the coming autumn.

Dundee-Barnhill.—The Dundee Town Council has remitted this light electric railway scheme to the Works Committee, who will appoint a sub-committee to report upon the proposal.

Gateshead.—So that the Council may have a good idea what the electric trolley tramway system really is, the whole body is to go to Leeds to inspect the system there.

Glasgow.—A proposal is before the Corporation to raise the salary of the tramway manager from £1,250 to £1,500. This is in view of the change from horse to electric haulage. There is also a proposition that in view of the surplus in the tramway receipts, and of the introduction of electrical traction on the Springburn route, it be an instruction to the Tramway Committee to reduce the fares on that route as an experiment.

The Tramways Committee proposes various tramway extensions amounting altogether to 11·13 miles. The sub-committee have had under consideration communications from the British Electric Traction Company, who had given notice of plans, sections, &c., embodying full particulars of the proposed light railway extensions to the Paisley and Johnstone tramway system, and suggesting that a meeting might be arranged. Sir James Marwick wrote that the Corporation would oppose the proposals of the company to construct a light railway on a road on which the Corporation had been authorised by Parliament to construct an extension of their tramway system. They would also oppose the company obtaining powers which would prevent such extension. The sub-committee had also a meeting with a sub-committee of the District Committee of the First or Upper District of Renfrewshire with reference to the application of the British Electric Traction Company. The Corporation Sub-Committee stated that they were prepared to recommend the Corporation to resist the application so far as relating to roads in or leading into the city, and to apply for powers to extend the Corporation tramways along Paisley Road from Halfway House to Paisley. They also stated that the Corporation, in the event of powers being obtained to construct a double line of tramways, would pave and maintain the roadway within the tramway rails and for 18 inches on the outside thereof, as in the case of other tramways. The County Sub-Committee of the Upper District stated that they were favourable to an arrangement being come to with the Corporation, provided the Corporation would undertake to lay the tramways in question within a limited period, and that they would report the result of the meeting to their committee. On the report by the general manager, the sub-committee have agreed to accept the offer of the Westinghouse Company to equip the High Street line for electric traction on practically the same terms as their contract for the Springburn line. It was also agreed that the convener should act as representing this committee on the sub-committee in charge of the lighting on the Springburn route.

Halifax.—The official opening of the municipal electric tramway was to take place yesterday (Thursday).

Harrogate and Knaresborough.—The promoters of the Harrogate and Knaresborough Light Railway have prepared the necessary plans, &c., and these are being deposited with the various public bodies interested in or affected by the scheme. The promoters have been encouraged by support from all the local authorities, with the exception of Harrogate. According to the plans the length of the direct line from Station Parade, Harrogate, to the terminus at Knaresborough is 3 miles 4 furlongs and 6 chains. Provision is also made for a loop line and sidings, so that altogether rails will be laid for distances of 4 miles 5 furlongs and 5 chains. The estimated cost is £76,000. What may be termed the main line starts near the Jubilee Monument in Harrogate, thence proceeds by Station Bridge and North Park Road to the Knaresborough Road, which it follows through Starbeck, and on to Knaresborough, terminating in Fisher Street. The loop line intended to serve High Harrogate leaves Station Parade in an opposite direction, but ultimately forms a junction with the main line in the Knaresborough Road. Electricity will be the motive power. It is proposed to have the generating station at Starbeck, to which access will be obtained by means of a short siding. The promotors also intend applying for powers to lay down a main to the generating station in order to utilise water at present running to waste.

Hull.—The arrangements for the commencement of the construction of the electric tramways and the repaving of the main streets with wood are about complete. A start at taking up the old rails has been made on the Hessle Road, and it was arranged that the first rail of the new sytem should be laid yesterday afternoon by the chairman of the Works Committee at the south end of Porter Street.

Leeds.—The City Council at a recent meeting decided to extend the electric tramways to the Headingley, Chapeltown, Hunslet and Dewsbury Road sections, and Dr. Hopkinson, under whose charge the Kirkstall and Roundhay sections were laid, was engaged to carry out the work. The Tramways Committee had a consultation with Dr. Hopkinson on Monday, and an electrical sub-committee was appointed to confer with that gentleman with regard to the enlargement of the generating station, the necessary engines, and other details. Estimates will shortly be obtained, and the work will then be proceeded with without delay. A model of an apparatus was exhibited to members of the committee, the object of which is to prevent accident to life or limb in the event of an overhead wire breaking, by automatically shutting off the current. The apparatus, for which a provisional patent was obtained last month by Mr. Ralph Bostock, licensed victualler, and Mr. Frank Arthur Cheetham, silk spinner, Brighouse, is attached to the poles, and it is claimed for it that as soon as a wire breaks, the current between the poles is shut off. Mr. Hannam (the chairman) and other members of the committee thought favourably of the invention, but suggested to the patentees that it should be tested with trolley wires of the same thickness as those in use in Leeds, a suggestion which they decided to adopt.

In consequence of the breaking of a guard wire last week, it is stated that thicker guard wires are to be used throughout the entire route.

Limerick.—The Electric Tramway Company, Limited, have notified their intention of applying for permission through the city and county grand juries for permission to lay down a series of tramways through the city and suburbs, the gauge varying from 3 feet 6 inches to 5 feet 3 inches. Though the scheme has been outlined, the plans have not yet been furnished.

Liverpool.—At last week's City Council meeting, Mr. C. Petrie submitted the recommendation of the Generating Stations Committee—"That the tender of Messrs. Willans and Robinson, Limited, Rugby, for the supply of two compound engines and dynamos at the price of £6,530 each, and one triple-expansion engine and dynamo at the price of £6,939, subject to a deduction of 2½ per cent. upon the respective amounts, be accepted." The engines, Mr. Petrie said, were for the generating station in Pumpfields, for lighting and traction. The question was purely technical, and the Council would be well advised in taking the opinion of its officials, who recommended the proposed engines. Some little misapprehension existed to the effect that there was a difference of opinion between the reports of Dr. Hopkinson and Mr. Holmes, their electrical engineer. He had mentioned this to Dr. Hopkinson, who had written stating:—"I am of opinion, and always have been of opinion, that the engines proposed by Mr. Holmes for the new large central station will give thoroughly satisfactory results both for traction and lighting." The committee's recommendation was referred back to the committee last month. The committee had since further considered it, and they felt, having the report of Mr. Holmes before them, that they could not alter their recommendation. It was only because the Council did not quite understand the matter that the recommendation was referred back. Many misleading statements were made last Council meeting. One was that the engines made 800 revolutions, whereas they made only 230. The committee had inquired fully into the question, and if they were not perfectly confident that this machinery would give the greatest possible satisfaction, they would not have recommended its purchase.—Alderman F. Smith seconded the recommendation.—Mr. Rutherford moved as an amendment: "That before ordering the high speed engines mentioned in the recommendation, the special committee be requested to obtain the unbiassed opinion of Sir Benjamin Baker, Sir Frederick Bramwell, Mr. Kincaid (of London), Mr. Pearson (of New York), or some other acknowledged authority of eminence and experience in electric traction upon the two questions (*a*) the unit of power; (*b*) the type of engines it would be best for Liverpool to adopt in the projected 10,000 horse-power power station at Pumpfields." He did not assert that the engines recommended were not the right kind to order, but he thought the Corporation should take the best authority on the subject before committing the city to a large expenditure. The recommendation was the same as that submitted at the last Council meeting, when it was sent back to the committee on its merits. Now, however, personal matters had been introduced into the consideration of the subject, and some members who voted against the recommendation last month had that day told him that they would now vote against him whatever he might say. Mr. Petrie had referred to Dr. Hopkinson's letter, and suggested that that letter got rid of the difficulty of the difference of opinion between Mr. Holmes and Dr. Hopkinson, but that opinion was not official. He had no personal hostility towards the committee, and he trusted that if his amendment should happen to be carried Mr. Petrie would not resign. On the other hand, he might assure them that were he (the speaker) beaten he would not resign. Mr. Rutherford proceeded at great length to give a history of the business from June 11th last year, when Mr. Holmes was asked to report on the electrical power for the trial route to the Dingle. He pointed out that Mr. Holmes considered that economy and efficiency would result from combining the generation of electricity for lighting and tramway traction. Mr. F. S. Pearson, who had had twice the experience of anybody else in electric tramcars, thought differently, and said so. That was why, when Mr. Pearson was proposed as consulting engineer, the electric light section of the Council, having determined to get control of the electricity for the trams, rose as one man against Mr. Pearson's appointment, and swore they would have none of him. Mr. Holmes now recommended for the new electric generating station at Pumpfields high speed machinery whose type was experimental, made by makers to whom the construction of the engines was an experiment, and modified besides by novelties in design which Mr. Holmes had introduced. He contended that Dr. Hopkinson had not endorsed, but excused, these recommendations, and in the course of an extended argument urged that slow speed engines were the best for developing large power like 2,500 or 3,000 electric horse-power, which ought to be the unit. They were entitled to know not whether these recommended engines would give satisfactory results, but whether they were the best type, and what was the best unit of power to adopt, because they were making a start with a huge undertaking which would not only provide light for the streets and traction for the tramways, but be eventually the source from which all the small industries of Liverpool would draw their power. Mr. Rutherford proceeded to urge that the proposed engines were unsuitable for traction purposes, because they were high speed, and, therefore, more difficult in governing any variability of load, and more liable to lead to accident on account of the high rate of speed. He cited various authorities showing that the slow speed engines were more suitable for traction purposes. At all events, he submitted there was a reasonable doubt as to which form of engine was the better, and expert evidence should be obtained upon it. The experience of the whole world was that slow speed engines should be used; but at least the Council before deciding upon any definite policy should take the opinion of the leading engineer in England—someone above petty considerations, and whose knowledge would guide them to a proper and just conclusion.—Mr. M. Hyslop Maxwell seconded the resolution.—Alderman Fred. Smith defended the action of the committee. Mr. Rutherford asked them to take the opinion of some expert. Had they not appointed Dr. Hopkinson as an expert? Referring to the unofficial letter sent by Dr. Hopkinson, the speaker contended that that gentleman would not go back upon the opinion therein expressed even in an unofficial letter. The alderman was proceeding to criticise Mr. Rutherford's speech, when the Council adjourned.

When the Council met again on the 3rd inst. the matter was continued in spite of Mr. Rutherford's proposal to withdraw his amendment. Mr. Petrie, as chairman of the committee, objected to that course because Mr. Rutherford had made certain statements which must be answered, and they had a complete answer to every one of them. Alderman F. Smith, who continued the debate, said that what he understood the Council desired to do was to undertake a very great and beneficent scheme of electric traction for Liverpool. In the preparation of that scheme the committee thought it desirable to provide two stations of 10,000 horse-power each. Mr. Rutherford had pictured the terrible effect that would happen to Liverpool in case all the tramcars were stopped at one moment. If Mr. Rutherford had been a little more candid with the Council he would have told them that he had asked this very question of the engineer, and that the engineer had explained to him that it would mean that Liverpool trams would run in four sections, so that no such disaster as that pictured by Mr. Rutherford could possibly take place. With regard to the type of engines that should be used undoubtedly there was no settled and absolute opinion even amongst the foremost electrical engineers. Alderman Smith then devoted himself to arguments justifying the committee's confidence in their electrical engineer. The only modification made by Mr. Holmes to adjust the engines to what he deemed to be the requirements of Liverpool was a change of fly-wheel. They wanted to put an engine down that would not wreck their station. The high-speed engine had a fly-wheel of not more than 16 tons, and had it within its dynamo. Whereas a slow speed had a fly-wheel, which was exposed, of about 60 tons. Accident was less likely with a high speed engine than a low speed engine. Electricity was a comparatively new science, and there was continual change and progress. Therefore, was it not reasonable that their able officials should be allowed to be in the van of progress, rather than following slavishly in the rear of other people? The committee followed Mr. Rutherford on another matter, and he led them into a little bit of disaster. The committee had to be led by somebody (Mr. Grant: Forwood), but were they going to be led by Mr. Rutherford, with the secondhand opinions of competitors for some of this Corporation work against the opinions of their capable officials. Mr. Rutherford was in this matter in a minority of one on the committee. With an expenditure of £20,000 the Council should trust the committee, if they were worthy to be trusted. As an individual member, he (Alderman Smith) had given the subject his best consideration, and had honestly come to the opinion that the advice of Mr. Holmes ought to be followed. Mr. Holmes was an electrical engineer of standing, worthy of being followed. He would follow Mr. Holmes until it was shown by competent authorities that he was wrong. The discussion was carried on at considerable length, and Mr. Petrie, the acting chairman of the Generating Committee, replied. He said that the committee never admitted that there was any difference between the report of Mr. Holmes and that of Dr. Hopkinson as to the type of engine to be purchased. Mr. Rutherford had discussed the question at the Council three or four times, and the points he raised had been answered intelligently and courteously by Mr. Holmes. Mr. Rutherford made statements which he had been told at the committee were wrong, and he had seen letters which intimated that he was wrong, yet he reasserted them at the Council. He had made the question a personal matter. He had said, "I will show you up in the Council. I will show your committee up in the Council and I will state a lot of things you won't like to hear." There was nothing any member of the committee had done that he was ashamed of. If Mr. Rutherford knew of anything he should have stated it to the Council. He had two hours of the Council's time on Wednesday, which was practically wasted, and had only "shown himself up." The engines referred to at Bristol and Dublin were made for lighting purposes, but were tried for traction and found unsuitable, because they were never intended for traction. It had been stated that these engines were not used for traction in this country at all. That was quite incorrect, and Mr. Rutherford knew it was incorrect. They had worked, and with very satisfactory results at one of the stations of the South London Railway Company. They had worked for two and a quarter years, and the repairs to them had practically been *nil*. As to the variability of load the firm was willing to give any reasonable guarantee that the engines would stand any strain of that kind. The South London Railway Company were so satisfied with the engines that they had ordered 16 (?) sets of plant, each of 1,000 horse-power, for the railway. The municipalities of Leeds and Bradford had tried them and were ordering additional ones for traction purposes. The Liverpool Corporation had tried the engines for electric lighting, and had found them very satisfactory, as shown by the fact that they were the second cheapest producers of electricity in the cities of the United Kingdom. The cost of the engines would be about £20,000. On May 4th the Council referred the committee's recommendation back; but, after careful consideration, the committee had come before them again with the same recommendation. The committee had been guided by their officials, and it was to the interests of the officials that they should recommend what was best for the city. The division was then taken, the voting for Mr. Rutherford's amendment being 12, and against 49.

Manchester.—A sub-committee of the Swinton and Pendlebury District Council have arranged with the solicitors to the Manchester Carriage Company that the tram lines which are to be laid in Pendlebury shall be laid so that the cars may, if thought proper at some future time be run by mechanical power without necessitating re-construction when it is decided to adopt electricity.

Newcastle.—On 3rd inst. letters were before the special committee from Dr. Hopkinson and Mr. Columb, stating their charges for advising *re* electric and cable traction. The committee has agreed to engage both gentlemen, and the city engineer is to supply them with plans showing the proposed routes. Both gentlemen are to draw their estimates from a given basis of mileage, weight of rails, strength of foundations, engines, and machinery of every description, and the quantity of rolling stock, both systems to be worked on a basis equal to a 2½ minutes' service. It was agreed to report meanwhile to the Council upon the routes which the committee considers should be included in the new scheme.

Norwich.—The recent action of the House of Commons Committee in cutting the Surrey Street route out of the electric tramway scheme has placed a serious obstacle in the way of the St. Stephen's Street and Newmarket Road line, and while it is not yet abandoned, no fresh steps have yet been taken to arrange for an alternative route. The Magdalen Road route also presents difficulties at present, owing to the operations in progress for sewerage, and this portion of the city cannot for some time be undertaken, although the line is likely to prove one of the most remunerative on the system. The contractors are therefore confined to three main routes, Thorpe Road, Dereham Road, and Aylsham Roads. All arrangements are now complete for the car sheds near the Prince of Denmark at Sprowston, and the building of these premises has begun.

Penarth-Cardiff.—On 1st inst. a public inquiry was held at Penarth by the Light Railway Commissioners (Earl of Jersey, Mr. G. A. R. FitzGerald, Colonel Boughey, and Viscount Emlyn, acting secretary), with regard to the proposed light electric railway from Penarth to Cardiff. Various local authorities, the Taff Vale Railway Company, and the Gas Light and Coke Company, were represented. Mr. Hans Hamilton appeared for the promoters. In opening the case he said the company was formed at the end of last year by some influential gentlemen in Cardiff and Penarth, and in conjunction with gentlemen who had been and who were connected very largely with electrical traction and electrical undertakings in London. So strong was the feeling in both towns of the necessity for the undertaking that, if necessary, all the capital could be found in Cardiff and Penarth alone. The nominal capital was £25,000, but power had been given to increase this if required. Penarth had an estimated population of between 17,000 and 18,000, and the population of Cardiff was 180,000. The distance from the Town Hall in Cardiff to the Post Office at Penarth was about four miles, and the traffic between the two towns consisted of gentlemen who resided at Penarth, and who went into Cardiff for business, whilst near the spot at where the proposed railway would commence, viz., Grangetown, there was a large and increasing working class population. If the light railway was granted, trams would be run every 10 minutes. The road between the two towns was privately owned by Lord Bute and Lord Windsor, and a portion of it was within the borough and a portion in the Penarth Urban District. It had been felt for some time that a great expansion of Penarth would follow if adequate communication was granted between the two towns, and in 1897 a syndicate was formed, called the Penarth Tramways Syndicate, of some of the leading inhabitants of Penarth and some of the principal business men of Cardiff, with the object of constructing electrical tramways in Cardiff and along the road proposed for the new light railway. The application was proposed to be made under the Tramways Act, but, as the Cardiff Corporation threatened to oppose, the project was dropped. The reason for the opposition at the time was, in the first place, the fact that the Cardiff Corporation desired to extend their borough boundary so as to include Penarth, and if the borough was extended they wished to construct the tramway themselves and to exercise their power of purchasing the existing tramways. As a result of the Local Government Board inquiry, however, the extension was not allowed, and that was why the present application was being made. The proposed light railway would commence where the houses ceased at Grangetown, and would end at the Post Office at Penarth, the total length being a little short of 3 miles. The Plymouth Road extension is dropped entirely. Lord Bute and Lord Windsor strongly advocated the construction of the light railway, and they would be willing, if the project was granted, to give land for the widening of the road wherever it was necessary. Counsel proceeded to deal at length with the objections of the Cardiff Corporation and the Taff Vale Railway Company.

Mr. Ll. B. Atkinson, electrical engineer at Cardiff, and residing at Penarth, said the gauge of the new line would be the standard gauge of 4 feet 8½ inches. The lines would be laid level with the surface of the road, and the road between the rails and for 18 inches on each side would be paved with granite setts or wood blocks at the option of the local authority. The railways proposed were four in number, No. 5 having been abandoned by arrangement with the District Council of Penarth. The four lines of rails would have a total length of 2 miles 5 furlongs and 6·60 chains, and would commence at Grangetown by a junction with the existing tramways. With regard to the inclines, Railways No. 1 and 2, from the commencement to the River Ely, would be on a practically level road, Railway No. 3, from the River Ely to Cogan Hill, would be on an incline of 1 in 19, and railway No. 4, which commenced on Cogan Hill, would have a maximum gradient of 1 in 13, for quite a short distance. It was proposed, however, to reduce this incline to 1 in 21. The width of the road was, for the most part, ample. The cost of widening the road had been included in the estimate. The mode of working the railway was by electricity with overhead wires, and the promoters were either prepared to erect their own generating stations or to enter into a contract with the Cardiff Corporation. A provisional agreement had been entered into by which the local authority could purchase the railway at any time after 10 years at a value excluding the goodwill, or, at any time after 35 years, they might purchase without a goodwill. He took it that the Cardiff Corporation would have the power of purchasing the portion in their district. It would be a single line, with loops for passing. He had known electric tramways to be erected on roads which had a greater incline than the Penarth Road. The speed would depend upon the local authorities, but he anticipated a speed of 9 or 9½ miles an hour, including stoppages.

Mr. Vivian Douglas Cooper, engineer, said that he estimated the total cost of the construction of the line would be, approximately, £19,043.

Mr. B. Francis Williams then proceeded with the opposition on behalf of the Cardiff Corporation. He called Mr. William Harpur, the borough engineer, who gave evidence against the scheme.

After hearing further evidence and holding a consultation among themselves, the Commissioners notified that they could not approve of the proposed arrangement between the promoters and the land owners, as it would hamper the municipality if they required to purchase. No. 1 railway had therefore to be left out, and after the opposition of the Taff Vale Railway had been heard, the Commissioners intimated that it was unwise to grant such a small bit of line as that proposed from Penarth to Ely Bridge, and the promoters withdrew their application.

Reading.—The Town Council on 2nd inst. adopted the following report of the Finance and General Purposes Committee:—"That the committee do recommend to the Council that an application be made to the Board of Trade for a provisional order in the next session of Parliament authorising the local authority to extend the existing tramways after they shall have been acquired by the local authority as follows, namely, from the terminus near the Cemetery to the South-Eastern Railway bridge in London Road and to St. Peter's Road, Earley Rise, and from the terminus near the barracks to the Pond House, and also authorising the local authority to work the tramways themselves and to use electricity and other mechanical power for working the same."—In the discussion Mr. Martin, chairman of the committee, said the reason why they did not propose any additional extension was because they had not decided on an important question, as to what their future traction should be, whether it should be electricity or a continuation of horse traction, or by compressed air or some other new traction which might crop up during the next two years. They would thus gain two years more experience, which he thought placed them at a decided advantage, instead of rushing into a scheme at the present moment and deciding off-hand what traction they would take up. In considering the question of traction, another element was the question of gauge, and if they decided on electric traction they would no doubt have to alter the gauge throughout the whole of the town, whether it be from east to west or north to south. They thought it much better to proceed by steps.—Mr. Wellman believed that the minds of most people were made up in favour of an electrical overhead scheme, and that they were convinced that it was no good waiting and sending a deputation all over the world to find out the best scheme. The example of those business men who had risked their own money in starting companies for laying down electric tramways ought to be good enough for them; anyhow, it was good enough for the large number of people of Reading. He believed, therefore, that their minds were made up to have a good and efficient service all over the town, and not only in the west and east, but to Caversham, Redlands, Whitley, Bath Road, and anywhere where there was a considerable population, it would be advisable and to their interest to extend the tramways. He felt sure that nothing short of a complete and efficient system would satisfy the town. They were at present a long way behind other towns, and if they simply stuck to the lines laid down by this meagre resolution of the committee they would greatly disappoint the town.—Mr. Bonny said he was in possession of figures which went to prove that an outlay of £100,000 would be ample to provide a system of electric trams from the Pond House to Earley Rise, and from Whitley to Caversham. He had no doubt it would be a very profitable venture. Under the present miserable and wretched system the company paid a dividend of 7 per cent., and there was not the slightest doubt that they could pay more than that on an outlay of £100,000. He was informed by experts that that sum would pay all expenses of new equipment, new lines, and the whole cost of the installation of electrical plant. The report was adopted with only two dissentients.

Redditch.—The Redditch District Electric Traction Company, Limited, has just been registered, with £2,000 capital, to promote and obtain the necessary authority to make and maintain light electric railways and tramways in the counties of Worcester and Warwick or elsewhere.

Sheffield.—The Tramways Committee recommend that the British Thomson-Houston Company be requested to fit one truck of the 25 cars now on order with roller bearings of the Roller Bearings Company, and another with those of the Mossberg Company, and that the British Thomson-Houston Company be requested to construct the new trucks to allow of such bearings being put in, if the tests prove satisfactory. It is also recommended that the tender of the British Thomson-Houston Company, Limited, for the electric equipments and the Peckham trucks for the 13 cars on order from Messrs. Milnes & Co., at £433 6s. 8d. per car be accepted, also that the tender of the British Thomson-Houston Company, Limited, for 12 single-deck cars, including electrical equipment and trucks, at the sum of £617 16s. 8d. per car, be accepted.

Stourbridge.—A Dudley paper says that the British Electric Traction Company are pushing on well with the work connected with the conversion of the tramway from Stourbridge to Hart's Hill into an electric line, but nothing is yet being done as regards a start with the Kinver line.

Tipton.—At last week's Council meeting, when the report of the deputation to a West Bromwich conference on the tramway question was read, Councillor Doughty said that no other local authority was in the same position as themselves. Wednesbury had everything to gain by the trams, as had West Bromwich, and Dudley had already expressed the opinion that they would take the trams into their own hands. Darlaston only possessed a mile or more of trams. He thought they would sanction almost any scheme that might be put forward in order to retain Tipton. Trams were an absolute necessity, but in his opinion the overhead system was not satisfactory, and he thought if they could induce any company to lay down a cable or conduit system it would be an advantage to the public. He thought they could reasonably ask any new company formed to put down the conduit system of electricity. He seconded the adoption of the report, and this was agreed to.

York.—At Monday's City Council meeting, Alderman Agar, in moving the confirmation of the minutes of the Streets and Buildings Committee, referred to the refusal of the committee to allow the York Tramways Company the use of electrical power for the haulage of their cars. He said this action had been taken exception to, but he was satisfied that if those who took exception to it knew that the company would use that power by overhead wires suspended on standards, they would at once see that that would cause a great block in their narrow streets, and that the committee had done right.

TELEGRAPH AND TELEPHONE NOTES.

Hereford Telephones. — Increased facilities for telephonic communication have now been afforded by the National Telephone Company and the Post Office. The town is now connected with the trunk service.

Soudan Telegraphs.—A Reuter despatch dated Suakim, June 5th, says that the telegraph lines from there to Kassala and Berber are being splendidly laid. Bimbashi Manifold has left for the front, *vid* Cairo, after completing his work at this end. Of the line to Kassala 130 miles have been laid, and of that to Berber 30. Both lines are expected to be completed in three months.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1898 ...	...
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Amazon Company's cable—		
Cable beyond Gurupa ...	June 8th, 1898 ...	...
Cyprus-Latakia	Feb. 10th, 1898 ...	...
Bolama-Bissao	April 12th, 1898 ...	...
Maranham-Para	„ 17th, 1898 ...	...
Hong Kong-Manila	May 3rd, 1898 ...	...
Loanda-San Thomé ...	June 3rd, 1898 ...	...
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Cartagena Barranquilla ...	July 4th, 1896 ...	...
Saigon-Bangkok	June 1st, 1898 ...	June 2nd, 1898.

Telephone Communication between Brussels and Manchester.—It is stated that some experiments were made on 6th inst. with the telephone between Manchester and Brussels, the operators at the two cities being put in direct communication with each other. Both land and sea wires had to be utilised, the wires running from Brussels through Courtrai and Lille to Calais, where they were connected with the London-Paris telephone cable under the Straits of Dover.

CONTRACTS OPEN AND CLOSED.

OPEN.

Barnet.—June 24th. The Lighting Committee want tenders from firms willing to undertake such installation for lighting the district by electricity. Particulars at the Council offices, and see this week's "Official Notices."

Bethnal Green.—June 28th. The Board of Guardians invite tenders for supplying the necessary plant and installing the electric light at the new infirmary, Palestine Place. For particulars see our "Official Notices" this week.

Bournemouth.—June 20th. The Corporation is inviting tenders for the supply, &c., of cables, arc lamps, incandescent lamps, wiring, switchboards, fittings, &c.; also steam dynamo, &c. Particulars from the borough engineer, Mr. F. W. Lacey, also see our "Official Notices" May 27th.

Bulgaria.—June 27th. Some little time ago the municipal authorities of Sophia, Bulgaria, invited tenders for the concession for the electric lighting of the public streets of the city, and for the construction and working of an electric tramway. The authorities are again inviting tenders, until the 27th inst., for this concession, particulars of which may be obtained from above.

Bury St. Edmunds.—June 13th. The Corporation invites tenders for the supply and erection of Lancashire boilers, three 60-kw. steam dynamos, transformer and booster, accumulators, street mains, and various other machinery and apparatus for the electricity undertaking. Consulting engineer, Mr. F. H. Medhurst, 13, Victoria Street, S.W. See our "Official Notices" May 13th.

East London (Cape Colony).—June 28th. The Town Council is inviting tenders for erection of buildings and the supply of electric lighting machinery, electric tramcars, plant, rails, &c., and for their maintenance for six months from completion. Particulars from Messrs. Dyer & Dyer, 17, Aldermanbury, London, E.C., on payment of £5, repayable on the receipt of a *bonâ fide* tender.

Edinburgh.—June 14th. The Corporation wants tenders for the electric wiring of the police chambers (400 lamps). Particulars from the electrical engineer, Dewar Place, also see our "Official Notices" June 3rd.

Edinburgh.—June 14th. The Corporation wants tenders for the supply of cast-iron pipes, pavement boxes, and collars for joining earthenware casing. Particulars from the resident electrical engineer.

Llandudno.—June 16th. The District Council wants tenders for the supply of meters of various sizes for 12 months. See our "Official Notices" this week for details of sizes.

London.—June 21st. The London County Council is inviting tenders for engines, dynamos, accumulators, switchboards, feeders, distributors, and service mains and all accessories, to be fixed complete in buildings at the Crossness Outfall Works, near Erith, Kent. The L.C.C. also requires tenders for providing and fixing cables, wires, conductors, casing, pendants, brackets, and other fittings, columns, lanterns, lamps, switches, and switchboards, distributing boards, fuses, cut-outs, &c., necessary for the lighting by electricity of the Crossness pumping station and works, near Erith, Kent. Particulars of both contracts from the Engineer's Department, County Hall, Spring Gardens, S.W. See also our "Official Notices" May 27th.

Sheffield.—June 13th. The Tramway Committee is inviting tenders for the erection of an electric power station for its tramway scheme. Particulars from the City Surveyor.

Southampton.—June 20th. The Corporation invites tenders for the supply and erection of lamp columns, arc and incandescent lamps, automatic switches and fittings. Consulting engineers, Messrs. Kincaid, Waller & Manville. See our "Official Notices" June 3rd.

St. Pancras.—June 14th. The Vestry wants tenders for condensing plant, steam pipes, &c., for the Regent's Park electricity station. Particulars from the chief clerk, Electricity Department, 57, Pratt Street. See our "Official Notices" June 3rd.

Tynemouth.—June 20th. The Corporation wants tenders for the supply of steam dynamos, balancer and boosters, &c. Consulting engineers, Messrs. Lacey, Clirehugh & Sillar. See our "Official Notices" June 3rd, for particulars.

Victoria.—June 24th. The Council of the city of Hawthorne (Colony of Victoria, Australia) is inviting tenders for the supply and erection of buildings, boilers, engines, dynamos, transformers, mains, meters, arc lamps, poles; also running the plant for three years. See our "Official Notices" March 11th.

York.—June 24th. The Corporation is inviting tenders for the erection of an electric light station. Particulars from the City engineer, Guildhall.

CLOSED.

Aberdeen.—For electric wiring and fitting work at the new building at the bathing station the Council has given the contract to Mr. R. Botting at £117.

Balmoral Castle.—The Electric Construction Company, Bushbury, near Wolverhampton, are to supply the dynamos necessary for the installation of the electric light at Balmoral Castle.

Dundee.—The Electric Committee has accepted the following tenders for supply of steam coal for the electricity works:—Robert Taylor, 1,500 tons of Wallsend diamond nuts (Aitken) at 9s. per ton; W. Taylor & Co., 1,500 tons of No. 1 Hamilton small coal (Eddlewood ell), at 8s. 2d. per ton—all delivered at the electric lighting station.

Belfast.—After considering the tenders submitted for the wiring of the new police office and cells, the Corporation has given the contract to Mr. W. H. Drennan.

Harrogate.—The Town Council has accepted the tender of Mr. Steinthal for ornamental electric lamps for lighting the Spa and Gardens at £189.

West Ham.—Messrs. Veritys' tender for the electric fittings for West Ham Corporation has been accepted. There were 11 competitors. Messrs. Veritys' quotation, which was not the lowest, was for the supply of the fittings at 5 per cent. below the schedule price.

FORTHCOMING EVENTS.

1898.

Friday and Saturday, June 10th and 11th.—Municipal Electrical Association Conference continued.

Friday, June 10th, at 8 30 p.m.—The Institution of Junior Engineers at the Westminster Palace Hotel. Special meeting to welcome Sir T. Salter Pyne, C.S.I., honorary member of the Institution.

At 5 p.m.—Physical Society. Agenda:—1. Exhibition of a Model illustrating Dr. Max Meyer's new theory of Audition, by Prof. S. P. Thompson, F.R.S.; 2. "Attenuation of Electric Waves along a line of negligible Leakage," by E. H. Barton, D.Sc; 3. "Diffusion Convection," by A. Griffiths, B.Sc.

Thursday, June 16th, at 9 p.m.—Institution of Electrical Engineers' Conversazione at the National History Museum, South Kensington.

At 8 p.m.—Chemical Society, Burlington House. Papers to be read:—"Preparation of a Standard Acid Solution by Direct Absorption of Hydrogen Chloride," by G. T. Moody, D.Sc.; "Researches on the Terpenes. III.—Halogen Derivatives of Fenchene and their Reactions," by J. A. Gardner, M.A., and G. B. Cockburn, B.A.; "Researches on the Terpenes. IV.—On the Oxidation of Fenchene," by J. A. Gardner, M.A., and J. B. Cockburn, B.A. Ballot for the election of Fellows.

NOTES.

The Municipals' Dinner.—The dinner of the Municipal Electrical Association was held on Wednesday evening at the Holborn Restaurant.

Errata.—On page 751 of last week's issue, line 17 right-hand column, for "torque" read "tongue;" and on page 755, line 11, for "with resistances *and* effect," read *an* effect.

On page 752 of last week's ELECTRICAL REVIEW an error arises in Mr. Apps's Röntgen Society paper on "A New Induction Coil." In line 35, for 4½ inches read 44½ inches.

Lighthouse Illumination.—An important alteration is to be carried out in connection with the revolving light at Cape Gris Nez. A new lighthouse is to be erected, much higher than the present one, so that the light will be seen at a distance of 48 miles. It is to be an electric light, having a white flash every second, and the candle-power will be no less than 3 millions. It is computed that the light will pierce the fog for a distance of 16 miles.

Machinery Interviews. — *Machinery*, of South Africa, is one of those papers which goes the length of publishing so-called interviews with machinery builders. A recent number contains one such with Mr. Norbury, of Galloway's, Limited, the Manchester boiler makers, which is in the worst possible style of interview, being little else than a clumsy vehicle for carrying certain statistics as to Messrs. Galloway's works, which would have been far better described in a regular descriptive article and of more interest, besides giving less prominence to a list of exhibition awards as tedious as the interminable list of things which constitutes the poetry of Walt Whitman. We do not think that the views propounded as to steam jacketting will meet the approval of many engineers. If anyone has found the steam jacket to be as described simply a means of robbing Peter to pay Paul, we should advise a reform in the construction of the jacket and a perusal of Fletcher's little book on the steam jacket. We are glad to find nevertheless that Mr. Norbury has been to Johannesburg, and think that other leading English firms would do well to send out representatives capable of speaking with authority, in order to look up business, not merely in the Transvaal but in other countries. It is not necessary they should all be interviewed.

The War and the Cables.—The *Times* correspondence on the cutting of the cables in war time—which we have already reproduced in the ELECTRICAL REVIEW—is continued by Mr. Charles Bright, as follows:—

With the authority of experience, Mr. Parsoné appears to have been the first to remind the public that more than one cable owned by a company of neutral nationality has been interrupted in the course of warfare. Without desiring to take up your space by a disquisition on the morality, or otherwise, of cutting neutral cables, or on the question of indemnity claimable, perhaps I might remark that, in my opinion, a useful purpose has been served, if only in exemplifying what we may actually expect in the event of our country being at war with another European Power. Surely a consideration of the prospects points, Sir, to the necessity—aye, urgent necessity—of a system of cables connecting the entire British Empire by direct and independent means—*i.e.*, without touching on foreign soil. In the event of a permanent and reliable understanding being arrived at with our American cousins, the United States would not require to be regarded as foreign territory; and if, for certain purposes, a further alliance, including Japan, were agreed to, two Pacific cable schemes might be united in one. Reciprocally, a telegraphic clause would be one of the most important items in any convention constituting an Anglo-American alliance and Customs union, whether Japan be also allied with us for strategic and trade purposes or not. Such a convention would tend to ensure the naval supremacy of the English-speaking world in the Pacific, and would render us independent of the good offices of our European neighbours. It is known that the Americans are taking active steps in the direction of a cable from San Francisco to Japan. If the understanding here referred to were brought about, a comparatively short branch from the above to Australia would also embody every element of the all-British line lately considered by the Colonial Office. My remarks are, of course, rather from the national point of view than from that of a shareholder in existing cable systems. Moreover, they do not apply to the project for an all-British line to the Cape and Australia *viâ* Gibraltar and various important naval stations—an admirable project in itself, so far as it goes. I am glad to think, Sir, that you recognise the entire subject as one of vital importance just now, and I trust that, considering the strained condition of European politics, the matter will be thoroughly gone into.

Mr. T. E. Holland replies to the above letter, also that of Mr. Parsoné, in the following terms:—

Will you allow me to refer in a few words to the interesting letters upon the subject of submarine cables which have been addressed to you by Mr. Parsoné and Mr. Charles Bright? In asserting that "the question as to the legitimacy of cable-cutting is covered by no precedent" I had no intention of denying that belligerent interference with cables had ever occurred. International precedents are made by diplomatic action (or deliberate inaction) with reference to facts, not by those facts themselves. To the best of my belief no case of cable-cutting has ever been made matter of diplomatic representation, and I understand Mr. Parsoné to admit that no claim in respect of damage to cables was presented to the mixed Commission appointed under the Convention of 1883 between Great Britain and Chili.

In the course of his able address upon "Belligerents and Neutrals," reported in your issue of this morning, I observe that Mr. Macdonell suggests that the Institut de Droit International might usefully study the question of cables in time of war. It may, therefore, be well to state that this service has already been rendered. The Institut, at its Paris meeting in 1878, appointed a committee, of which M. Renault was chairman, to consider the whole subject of the protection of cables, both in peace and in war; and at its Brussels meeting, in 1879, carefully discussed the exhaustive report of its committee, and voted certain "conclusions," notably the following:—

"Le câble télégraphique sous-marin qui unit deux territoires neutres est inviolable.

"Il est à désirer, quand les communications télégraphiques doivent cesser par suite de l'état de guerre, que l'on se borne aux mesures strictement nécessaires pour empêcher l'usage du câble, et qu'il soit mis fin à ces mesures, ou que l'on en répare les consequences, aussitôt que le permettra la cessation des hostilités."

It was in no small measure due to the initiative of the Institut that diplomatic conferences were held at Paris, which in 1882 produced a draft convention for the protection of cables, not restricted in its operation to time of peace; and in 1884 the actual convention, which is so restricted.

It may not be generally known that in 1864, before the difficulties of the subject were thoroughly appreciated, a convention was signed, though it never became operative, by which Brazil, Hayti, Italy and Portugal, undertook to recognise the "neutrality" in time of war of a cable to be laid by one Balestrini. So, in 1889, the United States were desirous of concluding a general convention which should assimilate the destruction of cables in the high seas to piracy, and should continue to be in force in time of war. The Brussels conference of 1874 avoided any mention of "câbles sous-marins."

The moral of all that has been written upon this subject is obviously that drawn by Mr. Charles Bright, viz., "the urgent necessity of a system of cables connecting the British Empire by direct and independent means, *i e*, without touching on foreign soil."

A New York telegram says that despatches from Santiago announce that the steamer *Adrian*, convoyed by the gunboat *Dolphin*, succeeded in cutting two of the three cables connecting Cuba with Jamaica and Hayti on Friday last. The cable cutting has been done with the tacit approval of England and France, and no complications are likely to ensue.

Motor Starters.—The *Electrical World* recently said regarding motor starters:—

What is ordinarily known as an automatic motor starter might better be termed a motor stopper, the name really signifying a device by which, when the current is shut off, the full resistance of the starting rheostat is inserted in the circuit. An ideal automatic motor controlling mechanism would consist of a device so arranged that when the main switch is closed on the motor the resistance arm would move gradually from resistance all in to resistance all out, at which position it would remain until the current was turned off or the motor was overloaded, in either of which cases it should again insert full resistance, and in case of overload preferably open the armature circuit. No such device is at present on the market.

Mr. F. E. Herdman, of Milwaukee, Wis., has written to our contemporary on the matter, as follows:—

I built an automatic starter, similar to the one you describe as an ideal starter, over a year ago, and the same has been regularly manufactured and on the market since that time. This starter is operated by simply closing a double-pole knife-switch to the main circuit, this action deflecting a strong spring which operates the rheostat contacts, cutting out the resistance at a speed determined by a pneumatic dash-pot. When the circuit is open, the resistance is automatically thrown into the circuit. The starter is supplied with an under voltage and an overload release, the action of either opening the double-pole knife-switch. The main switch cannot be closed unless the resistance is all in circuit with the motor, and when the knife-switch is closed the resistance will not be cut out of circuit unless the current flows through the motor, and the knife-switch would not stay closed when the hand is taken from it unless such a current existed.

Our contemporary adds that the starter described by Mr. Herdman fulfils the requirements mentioned as some of those of an ideal motor controlling mechanism.

The Heating Capacity of Wood.—An American exchange says that a writer in the *Staats Zeitung* corrects a very common supposition in regard to the heating capacity of wood, the most notable fact in the case being that such a practical and easily demonstrable error should so long have prevailed, namely, that the heating capacity of hard wood is greater than that of soft wood. The fact, as ascertained by repeated determinations, is that the greatest heating power is possessed by one of the softest varieties of such material, viz., the linden. Taking its heating capacity by the unit, the second best heater is also a soft wood—fir, with 0·99 heating power; next follow the elm and pine, with 0·98; willow, chestnut, larch, with 0·97; maple and spruce fir, with 0·96; black poplar, with 0·95; alder and white birch, with 0·94 only; then comes the hard oak, with 0·92; the locust and the white beech, with 0·91; and the red beech, with 0·90. These examples leave no doubt of the general fact that hard wood heats the least.

Röntgen Society.—At the meeting of this society held at 11, Chandos Street, Cavendish Square, W., on Tuesday, 7th inst., papers were read by Mr. T. C. Porter on "Work on the X Rays," and Mr. A. A. Campbell Swinton, on "A Pin-hole Röntgen Ray Camera and Its Applications."

Mr. John Brooke Goodman.—Mr. John Brooke Goodman, a young electrician in the employ of the Electric Traction Company, at the works of the Central London Railway, now in course of construction between the City and Shepherd's Bush, lost his life by a distressing accident on June 1st. He was assistant superintendent of the electric lighting arrangements in the tunnels, &c., and on the day in question he was at the Oxford Circus station, where there is a small installation of two 200-volt, 100-ampere, 800 revolution dynamos, belted to high-speed vertical engines. The belt of the left-hand set had come off and had been replaced, the engine being again started at about quarter speed. Although the precise cause of the accident will never be known, it seems quite certain that when going round to look at the belt while the engineer was altering the tension screws, Mr. Goodman slipped or stumbled, lurched on to the pulley of the dynamo and was then thrown with terrible force against the wooden wall of the shed, rebounding on to the second dynamo with which his head came into such violent contact that his skull was fractured, death resulting within a minute or two. Mr. John Brooke Goodman was the third son of Mr. Edward John Goodman, assistant editor of the *Daily Telegraph*. He was born on December 20th, 1874, and was thus only 23 years of age. He had only been about six weeks in the employ of the Electric Traction Company at the time of the accident. His early death has cut short a very promising career. Industrious, energetic, and well informed in the technical and practical phases of electrical engineering, he would undoubtedly have risen to a high position in his profession.

Another New Element.—Prof. Ramsay, who several years ago, in conjunction with Lord Rayleigh, discovered argon, has succeeded in eliminating from the atmosphere a new gas. This elementary substance, which has been named crypton, or "concealed," is obtained by the evaporation of large quantities of liquid air. The residue is a hitherto unknown gas, transparent, heavier than argon, and, like that element, inactive. Crypton is present in the atmosphere in the proportion of 1 to 20,000 parts. The chief lines of the spectrum are green and yellow, the yellow being nearly coincident with the helium yellow line D 3.

The Paris correspondent of the *Standard* says that at Monday's sitting of the Academy of Sciences, M. Berthelot read a communication relating to the new constituent of atmospheric air, the discovery of which is due to the investigations and experiments of Prof. Ramsay and Mr. Morris W. Travers. These gentlemen lately received from Dr. Hampson 750 cubic centimetres of liquid air, which they reduced by evaporation to 10 cubic centimetres, and collected in a tube the gas furnished by the residue. This gas was deprived of its oxygen by the help of metallic copper, of its nitrogen by the action of the electric spark, and of oxygen after that by a mixture of magnesium and pure lime. This operation effected, there remained 26 cubic centimetres of a gas which presented, besides the weakly-defined spectrum of argon, an additional spectrum till then unknown. It was characterised by two exceedingly brilliant lines, one being almost identical with D 3. The other, green, may be compared in intensity with the green line of helium. Its wave length was 5,566·3. Another slightly weaker gave 5,557·3. The density of the gas was approximately 22·5, that of oxygen being 16. According to the velocity of sound, the ratio of specific calories is 1·666, the same as that of argon and helium. It therefore follows that the new gas is monatomic, and constitutes an element. These facts go to prove that the atmosphere contains a hitherto unknown gas heavier than argon, with a characteristic spectrum, less volatile than nitrogen, oxygen, and argon. Messrs. Ramsay and Travers give crypton as the name for this new gas. The position in the periodical table it is not possible to determine in an absolute manner. They, however, hazard the conjecture that the pure gas has a density of 40, and an atomic weight of 80, and that it may be classed with helium. Those gentlemen are continuing their investigations, and preparing a larger quantity of the gas to that end. M. Berthelot, who received a small supply of the new gas in a Fluckyer tube, has verified the existence of the new lines by means of his spectroscope.

The Parliamentary Electrical Energy Committee.—It is understood, says the *Times*, that the Joint Committee of Lords and Commons upon Electrical Energy (Generating Stations and Supply) have arrived at the conclusion that the proved public advantages of electrical energy in the generation of light and power warrant the granting to undertakers of compulsory powers for acquiring sites for generating stations and lands or easements for pipes and mains therefrom. The Committee recommend that provision be made for the granting of these powers in the provisional orders of the Board of Trade, subject to confirmation by Parliament, it being pointed out that such provision would facilitate a continuance of the existing practice according to which more or less uniform conditions under which undertakers are to work are provisionally settled by the Board of Trade. Procedure by private Bill should, the Committee hold, be reserved, as at present, for exceptional cases. As to the bodies which should be entrusted with these powers, the committee suggest either local authorities or incorporated companies (whether the incorporation be by special Act of Parliament or provisional order, or under the Companies Acts). With respect to liability for nuisance, the committee are of opinion that where the site for a generating station is acquired under compulsory powers, and is specified in the provisional order or special Act, the undertakers should not be subjected to any further liability than that which, according to Lord Blackburn ("Geddis *v.* Bann Reservoir," 3 App. Cas., 455), is imposed by the common law in the case of persons exercising statutory powers and duties. On the other hand, where the site for a generating station is acquired by agreement, they think the undertakers ought to be subject to the liability imposed by the common law. The committee explain that the several Bills now pending in Parliament, in which effect is proposed to be given to new developments of the electrical industry have been brought to their notice, but they have not considered them in detail nor taken any evidence upon them. They have treated them only incidentally as showing the lines upon which the industry is likely to expand. They have laid down the general principles which they suggest should guide Parliament and the Board of Trade, but whether those principles should, in whole or in part, be applied, and whether any, and what, special conditions should be imposed, must of course be decided in each individual case according to its merits. The committee express the view that compulsory powers may properly be given even where the proposed site is not within the area of supply; and in this connection they also agree that the laying of mains should be permitted from the generating station to the boundaries of the area of supply.

Bi-Metallic Wire on the Pennsylvania Railway Telegraph System.—An American exchange says that Mr. A. M. Schoyer, superintendent of telegraph, Pennsylvania lines west of Pittsburg, about a year ago placed bi-metallic wire in service on several of the branch lines of this great railway system in and around Pittsburg, and because of the very satisfactory service which that wire rendered, he has recently introduced bi-metallic wire on the main line of the road between Pittsburg and Columbus, the size of the wire being No. 9 B. & S. gauge. Our contemporary adds that the splendid position of the Pennsylvania system to-day shows conclusively that the utmost care is exercised in conducting all branches of its business, and because of the excellent service which that system renders to the public, it necessarily follows that any material which is used by it receives the stamp of approval of a company which is second to none. In view of this use it can be said that bi-metallic wire is now a standard type of wire for overhead construction.

War Fatalities.—From the New York *Electrical Engineer* we learn with regret that two of the Edison Company's electricians were working down the Bay laying torpedoes off Sandy Hook from a small boat, when they were run down by a French ship and drowned. These are the first war victims in the vicinity of New York. Our contemporary remarks that the sad incident is but a further proof of the active part that electricity is playing in the present war, and that pensions should be awarded to the families of the two men.

Royal Institution.—At last Monday's meeting the special thanks of the members were returned for the following donations to the fund for the promotion of experimental research at low temperatures:—Messrs. G. J. Romanes, £5; Sir Frederick Bramwell, £100; Prof. Dewar, £100; Dr. Ludwig Mond, £200; Charles Hawksley, Esq., £100; Sir David Salomons, Bart., £21; Dr. Rudolph Messel, £100.

The Royal Society.—Among the papers down for reading yesterday was one by Prof. W. Ramsay, F.R.S., and Morris H. Travers, "On a New Constituent of Atmospheric Air," and one by Mr. J. E. Petavel, "On the Heat Dissipated by a Platinum Surface at High Temperatures."

Presentation.—On Tuesday last, the staff of Messrs. Crompton & Co., Limited, entertained Mr. Chamen, Corporation electrical engineer at Glasgow, at dinner at the White Hart Hotel, Chelmsford, and presented him with a gold watch and chain and an illuminated address. Mr. Chamen was, previous to his appointment at Glasgow, engineer-in-chief of Messrs. Crompton's contract department.

Shock Fatality.—On May 19th, a young man in the employ of the United States Electric Lighting Company, at Washington, met his death under circumstances somewhat similar to those attending the victim of the Chelmsford accident. He was attending to the wires at a manhole when he received the full force of the current, and all efforts to restore him to consciousness were of no avail. The deceased was one of the best workmen the company had and was a thoroughly experienced hand. The affair was purely an accident, for deceased had given instructions for the current to be switched on to the cables from the station, but it was on sooner than he anticipated, he not having finished making the connection.

Technical Education.—The Kingston-on-Thames Technical Education Committee (under the Surrey County Council) has decided to hold a class for electric lighting during next winter, the pupils to receive object lessons at the Corporation's electric lighting works, established two years ago.

"Submarine Telegraphs."—The Queen has been pleased to accept a copy of the recent work on "Submarine Telegraphs," by Mr. Charles Bright, F.R.S.E., and of the *brochure* entitled "Science and Engineering during the Victorian Era," by the same author.

Personal.—We are glad to be able to announce that Mr. H. Hirst is rapidly recovering from the effects of the operation recently performed on him, and that he hopes soon to get up from his sick couch.

On Tuesday the Londonderry Corporation appointed Mr. Robert Valentine Macrory (late of Messrs. Siemens Bros. and Co.) to the position of Electrical Engineer for the City. There were 51 candidates.

NEW COMPANIES REGISTERED.

Limerick Electric Tramway Company, Limited (2,238).—Registered in Dublin May 2nd, with capital £2,000 in £1 shares, to equip and to maintain and work by electricity, steam, horse, or other mechanical power, all tramways belonging to the company, or in which the company may be interested, and to carry on the business of tramway, railway, omnibus, and van proprietors, &c. The subscribers are:—W. H. Wilson, 37 College Green, Dublin, stockbroker, one share; N. McGarvie, 19, Killeen Road, Rathmines, Dublin, stockbroker's clerk, one share; J. A Wilson, 37, College Green, Dublin, stockbroker, one share; W. Butler, 47, Goldsmith Street, Dublin, accountant, one share; J. Chambre, Commercial Buildings, Dublin, merchant, one share; H. F. Fuller, 8, Wellington Road, Dublin, M.Inst.C.E., five shares; G. W. Fitzgerald, 65, Haddington Road, Dublin, civil engineer, one share. The number of directors is not to be less than two nor more than seven. The subscribers are to appoint the first. Qualification, £50; remuneration as fixed by the company. Registered by T. W. Hardman & Sons, 14, Molesworth Street, Dublin. Registered office, 22, Mason Street, Dublin.

T. F. Braime & Co., Ltd. (57,524).—Registered May 26th, with capital £20,000 in £1 shares, to acquire the business carried on by T. F. Braime at the Northern Works, St. Helen's Street, Hunslet, Leeds, and to carry on the business of mechanical, electrical, and general engineers, stampers, pressers, piercers, brass founders and finishers, tinners, coppersmiths, &c. The subscribers (with one share each) are:—T. F. Braime, 148, Chapeltown Road, Leeds, engineer; Mrs. L. Braime, 148, Chapeltown Road, Leeds; J. H. Braime, Elm Cottages, Rothwell, near Leeds, engineer; Mrs. M. Braime, Elm Cottages, Rothwell, near Leeds; Miss M. E. Braime, Elm Cottages, Rothwell, near Leeds; G. Crowther, The Ridge, Bingley, chartered accountant; A. W. Waide, Methley, Leeds, farmer. The number of directors is not to be less than two nor more than five; the first are T. F. Braime, J. H. Braime, and A. W. Waide. Qualification, £200. Remuneration as fixed by the company. Registered by Waterlow Bros. & Layton, Ltd., Birchin Lane, E.C.

Redditch District Electric Traction Company, Limited (57,527).—Registered May 26th, with capital £2,000 in £10 shares, to promote and obtain the necessary authority to make and maintain light railways and tramways in the counties of Worcester and Warwick, or elsewhere, to make and maintain any such light railways and tramways, and to supply electric light, heat and motive power. The subscribers (with one share each) are:—E. Horton, The Grange, Prescot, near Walsall, manufacturer; J. J. Gittings, Glenthorn, Birchfield, Birmingham, manufacturer; W. J. Kershaw, 34, Waterloo Street, Birmingham, chartered accountant; H. P. Butt, 73, Thornhill Road, Handsworth, clerk; R. P. Dodd, 48, Kingscote Road, Edgbaston, Birmingham, civil engineer; R. Green, Silvermere, Clarence Road, King's Heath, civil engineer; C. H. Hales, 138, Oldfield Road, Balsall Heath, clerk. Table "A" mainly applies. Registered office, 37, Waterloo Street, Birmingham.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Metropolitan Electric Supply Company, Limited (25,395).—This company's annual return was filed on April 27th, when 62,400 ordinary and 100 founders' shares were taken up out of a capital of £1,000,000 in £10 shares. 2,032 are considered as paid, and £10 per share has been called and paid on the remaining 60,468 shares.

Bournemouth and Poole Electricity Supply Company, Limited (55,189).—This company's statutory return was filed on May 20th. The capital is £150,000 in £10 shares (7,500 preference). 6,000 of each class have been taken up, £10 per share has been called, £119,680 has been paid, and £320 is in arrears.

Oldham, Ashton, and Hyde Electric Tramway, Limited (55,318).—This company's statutory return was filed on April 27th. The whole capital of £80,000 in £10 shares (4,000 preference), has been taken up, and £4 per share has been called. £31,230 has been paid, £770 is in arrears, and £120 has been received in advance of calls.

County of London and Brush Provincial Electric Lighting Company, Limited (34,320).—This company's annual return was filed on May 20th. The capital is £800,000 in £10 shares (40,000 preference). 40,000 ordinary and 20,000 preference have been taken up. £10 per share has been called on 30,000 ordinary and 20,000 preference, and £2 per share has been called on 10,000 ordinary. £519,880 (including £40 in advance of calls) has been paid, and £160 is in arrears.

Willans & Robinson, Limited (40,660).—This company's annual return was filed on April 22nd. The capital of £300,000 in £5 shares (30,000 preference) has been taken up, and 14,463 preference and 14,462 ordinary are considered as paid; £5 per share has been called on 12,537 preference and 12,538 ordinary, and £1 per share has been called on 3,000 preference and 2,997 ordinary; £131,372 has been paid, and £3 is in arrears.

Electric Street Car Manufacturing Syndicate, Limited (55,080).—This company's statutory return was filed on April 22nd. The capital is £25,000 in £1 shares, of which 7,130 have been taken up. 10s. per share has been called, and £3,552 10s. has been paid, leaving £12 10s in arrears.

CITY NOTES.

Great Northern and City Railway Company.

This week the prospectus of this company has been before the public, inviting applications for £780,000 in 4 per cent. preferred ordinary "A" £10 shares at par, and £780,000 5 per cent. deferred ordinary "B" £10 shares at par. Interest at 3 per cent. per annum will be paid half-yearly on May 1st and November 1st, during construction, on both "A" and "B" shares, as authorised by Parliament, on amount paid up from time to time. The contractors, Messrs. S. Pearson & Son, Limited, guarantee the payment of a minimum interest of 4 per cent. per annum on the "A" shares, and of 3 per cent. per annum on the "B" shares during the period they work the railway, not exceeding three years after opening of the line.

The directors are Sir Charles Scotter, chairman, Sir Allen Sarle, the Earl of Lauderdale, Colonel R. Williams, M.P., Sir Francis Knollys, K.C.M.G., K.C.B. Sir Douglas Fox and Mr. Francis Fox are engineers. Secretary, Mr. H. Barrow Doo, 18, Eldon Street, Finsbury, E.C.

The Great Northern and City Railway (about three miles in length), in direct connection with the Great Northern Railway, will afford a short through communication between Finsbury Park station, where the various suburban lines of the Great Northern Railway Company converge, and Moorgate Street, in the City of London. This railway, with three intermediate stations at Drayton Park, Essex Road, and Old Street, will provide a frequent and convenient railway service for the densely populated district through which the railway will pass, and will thus fulfil the double purpose of serving a large local traffic, and of furnishing the Great Northern Railway system with a City terminus for its rapidly growing suburban traffic. The motive power will be electricity; but this railway will differ from other electric railways, in that both tunnels will be 16 feet in diameter, and will take the Great Northern Railway Company's heaviest suburban trains, consisting of 11 vehicles, with a seating capacity of 500 passengers. The journey will occupy 12 minutes.

The directors estimate the minimum annual revenue as follows:—

Local traffic:—	
At the low estimate of 10,500,000 passengers, which is less than 4,000,000 passengers per mile, at an average of only 2d. per passenger	£87,500
Local season-ticket holders, 10 per cent. of local receipts	8,750
Through traffic:—	
Assumed for first three years' working at only 25 per cent. above the Great Northern Company's guaranteed minimum	25,000
Sundry receipts:—	
Interest payable by Great Northern Railway Company, parcels, rents, advertisements, &c.	5,000
	£126,250
Less working expenses, say, 40 per cent., on local traffic, and 25 per cent. on the Great Northern through traffic	44,750
Net revenue	£81,500

The prospectus says that recent improvements in electric working prove that 40 per cent. is a liberal allowance for working expenses.

To pay interest at 4 per cent. on debenture stock of £520,000, and on preferred ordinary shares of £780,000, a net revenue will be required of £52,000.

The local traffic is calculated on a daily service of only 125 trains each way, upon which the carrying capacity will be equal to nearly four times the number of passengers assumed.

It is mentioned that the Metropolitan Railway runs daily through King's Cross 265 trains each way, the Metropolitan District 278 trains each way through Victoria, and the South London Electric Railway 220 trains each way for its purely local traffic.

The company has entered into a contract for the amount of the share and debenture capital of the company with Messrs. S. Pearson and Son, Limited, of Westminster, the well-known contractors, for the construction and equipment of the railway and works, in accordance with the Company's Acts, including land, buildings, rolling stock, electrical installation, motors, &c., with all Parliamentary, legal, engineering, administration, and other liabilities and expenses whatsoever during construction, including the payment of interest. The contractors assume all risks of compensation and damage by tunnelling or otherwise, and the company will enter upon a completed line, fully equipped with rolling stock, and in working order. Messrs. Pearson have entered into an agreement to work the railway for a period of three years after completion, the directors reserving to themselves the right to take over the working at any time at one month's notice.

The list opened on Tuesday and closed on Thursday.

London Electric Supply Corporation.

An extraordinary general meeting of this corporation was held on Tuesday at the City Terminus Hotel for the purpose of considering and, if thought fit, passing the following resolution: "That the capital of the company be reduced from £1,250,000, divided into 200,000 ordinary shares of £5 each and 50,000 preference shares of £5 each, to £850,000, divided into 200,000 ordinary shares of £3 each, and 50,000 preference shares of £5 each, and that such reduction be effected by cancelling capital which has been lost, or is unrepresented by available assets to the extent of £2 per share on each of the 111,000 ordinary shares which have been issued and are now outstanding, and by reducing the nominal amount of all the said ordinary shares from £5 to £3 each."

Lord Wantage, who was voted to the chair, said there had been a small but increasing profit every year since the date of the receiver's appointment. The working for the year 1897 showed a profit of £16,586, being more than double that of 1896. Their lamp connections showed a corresponding increase, for whereas in 1896 the numbers were 106,474, in 1897 they had increased to 123,730, or 17,256 increase for the year—a rate of progress equal to nearly 20 per cent. This favourable condition had been reflected in the value of the company's shares. It was 12 months since he last addressed the shareholders, and on that occasion they asked him to carry on the business for another year. He thought the shareholders would agree with him that the time had now arrived when the receiver should retire, and that the company should resume the possession after a break of four years. It was owing to the careful, economical, and skilful management of the receiver that the company had been saved, and was now in a prosperous condition. It was proposed that the whole board of directors should retire, leaving it in the hands of the shareholders to appoint a new board. Though it was not proposed to make any large changes in the constitution of the company, so far as the number of directors was concerned, he thought it was desirable that they should not fill up all the vacancies on the board at once, in case it might be found convenient to bring in other persons who would assist in the development of the business. He considered they should only elect four directors. The chairman then read a long report made by Mr. Bain, the receiver, on the affairs of the company. He concluded by moving the adoption of the resolution, which was seconded by Mr. Pyke, and unanimously agreed to.

A further resolution was afterwards passed altering the articles of association in order to conform with the requirements of the Stock Exchange with a view to obtaining a quotation for the company's stocks.

The following were then elected to act as the board of directors:—Lord Wantage, the Earl of Crawford, and Mr. R. S. Bain.

The Western and Brazilian Telegraph Company, Limited.

The report of the directors to be presented at the thirty-fifth ordinary general meeting of the company, held on Thursday, June 9th, at Winchester House, states that the total earnings amount to £72,332 9s. 10d., as against £71,315 12s. 2d., showing an increase of £1,016 17s. 8d. compared with the half-year to December 31st, 1896. The working expenses amount to £37,774 1s. 11d, as against £38,160 19s. 4d., a decrease of £386 17s. 5d. Including the amount brought forward from June 30th, 1897 (£3,867 15s. 2d.), and the dividend received upon the shares held in the "Platino" Company, the balance to the credit of the revenue account is £49,520 3s. 1d., from which has been deducted £8,060 8s. 4d. for interest on debentures and debenture stock, £2,159 12s. 4d. has been invested on account of the debenture stock redemption fund, and £5,000 placed to reserve fund, leaving a balance of £34,300 2s. 5d. The directors now recommend the payment of 6s. 9d. per share, free of income-tax, for the half-year on the ordinary shares, making, with the dividend paid in November last, £3 5s. per cent. for the year, leaving a balance of £1,428 5s. 11d. to be carried forward. In the case of shares which have been divided into "preferred" and "deferred," the 6s. 9d. per share now recommended will be payable, viz: 6s. to the "preferred" shareholders (making up the full dividend of £5 per cent. on these shares to December 31st, 1897), and 9d. per share to the deferred shareholders. The loss on exchange during the half-year has been diminished owing to the additional collection on international traffic which came into force on July 1st, but the rate of exchange has still fallen. The receipts of the current half-year show a considerable improvement upon those for the corresponding period of 1897. Negotiations for closer working between this company and the Brazilian Submarine Telegraph Company, Limited, have been in progress, and an agreement will shortly be submitted to you. The ninth annual drawing of the "A" and "B" debentures took place at the company's offices on January 17th last, in the presence of Mr. H. de Meray, notary public, when debentures amounting to £18,000 were drawn; of these £8,000 "A" and £9,300 "B" had already been exchanged for debenture stock and the balance, viz, £700 "B" debentures have since been paid off at par. The dividend warrants will be posted on June 9th, 1898. The retiring directors are Mr. W. S. Andrews and Lord Richard H. Browne, who offer themselves for re-election. The directors report, with much regret, the death of their late colleague, Major Wood.

The auditors, Messrs. Turquand, Youngs, Bishop and Clarke, retire, and are eligible for re-election.

The general meeting of this company was held at Winchester House yesterday, Mr. W. S. Andrews presiding. The negotiations for closer working between this company and the Brazilian Submarine Company are not yet completed. They are progressing satisfactorily and pretty actively, and, it is believed, will result successfully, the results being welcome to the Governments and the public and the companies. Of course, nowadays, it was necessary to do things which were agreeable all round. He asked them not to put any questions to him regarding the subject. The report was adopted We shall print a longer report of the meeting next week.

The Metropolitan Electric Supply Company, Limited.

The following circular has been issued:—

Sir or Madam,—You will receive herewith a notice of an extraordinary general meeting, which has been summoned to consider a scheme with reference to the alteration of the founders' shares, and the practical consolidation thereof with the ordinary shares of the company, and also, if thought fit, of passing a resolution approving an agreement, a draft of which will be submitted to the meeting, whereby the founders' shareholders will have their founders' shares converted into ordinary shares, and in consideration of so doing, will have an option of subscribing for 225 ordinary shares at par for each founders' share held by them.

Though your directors are prepared to advise the adoption of this scheme, and the passing of the said resolution, they recognise that the shareholders may wish for some explanation why the board are now prepared to recommend a settlement more in favour of the founders' shareholders than that originally offered by the board, and which was referred to by the chairman at the annual general meeting.

The board appreciate that the compensation contemplated by the proposed agreement appears a large one, but they believe it will be warranted by the advantages which will accrue to the whole body of shareholders by the surrender of the special rights attaching to the founders' shares.

At the annual meeting the shareholders expressed their unanimous approval of the policy of the board in purchasing a freehold site at Willesden, and the erection thereon of a large generating station. These works involve an early issue of capital, but as to the terms of such an issue the interests of the holders of the founders' shares and of the ordinary shareholders in the company are directly divergent.

Another, and perhaps a more cogent reason, exists in the necessity of creating a strong reserve fund, in doing which the directors are hampered both by express prohibitions introduced into the articles in the interests of the founders' shares, and also by the consideration that if those reserve funds were formed out of profits, which would otherwise be divisible amongst the holders of ordinary shares, they might, when formed, be claimed as to one-half by the holders of the founders' shares.

It seemed impossible, in the face of these difficulties, to avoid a litigation, which would certainly have caused the company much embarrassment, by delaying the issue of the new capital.

It was, moreover, apparent that a similar opportunity of extinguishing the rights of the founders' shares would, in all probability, never occur again, and the directors felt bound by the repeated pledges given to the ordinary shareholders, to spare no effort in getting rid of the founders' shares, and placing all the shareholders of the company on an equal footing.

The extraordinary general meeting called to consider the above question was held at Winchester House on Tuesday last, Sir Eyre Massey Shaw in the chair.

The Chairman said the circular fully explained the reasons for the meeting. When he met them last there appeared to be no possibility of coming to terms with the holders of the founders' shares. The founders were determined to contest the right of the company to issue new capital. The chairman went on to remark that compromise was the only possible basis of settlement, and by consolidating all their interests they would be able to build up a reserve. The business of the company was never in a sounder position than at the present time, notwithstanding considerable reductions in the price which had taken place at the beginning of the present year, from 7½d. to 6d. per unit. The increase in the revenue for the quarter showed a most satisfactory increase over that of 1897. The returns that morning showed 63,000 lamps connected for the 12 months against 43,000 for the preceding period. There were 394,000 lamps connected, and applications for 13,000. In spite of competition, therefore, from local authorities, they had every reason to believe in the progress of the company.

After the solicitor had explained the exact position of the founders' shares, and sundry questions had been raised and answered, the following resolutions were put to the meeting and carried:—

"That it is expedient that the special rights and privileges of the 100 founders' shares in this company, whether with regard to dividend, capital, reserve fund or otherwise, should cease and be abolished upon the terms that each registered holder of a founders' share or founders' shares in the company should, upon having such share or shares converted into one ordinary share or shares, have the option of subscribing for 225 ordinary shares in the company at par in respect of each founders' share so held by him, and that the draft agreement for the purpose submitted to this meeting be and the same is hereby approved."

"And the directors of this company be, and they are hereby authorised to adopt the said agreement, and to affix the seal of this company thereto, with full power to assent to any modifications in the agreement which they think expedient in the interests of this company, either before or after the adoption thereof."

A vote of thanks to the chairman then concluded the proceedings.

Brazilian Submarine Telegraph Company, Limited.

The forty-ninth ordinary general meeting of the shareholders of the above company was held on Wednesday at Winchester House, Old Broad Street, Mr. J. Denison Pender presiding.

The Chairman, in proposing the adoption of the report, said the first thing that devolved upon him was to refer with regret to the death of a colleague. Since they last met they had lost Lord Sackville Cecil. His training as a young man enabled him to acquire a knowledge of electrical business which was of considerable value to the company, and his death was therefore a great loss to them. When one unfortunately fell out, it was, of course, the duty of the directors to find a successor, and he was glad to say that in the present instance they had been able to secure the services of Sir John Wolfe Barry, K.C.B., as a member of the board. Although Sir John Barry might not be known to them personally, those who had watched the great engineering feats that had been carried out of late years must know his name perfectly well. He thought, therefore, they were to be congratulated upon having obtained the consent of Sir John Barry to act as a director. He would now draw their attention to a few points in the report. With regard to the accounts, the income for the half-year ending December 30th, 1897, amounted to £100,300; for the previous half-year it was £79,133, which showed an increase for the last half-year of £21,000. Of that increase £20,000 was due to increased message receipts and small sums of £62 and £250 respectively for interest and transfer fees, and dividends from other telegraph companies. The increase in the message receipts was satisfactory, and arose first from their having carried a larger amount of traffic than in the previous half-year—the increase being 97,000 words of ordinary commercial traffic and 18,000 words of press messages, which, as they knew, was carried at a considerably reduced rate. A considerable portion of that increased traffic was, he hoped, taken from competitive lines on account of the satisfactory working of their system. The second factor that had led to their increased receipts was the reduced loss on exchange upon the traffic receipts collected in Brazil, resulting from the provisions agreed upon at the International Conference in 1896, at which their company was represented. Those provisions which were now being carried out by the Brazilian telegraph department and by the telegraph companies, came into operation on July 1st last, and consequently its beneficial effect was apparent for the first time in the accounts which were now under review. Unfortunately, the fall in the gold value of the milreis had continued. Between July and December, 1897, it was fairly steady at an advance of about 7½, but in the current half-year it had fallen to a little less than 6d. It had of late, however, shown a rising tendency, which he hoped would continue to the advantage of the Brazilian Government and of themselves. If they compared the receipts of the past half-year with the corresponding period of 1896, they found an increase of £11,327—a much smaller sum than the £21,000 which he had just mentioned as the excess over the previous half-year. Turning to the expenditure side of the account, they found that the total expenditure for the half-year was £26,000 odd, and that for the previous six months was £20,500. That showed an increase of £5,661, which was fully accounted for by the fact that whilst in the June half of 1897 there was no expenditure upon repairs to cables, in the December half nearly £6,000 was spent under that head. He had before called their attention to the item of cable repairs, and asked them, in examining the accounts, not to take too much notice of any diminution under that head, because the experience was, that sooner or later heavy repairs had to be carried out. If they saved them in one year they came in another, and therefore, although they were to be congratulated on getting through a half-year without any heavy expenditure, if they took the average, that expense came out at a pretty considerable amount. So far, however, they had been exceptionally fortunate in that respect. There were increases and decreases of expense under a number of heads of which he would not trouble them with the particulars, but the net results were an increase of £36 in London and £234 at stations, together making £270, which he thought they would look upon as very satisfactory. Even against that small increase there was a decrease of £235 under certain heads, so that there was an actual decrease on the total. After payment of £3,200 for the debenture interest and sinking fund, and providing for the payments of income-tax, there was a credit balance on the half-year's business of £69,580, to which had to be added £7,221, the balance brought forward from June 30th, making together £76,801. The usual interim dividend for the September and December quarters, amounting together to £39,000, had been paid; £25,000 had been transferred to reserve, and £8,662 had been carried forward. Before arriving at that final figure there was deducted a special item of expenditure, quite apart from the ordinary expenses of the half-year. Last year, as they were all aware, the Diamond Jubilee of the Queen was celebrated, and to mark such an unique event many companies gave a bonus to their staff. The directors of the associated telegraph companies considered the matter, and decided to give a bonus to their staffs, and that was carried out on a principle jointly agreed upon all round. In their case the bonus also marked the twenty-fifth anniversary of the existence of the company, and he felt sure that every shareholder had reason to be satisfied with his investment, at whatever period of the company's existence he became interested in it. That consideration for their staff had been fully appreciated by those who served them at home and those who were abroad. He hoped they had still got with them many original shareholders, as he was pleased to say they had officers, who entered the service when the company was formed, and when submarine telegraphy was in a very different position to that which it held to-day as a public investment. They had had the defect in the No. 1 Lisbon cable mentioned to them at past meetings. That defect still existed, but as the cable was carrying the traffic in a satisfactory manner the directors had left well alone, and had not undertaken the removal of the fault, which, however, was in deep water, and which, when it did break down, would be a rather costly, and long business to put right again. He thought he had touched upon all the salient points, but it was rather hard to find anything new to say, seeing that they met half-year after half-year, and received their dividends and bonus regularly every three months. Not only were they receiving a really substantial return upon their investment, but funds were being put to reserve to insure their capital, and therefore there was very little more to be wished for. There was one paragraph in the report to which, perhaps, they would expect him to refer. The directors said:—"Negotiations for closer working with the Western and Brazilian Telegraph Company, Limited, have been in progress, and an agreement will shortly be submitted to you." He begged that the shareholders would not ask him to answer any questions on that subject, because the negotiations were not quite concluded at the present time, and when they were concluded they would all be called together to consider what he believed would be an agreement beneficial to the shareholders of that company and beneficial to the general public, and therefore certainly beneficial to the two countries by which those cables were connected.

Mr. F. J. Hamley said he noticed that £25,000 had been again added to the reserve fund, and he would like to know when the directors would consider that fund sufficiently large.

The Chairman said that, as a large shareholder, he would very much like to have an increased dividend, but the directors not only wanted to give a regular dividend every three months, but also to make the shares of the company one of the best securities going, and they could not do that without insuring their capital. That was the reason they were going on increasing the reserve fund.

Mr. F. Youle seconded the motion for the adoption of the report, and it was carried.

A vote of thanks to the chairman and directors and the staff concluded the proceedings.

Harrow Electric Light and Power Company, Limited.

The report of this company presented to the general meeting on May 24th says, that during 1897, 1,540 8-C.P. lamps were added to the mains, making a total of 5,440 lamps with 87 customers. It had been necessary to practically double the size of the station and provide more plant. The station is now equal to a supply of 9,000 lamps, and further plant can easily be put in. In 1897 50,109 units were consumed. The balance to credit of revenue was £513. This has been devoted to interest on debentures, mortgages, and loans, writing off preliminary expenses, &c. New capital (£20,000) has been issued.

The Electric and General Investment Company, Limited.—Subject to the completion of the audit, the directors have decided to recommend to the shareholders the payment of a further dividend upon the capital paid up on the ordinary shares at the rate of 30 per cent. per annum for the six months ended May 31st last, together with a bonus of 10 per cent., making, with the interim dividend of 10 per cent. already paid, a total dividend of 35 per cent. for the year, and also to recommend a dividend of £50 on each founders' share for the year. The trustees for the founders' shares reserve fund propose to distribute to the holders of such shares a sum of £20 per share out of the proceeds of investments sold and dividends received in respect of the founders' reserve fund, making, with the before-mentioned dividend, a total distribution of £70 on each founders' share. The dividends, &c., to be payable on June 28th, 1898.

Callender's Cable and Construction Company.—The accounts for 1897 show a credit balance of £24,746. It is proposed to pay a dividend for the year of 10s. per share, with a bonus of 2s. 6d., being 12½ per cent. The sum of £3 000 is appropriated for depreciation of machinery and plant, and £5,196 is carried forward.

The transfer books and register of members of the above company are closed from 8th inst. until 16th inst. inclusive.

Stock Exchange Notices.—The Stock Exchange Committee have ordered to be quoted in the Official List:—Eastern Telegraph Company, Limited—Further issue of £129,653 4 per cent. mortgage debenture stock. The Stock Exchange Committee has appointed a special settling day as under:—Tuesday, June 28th: Cape Electric Tramways, Limited—114,843 additional vendors' £1 shares, fully paid, Nos. 285,158 to 400,000.

Royal Electric Company of Montreal.—Messrs. Coates, Son & Co., have been advised that the directors of this company have declared a dividend on the share capital for the quarter ended May 31st of 2 per cent., being at the rate of 8 per cent. per annum, and that the same will be payable on and after July 2nd.

Commercial Cable Company.—The directors have declared a quarterly dividend of 1¾ per cent. on the capital stock, payable on July 1st.

TRAFFIC RECEIPTS.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending June 3rd, 1898, were £3,717 3s.; corresponding period, 1897, £2,461 14s. 7d.; increase, £1,255 8s. 5d.

The City and South London Railway Company.—The receipts for the week ending June 5th, 1898, were £949; week ending June 6th, 1897, £945; increase, £4; total receipts for half-year, 1898, £23,627; corresponding period, 1897, £23,335; increase, £292.

The Dover Corporation Electric Tramways.—The receipts for the week ending June 4th, 1898, were £184 10s. 10d.; total receipts to June 4th, 1898, £2,541 11s. 1d.

The Dublin Southern District (Electric) Tramways Company.—The receipts for week ending Friday, June 3rd, 1898, were £817 1s. 8d.; corresponding week last year, £578 6s.; increase, £238 15s. 8d.; passengers carried, 113,193; corresponding week last year, 87,882; aggregate to date, £10,315 4s. 10d.; aggregate to date last year, £10,627 17s. 7d.; decrease to date, £312 12s. 9d.; mileage open, 8 miles.

The Liverpool Overhead Railway Company.—The receipts for the week ending June 5th, 1898, amounted to £1,869; corresponding week last year, £1,324; increase, £545. 1898 includes Whit Monday, 1897 includes Whit Sunday.

The Western and Brazilian Telegraph Company, Limited.—The receipts for the week ending June 3rd, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,066.

THE TELEPHONE INQUIRY.

(*Continued from page* 722.)

The Select Committee of the House of Commons appointed to consider the desirability of giving greater facilities to municipalities in connection with telephonic development sat again on Tuesday last, under the chairmanship of Mr. Hanbury.

Mr. J. C. Lamb, C.B., second secretary at the Post Office, said that at the last sitting of the Committee they referred to the signing of the heads of agreement between the Post Office and the National Telephone Company in August, 1892. The full agreement was not signed till March, 1896. Two years were occupied in endeavouring to give effect to the policy of Her Majesty's late Government, and that involved laborious negotiations, which more than once threatened to break down. They had to find a solution of many difficulties. One was the question of the price to be paid for the trunk wires. The price was to be the sum shown by the company's books. Generally, the heads of the agreement said the price to be paid was to be the cost price, as shown by the company's books plus 10 per cent., but when they came to investigate the matter they found the cost price was not shown in the company's books, and therefore they had to come to an arrangement with them as to the method in which the value of the wires was to be ascertained. It was mutually agreed that two engineer experts should be appointed, one by the company, and one by the Post Office, to ascertain the estimated cost price. Another difficulty arose in connection with the areas, and it was only after long negotiation that any understanding could be arrived at; the company wished to work the trunk wires themselves, because they saw it would necessitate extra points of switching. When the Government would not agree to that, the company suggested that one end of the trunk wire should be worked from the company's exchange and the other end from a post office. That was also rejected, and then a plan had to be devised to reduce the difficulty of additional points of switching, and that took a very considerable time. Another question arose with regard to the number of wires to be erected between the exchanges of the company and the Post Office. They also had to come to an agreement with respect to poles. A great difficulty was that the company was not willing to enter into the question. They felt it was a thing they were urged by Government to enter into. They felt that in parting with the trunk wires they were parting with that part of their system which afforded very great protection against competition.

The Chairman: Did the full agreement of 1896 differ in any respect from the heads of the agreement?—It did not differ in principle.

Witness proceeded to deal with the question of the charges for the use of the trunk wires, which were those now in existence. At present they had no express messengers at the post offices to carry telephonic messages except in some parts of London.

The Chairman: The effect of the present arrangement is to play into the hands of the National Telephone Company?—No; it is not the law of the Medes and Persians. The present arrangement is simply arrived at as the result of a real consideration of what the public demands are.

Is it not a fact that under the present arrangement a telephonic message can only be sent to a subscriber of the National Telephone Company in Glasgow?—No.

To whom can it be sent?—It can be sent in the same way as it is frequently sent to Paris. That is, the correspondent at the other end attends the call office and receives the message.

But how does he know when to attend?—There are arrangements made for the regular attendance every morning of people who have business to do.

Are there the same arrangements in Glasgow?—I do not know; but it would be possible.

Mr. Cohen pointed out that that would not cover the point put forward by the chairman. How would a person not expecting a message know a message was being sent?

Witness said it was a usual thing for a telegram to be sent asking the person to attend at the call office.

The Chairman: Not a very business-like arrangement.

Witness said it was the custom. He considered there was no demand for the express messengers to carry telephonic messages. If there was a demand he would like to know where it was.

The Chairman: Do you see any difficulty in extending the system of telephonic communication by express messengers apart from the effect it would have on the telegraphic revenue?—I do not think there are any other difficulties.

Continuing, Witness said the trunk system had gone on extending since 1896. Thirty extensions had been carried out or were being carried out under guarantee by the company. The miles of wires purchased for the company were 29,000. The miles of wires constructed were 24,526. The mileage in course of construction at the present time was 4,647 miles. The mileage guaranteed was comparatively small. With regard to the areas of the company, the principles adopted in making them were as follows:—(1) Industrial areas of wide extent should be recognised in cases where there are any considerable towns forming centres of business. (2) That neighbouring towns intimately connected with one another in business relations should be included in the same areas; and (3) That small towns and villages in any one of which it would be hopeless to establish a local exchange system unless there was some cheap means of communication with each other, should be grouped together in one area. All urban districts were areas in themselves. Pretty well the whole of the country was divided into areas in which the National Telephone Company had the power to establish an exchange without further license. The company was under no obligation to start an exchange, but the Post Office could grant a license to any other body to start an exchange. Since the agreement was signed in 1896 in only one case had the monopoly of the telephone company been broken down, viz., in Guernsey. The charges there were low, but he did not know that they were lower than the company was prepared to supply the service at. Changes had been made in the areas from time to time, the tendency having been to rather increase the area. The largest area was the London area. Before the company was confined to areas, they had to a large extent arranged themselves in areas, and the London area was in existence. The area was not nearly so big as in some places abroad. There was no limit on the discretion of the Post Office as to laying trunk wires. The only effect a large area had was to reduce the use of short trunk wires. In a number of those areas they had Post Office exchanges competing with the National Telephone Company's exchanges. The principal exchange was at Newcastle-on-Tyne, where they had 626 subscribers. The number of subscribers to the National Telephone system in Newcastle-on-Tyne was much larger. The charges of the Post Office were: For business houses, £8 within half a mile of the exchange, £9 within three-quarters of a mile, and £10 within a mile. He believed the charge of the company was a uniform one of £10. Previous, however, to October of last year the Post Office charged £10 for half a mile, £12 for three-quarters of a mile, and £14 for a mile. The Post Office charges were based on what was supposed to bring in a profit to the tax payer. They were not allowed to canvass, and were not allowed to give preference to firms. The company gave preference, but he did not consider it was the business of the Post Office to complain. He could not say to what extent the preferences had been given by the company. The reduction in the price at Newcastle was bringing them an increase in the number of subscribers. They had offered to put their subscribers at Newcastle in communication with the subscribers of the company, but the company were not willing that that should be done. The Post Office had no legal power to insist upon such a connection.

Questioned by Mr. Stuart, Witness said it would not be possible for the Post Office to lay a trunk line of a few yards in Newcastle and so join their system to the National Telephone system. A trunk line was defined as a line used to connect one area with another.

The Chairman: Do you know any towns where there is competition in which the price charged is lower than where there is no competition?—I do not think that is so.

You do not think competition has had any effect upon their prices?—I cannot tell what effect it has, but as a matter of fact the company's charges are higher in Newcastle than in other towns, probably because they are smaller towns.

Mr. Cohen: Is it not a fact that their prices are based on your charges?—I think that is so.

The Chairman: You have been in unequal competition owing to higher rates?—Yes.

Without disclosing secrets could you tell the committee whether you have made any loss?—No.

And we may say you have made a fair profit?—Yes.

Although there are two competing systems?—Yes.

Are the charges of the company higher in Cardiff and Swansea?—For certain distances I think they are.

Questioned by Mr. Bartley, Witness said the company considered it their duty to fall in with the policy of the Government when the heads of agreement were drawn up, and he did not wish the impression to go forth that they purposely put difficulties in the way.

As regards sending Post Office messengers in London and not in other parts of the country, who authorised that arrangement?—The idea was to give a local service, and it was set forth in a Treasury minute. The whole service was contemplated as a local service, and the question of doing it between one town and another was not in the minds of those who did it.

How does it differ from sending from one town to another?—The impression I suppose was that the telegraph was sufficient to meet that.

Mr. Cawley: Is it in the interest of the public that the National Telephone Company should not have the competition of the Post Office?—I find it very difficult to answer that question. My opinion is that it is very undesirable for a private company to have a monopoly. On the other hand, I am firmly convinced that the establishment in one town of competing systems of telephones would not be in the interests of the public. My opinion is that the whole thing should be in the hands of the Post Office.

Sir J. Woodhouse: You agree there is no obligation imposed by the Post Office, either in the original license or by any agreement with the Telephone Company that they should supply the company with the facilities for which they are licensed?—Yes.

Therefore in two respects; first, no obligation to supply, and secondly, no restriction as to the charges to be made, it does not differ from any other monopoly granted?—The whole arrangement differs.

But don't you agree that it has been very much to the disadvantage of the public?—I think it has been.

Did I understand you to say with regard to the agreement of 1892, that Sir James Ferguson took one line of action, and the Government another?—No.

Do you mean that the Department would have taken one action and Sir James Ferguson another?—No. What I mean is that Sir James Ferguson was requested by the Government to carry out a certain line of policy, and he did so.

What was the difference?—The policy of the Department was to purchase the whole of the National Telephone Company's undertaking.

And the policy of the Government was to take only the trunk system?—Yes.

And the tendency of the policy of the Government was to discourage competition?—That was the tendency.

Further examined by Sir J. Woodhouse, Witness said there was no effective competition between the New Company and the National, for the New Company had no exchange. The competition in Manchester was a very feeble competition. The tendency of the policy of the Post Office since 1892 had been towards making the National Telephone Company a monopoly, but at the same time all the rights of the Postmaster-General had been fully preserved. The heads of the 1892 agreement were brought before the House of Commons in 1894 when it was laid on the table. The Treasury Minute lay in the House in May, 1892, and the Bill to raise the money for the purchase came before the House on May 26th, 1892. The agreement was signed August 11th, 1892, and the Postmaster-General went out of office on August 19th. The agreement was signed the day the vote of censure on the Government came in.

By Mr. Colville: Some of their subscribers in Newcastle had been obliged to become subscribers also to the National Telephone Company.

By Mr. Boscawen: General application had been made by local authorities and other companies for licenses to start telephonic services in different towns, and they were ready to comply with the terms of the Treasury minute. The Postmaster-General had been in consultation with the Chancellor of the Exchequer on the subject, and they had not seen their way to granting those licenses. He thought they had considered each case and had arrived at the conclusion that they were not justified in granting the request. They had received applications from the Corporations of Glasgow and Tunbridge Wells and Manchester, and in Glasgow it was admitted that the service was defective.

Mr. Boscawen: Yet in no case has a license been granted?—No.

Consequently, the condition in the minute is practically a dead letter?—The right is there still.

Is the right of any use if it is not carried into effect?—I think it is.

Is it the intention of the Post Office in the case of future applications to refuse as the previous ones have been?—I think that is a question that the chairman could answer better.

Have you any different line of policy in the Post Office?—I must decline to answer that, unless the chairman instructs me.

Have not the Telephone Company taken the cream of the country?—They began in that way, but they are extending their services.

Proceeding, Witness said he would not allow municipal bodies to establish telephonic systems in places where there was no service, but would leave it to the Post Office. The Post Office had not established many services of late years, because there was no demand for them. From their own point of view, the company had pursued the wise policy of getting the leading men of different places to work with them. He did not know the means employed, but it was the outcome of a bad system. From a commercial point of view, it was not an unreasonable system for the company to adopt. His remedy would be to take over the whole system, and put it in the hands of the Post Office.

By Sir H. Howorth: When the legal proceedings against the Telephone Company were going on the Post Office submitted proposals to the Treasury for establishing telephones, and in a letter dated December 16th, 1880, the Treasury consented on the understanding that it would enable the Department to negotiate satisfactorily with the telephone companies. He believed that great inconvenience to the public would arise if they had competitive systems in different places. It would probably take eight or nine years for the Post Office to establish a really proper competitive system over the country. In Sweden the State had bought up all the local districts, with the exception of one. In France there was no private company, and in Italy there never had been a private system. The only place where there was a municipal service was Holland, and in that country the trunk lines were in the hands of the Government. Some facilities had been given by the Government to the Telephone Company outside the agreement.

NEW HAVEN STREET LIGHTING.

The average reports of city lighting committees are not absorbingly interesting documents, but once in a while we (New York *Electrical Engineer*) come across one that gives us some real information. An example of such is the 1897 report of the Committee on Lamps of the city of New Haven, Conn., just issued. As the lighting of this city is in most intelligent hands a closer inspection of this report will prove of value to lighting committees and central stations as well. New Haven is lighted by three systems, gas, naphtha, and electric; there being 442 arc lights, 105 Welsbach, 633 plain gas and 512 naphtha lamps. All lighting is done by contract with private companies. The city is now paying $98·55 per arc light of 1,200 C.P., the electric lights being lighted at dusk and extinguished at dawn every night in the year, thus covering 4,000 hours of burning. Regarding the question of complaints due to outages, &c., we notice that from these various causes gas gave rise to 1,168 complaints, naphtha 709, electric lights 401. Quite a marked percentage of these complaints were due to the effect of a high wind last November, in which, however, the electric light showed up remarkably well. While none of these were out or broken, the Welsbachs showed one out, plain gas showed eight out and one broken, while naphtha showed 77 out, for that one night. During the whole year 278 lamps were reported out at various times, of which 50 occurred in a single night during February, 1897, when one of the circuits was broken by a falling tree during an extraordinarily high wind. Considering that the total number of electric lamps is 442 burning every night, and that only 278 lamps were reported out during the entire year, the record is a very good one. That the service must have been excellent is strongly evidenced by the fact that the entire amount deducted during 1897 from the bills of the electric light contractors was only $21 33.

In his very able comments on the figures presented, Mr. Henry Hopkins, Superintendent of Street Lighting of New Haven, states that the service rendered by the electric lighting contractors has been of a high grade. Mr. Hopkins also has something to say on municipal ownership of electric lighting plants, and as we believe his motives will not be questioned by any one who has followed his career, his opinion is worth recording. Mr. Hopkins says:—"From what data and facts I have been able to obtain on both sides of the subject, I would say, that until the time comes when more information and accurate facts can be obtained, it would not be good business policy to enter into any such project. The recent showing up of the Philadelphia Municipal Gas Works amply sustains my belief, and ardent supporters of municipal ownership must have received a severe shock. And it is only one of many cases that could be quoted." Coming from a city official, this is a most encouraging sign that there are still many clearheaded men in municipal employ in America.

Electric Power for Mines Drainage. — A second scheme for unwatering the Tipton mines was enunciated before the South Staffordshire Mines Drainage Commissioners on Wednesday last week. It was explained that the first scheme had gone as far as it would at present. The drainage of the level had not quite had the anticipated effect. They expected it would fetch out at least 3,000,000 gallons, whereas it had only brought a third of that amount. The question they had to decide therefore was what was to be done in regard to the unwatering of the mines, seeing that they could not expect by any reasonable amount of levelling to attain the end they desired — in fact, the cost of driving levels into every proprietor's colliery would be larger than could be met by the funds the Commissioners had at their command. It was, however, absolutely necessary that they should deal with the water in some way or other. The original Tipton district engineering scheme was to have two large pumping engines at different stations, and an extensive hydraulic system whereby they could pump from various points in the district which were not reached by the main engines. Since the scheme was propounded, the Midland Electric Corporation for Power Distribution, Limited, had tried to establish themselves in the district, and if they succeeded, as they believed they would, the Commission, instead of having to find a large capital for an hydraulic system, besides the heavy cost of maintenance, would get a supply of electrical power at so much per unit, whilst the capital outlay would be considerably less. It appeared most desirable, if the Electric Power Company came into the district, that they should take advantage of their scheme, in order to drain the surface at points where at present water got into the mines because they were lower than the brooks, and at which no amount of levelling would be thoroughly effective. Their general manager (Mr. E. Howl) and surface works engineer (Mr. E. B. Marten) had gone carefully into the question, and found that there were at the present time about 50 points in the district below any drainage, where reservoirs could be made and pumps started driven by electrical power. By having these stations and electrically-driven pumps to deal with excessive rainfalls quickly, it was believed that the quantity of water now getting into the mines would be reduced by about one-third, which would be a great saving. They were now pumping, roughly, about 9,000,000 gallons every 24 hours, and if the suggested scheme could be carried out this quantity would be reduced to about 6,000,000 gallons, which their present engines could cope with. Then it was proposed to deal with that water which found its way into the mines, but would not flow to the main engines, by a system of semi-portable engines taken, by arrangement with proprietors, to collieries where they were most required. Probably eight or ten such pumping stations would drain the whole district, and enable mines to be worked that were now under water. The Commission had obtained authority to spend £100,000 on the Tipton district engineering scheme, but up to the present they had not spent much of this amount. It was calculated that the capital sum required to provide the 50 pumping stations would be about £20,000, in addition to which there would be the price to be paid to the company for the supply of the electrical energy and the cost of looking after the various stations. The sooner, the chairman added, the Electric Company came forward and helped the Commission out of their difficulty the better. The company had offered the Commission terms which were satisfactory, and he sincerely trusted that they would be able to carry out their proposals.

Electric Launches.—We understand that the British Electric Traction Company have undertaken the control of the Immisch Electric Launch Company, and that launches can now be booked at Donington House, Norfolk Street, Strand. The Immisch Launch Company, who were the pioneers of the electric launch business, now possess a fleet of over 20 launches, which are acknowledged to be the finest on the river Thames. An interesting descriptive and illustrated pamphlet, giving full particulars as to rates, and much useful information to frequenters of the river, can be had on application. The headquarters of the company are still at Platt's Eyot, Hampton.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, June 1st.	Closing Quotation, June 8th.	Business done during week ended June 8th, 1898. Highest.	Lowest.
137,400*l*	African Direct Telegraph, 4 % Deb.	100	4 %	...	...	100 —104	100 —104	...	...
25,000	Amazon Telegraph, shares	10	...	...	...	7 — 8	7 — 8	...	...
125,000	Do. do. 5 % Debs. Red.	100	...	...	...	93 — 96	93 — 96	...	...
923,960*l*	Anglo-American Telegraph	Stock	£2 9s	£2 13s	3 %	64 — 67	64 — 67	65½	64½
3,038,020*l*	Do. do. 6 % Pref.	Stock	£4 18s	£5 6s	6 %	115 —116	115 —116	116	115⅛
3,038,020*l*	Do. do. Deferred...	Stock	...	...	...	15¾— 16¼	15¾— 16¼	16¼	15⅝
130,000	Brazilian Submarine Telegraph	10	7 %	7 %	7 %	15½— 16	15½— 16	15⅝	15½
75,000*l*	Do. do. 5 % Debs. 2nd series, 1906 ...	100	5 %	...	...	112 —116	112 —116	...	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	4 %	...	2¾— 3¼	2¾— 3¼	...	...
10,000,000$	Commercial Cable	$100	7 %	8 %	8 %	180 —190	180 —190	...	...
918,297*l*	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	104 —106	105 —107	106½	105¾
224,850	Consolidated Telephone Construction and Manufacturing	10/-	1½%	2 %	...	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Telegraph	10	8 %	8 %	7 %	6½— 7½	6½— 7½	7	6½
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	14½— 15½	14½— 15½	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 11	10 — 11	...	...
30,000*l*	Do. do. 4½ % Debs., Nos. 1 to 6,000 ...	50	4½%	4½%	4½%	103 —106%	103 —106%	...	...
60,710*l*	Direct United States Cable	20	2¼%	2½%	...	10½— 11	10½— 11	10¾	10 9/16
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	100—103	100—103	102½	102¼
400,000	Eastern Telegraph, Nos. 1 to 400,000	10	6½%	6½%	...	17 — 17½	17 — 17½	17⅜	17
70,000	Do. 6 % Cum. Pref.	10	6	6 %	...	18 — 19	18 — 19	18½	...
89,900	Do. 5 % Debs., repayable August, 1899 ...	100	5 %	5 %	...	101 —104	101 —104	...	...
1,302,615*l*	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	124 —128	124 —128	126	...
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	17½— 18	17½— 18	17⅞	17⅝
25,200*l*	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	5 %	5 %	100 —104	100 —104	...	...
100,500*l*	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	5 %	5 %	101 —104	101 —104	...	...
320,000*l*	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	126 —129	126 —129	...	...
35,100*l*	Eastern and South African Telegraph, 5 % Mort. Deb., 1900 red. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	...	100 —104	100 —104	103¾	...
46,500*l*	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	...	101 —104	101 —104	...	...
300,000*l*	Do. 4 % Mort. Debs., Nos. 1 to 3,000, red. 1909	100	4 %	4 %	...	101 —104	101 —104	102	...
200,000*l*	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	4 %	4 %	...	105 —108	105 —108%	...	...
180,227	Globe Telegraph and Trust	10	4⅛%	4½%	4½%	11¼— 11¾	11½— 12	11⅞	11 9/16
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6 %	16½— 17	16¾— 17¼	...	...
150,000	Great Northern Telegraph, of Copenhagen...	10	10 %	10 %	10 %	28½— 29½	29 — 30	29 5/16	29
160,000*l*	Do. do. do. do. 5 % Debs. ...	100	5 %	5 %	5 %	100 —103	100 —103	102¾	...
97,000	Halifax and Bermuda Cable, 4½ % 1st. Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	98 —103	98 —103	101¾	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	50 — 53	50 — 53	...	...
100,000*l*	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	6 %	6 %	108 —111	108 —111	...	...
28,000	Montevideo Telephone, 6 % Pref., Nos. 1 to 28,000 ...	5	4 %	4 %	4 %	2¼— 2¾	2¼— 2¾	...	...
484,597	National Telephone, 1 to 484,597	5	5½%	5½%	6 %	5½— 5¾	5½— 5¾	5¾	5⅝
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	14 — 16	14 — 16	14¾	14⅝
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5⅜— 5⅝	5⅜— 5⅝	5½	...
1,329,471*l*	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	101—106	101—106	...	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	⅝— ¾	⅝— ¾	...	...
100,000*l*	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	4 %	4 %	4 %	105 —108	105 —108	104½	...
11,839	Reuter's	8	5 %	5 %	5 %	8 — 9 xd	8 — 9	8⅛	...
3,381	Submarine Cables Trust	Cert.	...	...	...	136 —141	136 —141	...	...
58,000	United River Plate Telephone	5	4 %	5 %	...	4 — 4½	4 — 4½	...	...
146,733*l*	Do. do. 5 % Debs.	Stock	5 %	...	...	104 —107	104 —107	...	...
15,609	West African Telegraph, 7,501 to 23,109	10	4 %	*nil*	*nil*	3½— 4½	3½— 4½	...	...
213,400*l*	Do. do. 5 % Debs.	100	5 %	5 %	5 %	99 —102	99 —102	...	...
64,269	Western and Brazilian Telegraph	15	3 %	2 %	3¼%	12 — 12½	12 — 12½	12¼	12 1/16
33,129	Do. do. do. 5 % Pref. Ord.	7½	5 %	5 %	5 %	7½— 8	7½— 8	7⅞	...
33,129	Do. do. do. Def. Ord.	7½	1 %	*nil*	½%	4 — 4½	4¼— 4¾	4 7/16	4⅜
389,521	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	104 —107	104 —107	...	...
88,321	West India and Panama Telegraph	10	⅞%	1 %	¾%	½— ¾	½— ¾	⅝	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	6 %	6 %	7¼— 7¾	7¼— 7¾	7 11/16	7 1/16
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	6 %	6 %	5 — 7	5 — 7	...	...
80,000*l*	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	5 %	106 —109	106 —109	...	...
1,163,000$	Western Union of U.S. Telegraph, 7 % 1st Mort. Bonds	$1000	7 %	7 %	7 %	103 —108	105 —109	...	...
160,100*l*	Do. do. do. 6 % Ster. Bonds ...	100	6 %	6 %	6 %	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

Present Issue.	NAME.	Stock or Share.	1895.	1896.	1897.	Closing Quotation, June 1st.	Closing Quotation, June 8th.	Highest.	Lowest.
30,000	Charing Cross and Strand Electricity Supply	5	5 %	6 %	7 %	12 — 13	12 — 13	12½	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	...	...
26,000	*Chelsea Electricity Supply, Ord., Nos. 1 to 10,277... ...	5	5 %	5 %	6 %	8½— 9½	8½— 9½	8¾	8½
60,000	Do. do. do. 4½ % Deb. Stock Red....	Stock	4½%	4½%	4½%	115 —117	115 —117	...	...
50,000	City of London Electric Lighting, Ord. 40,001—90,000 ...	10	5 %	7 %	10 %	24½— 25½	24½— 25½	25¼	24¾
10,000	Do. Prov. Certs. Nos. 90,001 to 100,000 £5 ...	10	...	...	...	16½— 17½	16½— 17½	16⅞	16½
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16½— 17½	16½— 17½	16⅞	16⅝
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	129 —134	129 — 134	...	...
30,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—30,000	10	*nil*	*nil*	*nil*	13 — 14	13 — 14	13¾	13⅜
10,000	Do. do. do. Nos. 30,001 to 40,000 £4 paid.	10	...	...	...	6½— 7½	6½— 7½	6¾	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	15 — 16	15 — 16	15¼	...
17,400	Edmundsons Elec. Corp., Ord. Shares 1—17,400 £4 paid	5	...	...	...	3½— 4½	3½— 4½	...	...
10,000	House-to-House Electric Light Supply, Ord., 101 to 10,100	5	...	...	4 %	9 — 10	9 — 10	...	...
10,000	Do. do. 7 % Cum. Pref. ...	5	7 %	7 %	7 %	11 — 12	10½— 11½	10⅝	...
62,400	*Metropolitan Electric Supply, 101 to 62,500	10	4 %	5 %	6 %	16 — 17	15 — 16	16⅜	15 5/16
220,000*l*	Do. 4½ % First Mortgage Debenture Stock	...	4½%	4½%	4½%	117 —121	117 —121	...	...
6,452	Notting Hill Electric Lighting	10	2 %	4 %	6 %	18½— 19½	18 — 19	19	...
31,980	*St. James's and Pall Mall Electric Light, Ord.	5	7¼%	10½%	14½%	16 — 17	16 — 17	16⅝	16¼
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	10 — 11	9½— 10½	...	...
50,000	Do. do. 4 % Deb. Stock Red. ...	Stock	...	...	4 %	107 —110	107 —110	...	...
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2 — 2½	2 — 2½	2 7/16	2 5/16
79,900	Westminster Electric Supply, Ord., 101 to 80,000 ...	5	7 %	9 %	12 %	16 — 17	15½— 16½	16⅛	15⅝

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation June 1st.	Closing Quotation June 8th.	Business done during week ended June 8th, 1898. Highest	Lowest.
30,000	British Electric Traction	10	...	...	...	15½— 16	15½— 16	15½	...
10,000	Do. do. 6 % Cum. Pref. 30,001—40,000 £4 pd. (issued at £2 10s. prem. all pd.)	10	...	...	...	7 — 8	7 — 8	7⅝	7½
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	3	2½%	*nil*	*nil*	1¾— 2	1⅞— 2⅛	1⅞	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	*nil*	4 %	2¼— 2½	2¼— 2½	2 5/16	2¼
125,000*l*	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	110 —114	110 —114	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red. ...	Stock	...	...	...	101 —104	101 —104	...	...
19,894	Central London Railway, Ord. Shares	10	...	...	...	10 — 10½	10 — 10½	10½	10¼
129,179	Do. do. do. £6 paid	10	...	...	...	6 — 6½	6 — 6½	6¼	...
59,254	Do. do. Pref. half-shares £1 paid ...	...	...	...	...	1¼— 1¾	1¼— 1¾	1 9/16	...
67,680	Do. do. Def. do. £5 paid ...	...	...	...	...	4¼— 4¾	4¼— 4¾	4⅝	...
630,000*l*	City and South London Railway	Stock	1 3/16 %	1 9/16 %	1⅞ %	68 — 71	68 — 71	70⅛	69½
82,850	Crompton & Co., 5 % 1st Mort. Reg. Debs., 1 to 743 of £100, and 901 to 1,070 of £50 Red.	...	...	...	...	... ...	88 — 93	91¾	...
99,261	Edison & Swan United Elec. Lgt., "A" shares, £3 pd. 1 to 99,261	5	5 %	5½%	...	2¼— 2¾	2¼— 2¾	2½	...
17,139	Do. do. do. "A" Shares, 01—017,139	5	5 %	5½%	...	4 — 5	4 — 5	4 11/16	...
194,023	Do. do. do. 4 % Deb. Stock Red. ...	100	...	...	...	103 —105	103 —105	...	...
110,000	Electric Construction, 1 to 110,000	2	5 %	6 %	...	2⅝— 2⅞	2⅝— 2⅞	2⅝	...
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 ...	2	7 %	7 %	...	3⅛— 3⅜	3⅛— 3⅜	...	...
111,100	Do. do. 4% Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	106 —108	106 —108	...	...
91,196	Elmore's Patent Copper Depositing, 1 to 70,000	2	...	...	...	½— ¾	½— ¾	...	...
67,275	Elmore's Wire Manufacturing, 1 to 69,385, issued at 1 pm.	2	...	...	...	⅜— ⅝	⅜— ⅝	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	10½%	7 %	7 %	9 — 11	9 — 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ord.	10	8 %	12 %	10 %	21½— 22½	21½— 22½	22¼	22
3,000	Do. do. do. 7 % Pref.	10	7 %	7 %	7 %	18½— 19½	18½— 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½%	4½%	4½%	110 —115	110 —115	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	10 %	21 — 22	21 — 22	22	21⅜
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	102 —106	102 —106	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	2⅞%	2⅞%	3¼%	10⅝— 10¾	10 7/16— 10 9/16	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15¾— 16¼	15¾— 16¼	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	34 — 37	34 — 37	...	...
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105	103	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	...	...	132 —135	130 —133	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 10½.
House-to-House, 4½% Debentures of £100, 107—110.
Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 15—16; 1st Preference Cumulative 6%, £5 (fully paid), 8—8½. Debentures, 107—110. Dividend, 1897, on Ordinary Shares 10%.

* From Birmingham Share List.

London Electric Supply Corporation, £5 Ordinary, 3½—4.
*T. Parker, £10 (fully paid), 15¼.
Yorkshire House-to-House Electricity, £5 Ordinary Shares fully paid, 8—8½. Dividend for 1896—6 %.

Bank rate of discount 3 per cent. (June 2nd, 1898).

THE MUNICIPAL ELECTRICAL ASSOCIATION, 1898.

SWITCHBOARD APPARATUS.*

By J. R. Blaikie, Chief Assistant Electrical Engineer, Bristol.

The control and measurement of electric energy is one of the most fascinating details of this branch of engineering.

The switchboard, with its glittering array of polished metal and graduated dials, has always an attraction for the lay mind, while its intricacy or beautiful simplicity is a source of wonder or poetic appreciation to those better acquainted with such devices.

Almost every station has some noticeable peculiarity with regard to its switch gear, and there are few stations that have not lived to see radical changes brought about in this portion of the original scheme. The result at the present time is that it is almost impossible to classify the types now in use. This striking nonconformity, although intensely interesting, is not particularly happy, since it appears to show either ignorance or vanity on the part of the designers.

One must admit that the spirit of commercial industry is to suppress varieties in favour of a standard. It would be ridiculous to suppose that the mere straining after novelties has been the whole cause of the present multifarious assortment. Switchboards have been conscientiously designed and constructed to suit individual cases, simply because there was no general standard that might be adopted. After certain results and experiments, modifications and improvements have been gradually introduced. But this form of private research work is too frequently misguided and uneconomical. The experimenter cannot, as a rule, afford to test a portion of his work to destruction. So long as it answers his immediate purpose he is satisfied.

A certain elegance of variety and some treasures of ingenuity must be sacrificed to further the march of scientific progress. One must be content to labour in a vast organisation and strive towards a higher ideal than a more or less original switchboard. It is hard for a young enthusiast to surrender an opportunity for displaying a capacity for design in a field of such unlimited possibilities. It is far easier for him to imagine that there are peculiar necessities and requirements in the case under consideration; but seeing that there are life risks, and that the very heart of the undertaking lies in the switchboard, surely it should be the outcome of the strongest possible combination of experience, and beyond the reach of individual fancy.

* Read June 8th.

Before dealing with the disposition of the component parts of the switch gear, it might be well to inquire into the duties and characteristics of the details.

The necessity for ever breaking a circuit while carrying much energy is not universally granted. For example, Prof. Forbes, in his paper on "The Electrical Transmission of Power from Niagara Falls," November 9th, 1893, says: "I hold that it is a piece of culpable ignorance, ruinous to the machinery, if anyone should ever, on a large power circuit with alternating current, suddenly break the circuit while current is passing. The practice is quite unnecessary, and has given rise to a large proportion of the breakdowns of alternating current machinery." Nevertheless, there are switches at Niagara (see *Cassier's Magazine*, page 291, Niagara number) capable of breaking 5,000 horse-power, without damage to themselves, &c. Prof. Fleming agrees with Prof. Forbes, but he asks what happens if the circuit opens itself, and what is to be done about fuses. Unfortunately Prof. Forbes omits these points in his reply.

In practice, of course, one never opens a circuit conveying much energy, unless some unforeseen circumstance throws the whole or a portion of the machinery out of the usual control. Could not such emergencies be met by inserting a moderate amount of resistance or impedance in the circuit, increasing either by degrees, if necessary? The same might apply to cut-outs when they are under the observation of an attendant. In the author's opinion main switches should work through steps in this manner, making it impossible to make or break with large currents.

Assuming, as is customary, however, that a sudden break is necessary, or that the switch is in such form that a sudden break could be made by a mistake, or accident, on the part of the attendant, while transmitting a large amount of energy, the essential characteristics of the design appear to be as follows:—

1. That there shall be no danger to the operator, either by electric shock or from particles of molten metal flying free, this latter to apply to adjacent apparatus as well.
2. That there shall be no maintained arc.
3. That the contacts shall not be burnt or injured, in such a manner, as to prevent the efficient working of the switch on closing again.

4. That the contacts and current carrying portions of the switch shall always be in such a condition that no heating will occur while carrying the maximum current for an indefinite period.

With reference to the first condition there are several well known satisfactory examples. The plug form having a large insulating handle and shield, the breaks being in earthenware pots, gives a pretty certain immunity from danger. A sufficiently long handle or mechanism actuated by cords can be considered safe.

Another method is to mount a plate glass screen between the operator and the breaking contacts, but this does not protect the other apparatus.

To secure a certainty of break many contrivances have been devised. The simplest means is a sufficiently long air-gap in the circuit.

For the sake of eliciting the opinions of the gentlemen assembled, some breaks (total length) for various conditions are suggested, assuming that the breaks are made with considerable and uniform rapidity.

Amperes	100 to 300 volts alternating or continuous.	500 to 1,000 volts continuous.	2,000 volts alternating.
	Inches.	Inches.	Inches.
5	¾	4	4
25	1	6	6
50	1¼	8	10
75	1¾	10	12
100	2	12	13
150	3	12½	14
200	4	13	15
300	5	14	16
400	6	15	18
500	7	16	20

(When these breaks are in the tubes, and so protected from air currents, it might be well to add, say, 50 per cent. to the length of the gap, and the same if the breaks are in a vertical direction.)

The air-gap may be in one line, but in order to save space and ensure a rapid break, it is more frequent to have several breaks made simultaneously in a circuit. It is not safe, however, to draw out two or more arcs, close together in air, without a substantial fireproof insulator between, as a slight current of air will blow them together, and thus defeat the action of the switch.

The plug switch becomes rather too cumbrous in large sizes since the sockets must be very deep or the plugs must be spaced out considerably.

One very happy solution is the use of an electro-magnet in the main circuit to blow out the arc when it is formed. Another effective, though perhaps rather complicated means, is the application of a shutter, or clapper, which flies through the path of the arc and blows it out with the air currents set up. Some other designs cause the circuit to be broken under water or an insulating oil, but to the author this appears to be a last extremity, as there are obvious objections to the use of a liquid.

To satisfy the 3rd condition "that the contacts shall not be burnt, &c.," is a comparatively simple matter. The rate of breaking is a primary consideration, though it may not apply so forcibly in the case of the alternating currents. The use of springs, or the multiplicity of simultaneous breaks, suggests itself at once. A liberal weight of metal, or the proximity of a good heat conducting fireproof insulator, reduces the temperature of the arcing points somewhat. As an extra precaution, the blades are usually made of wedge shape, and plugs are tapered, so that they may clear themselves more or less on returning, by shearing off the small globules of metal left on the contact faces. It is therefore desirable that the mechanism should be able to withstand such strains, and so proportional that sufficient force can be applied. Another way of overcoming this difficulty is to provide auxiliary contacts which break just after the main contacts, and so carry the arc. These contacts may be merely butting surfaces, which are not much the worse for being burnt, or provided with easily renewable faces, or some material having a high melting or volatilising point; such as carbon.

The degree, in which the various switches on the market meet this requirement, is readily seen.

The current-carrying capacity of the contacts is of the greatest importance, since a defective contact deteriorates at a sort of compound interest law. Taper plugs and spring jaws almost invariably share this responsibility. When one reflects that trouble from this source may loosen the whole contact from the board by destroying an ebonite bush, melt the solder from a sweating thimble, and allow a cable to fall, or even render the handle of the switch useless or unsafe, there is enough material for serious thought. In addition to this, there is not a very far remote chance of fire. Possibly there may have been few accidents up to the present time from this cause, owing to the newness of the apparatus, or from the fact that many switches are not working up to their full capacity. Certainly in point of design this is one of the weakest features. In some instances, the spring in cast brass and copper, without any means of adjustment for wear, is all that can be relied upon. In the case of four plugs rigidly fixed to a handle there are instances where they are supposed to go tight home into four *fixed* conical sockets. There are a few relics of the dark ages, when current was allowed to pass through the hinge or pivot of a switch. Of course there are contacts of the laminated type, built up of hard drawn or hammered copper, which are admirably suited to their purpose. As a general conclusion, under this heading, it appears that it is advantageous to have few, preferably only one breaking contact in a circuit, which can easily be arranged by means of flexible connections. This arrangement gives the operator an opportunity of feeling the condition of the spring contact while forcing the switch home.

It has occurred to the author with reference to this subject, that there might be a useful application of a well-known invention of a paint which changes colour on heating.

The merits and risks of automatic apparatus open a very wide question. Where springs are employed, they should only be strained through a small part of their range, and carefully secured from all possible chances of getting heated, either by current passing through them, or by conduction or radiation from other sources. There should also be some provision for retaining the spring, or parts of it, should it happen to break. A single speck of rust on a steel spring will sometimes cause it to break; but the reliability of such springs as are used in watches and rifle locks may be urged in favour of their use when thoughtfully applied. Weights released by triggers and catches are frequently used with success, but the inertia may sometimes be a drawback. Special attention should be paid to hinges, &c., in such apparatus, since a slight defect may alter the adjustment, or foul the whole mechanism. In switch work it is quite common to have brass working on brass, both of the same composition; this is sure to cut and bind in time. When it comes to talking of an automatic appliance that does not work, adjectives fail. Another point sometimes neglected is the provision of suitable buffers, or arrangements for taking up the mechanical shock or jar. Unfortunately nearly all insulating materials are mechanically weak, so they should never be subjected to rough usage. In most cases these switches are set by hand, and can therefore have strong reliable contacts. Where they have to be operated at a distance by means of a small current, the contacts are a serious trouble. An accumulation of small impulses can be used, or the much-abused mercury cups have to do duty. There are details in mercury cups, however, which make all the difference. The cups should be of iron nickel-plated, the copper forks should also be nickel-plated, and be shaped to cause as little splashing as possible.

For large currents and high voltages a multiplicity of breaks should be employed, so that a comparatively low speed will be sufficient. The author has had under his notice a switch for 15 amperes, 100 volts, in daily use for about three years. Three others, one for 15 amperes, 200 volts, the other two from 8 to 15 amperes, 100 volts, for 18 months. All these switches have given complete satisfaction, and up to the present time have required absolutely no attention.

Switches requiring a shunt coil permanently in circuit are generally looked at askance, not for the sake of the coal here represented (though one does sometimes hear about the fuel consumed by a voltmeter) but mainly because the shunt coil has been known to break down.

If it were recognised that a coil will not stand unlimited cooking at, say, 150° F., that it is subjected to high pressure strains, due to induction at times, and that in the case of alternating currents, the wires must be specially supported and secured to resist the tendency to vibrate, then perhaps a coil could be made worthy of the occasion. What may be good enough for a single arc lamp is not good enough to bear the reputation of a cental station.

So much for main switches. Plug connections have some points in common, though the problem is very much simpler. A taper plug between two blocks of metal, although almost universal for laboratory instruments, is rarely, if ever, used on a switchboard. A spring clip made to sandwich two projecting tongues is sometimes used, but the most usual form is a screw plug to connect bars on the back and front of a slate panel. Another form connects a back and front board by pushing a parallel plug through spring contacts. Ample weight of metal will, in most cases, make a sound connection, since there is nothing to impair the original fit.

For very heavy currents, perhaps, in the case of screw plugs, it may be well to have a spanner appliance instead of the ordinary fluted handle. The fire risks should also be considered, in the event of a plug being taken out by accident while carrying a current. Facilities for replacing a portion of the bars damaged in this way would be advantageous.

Fuses, although so simple in conception, are often one of the most troublesome details. For low tension circuits certainly the problem seems elementary, yet there are cases where links of copper as large as the mains have been substituted for fusible metal.

There is a difference of opinion as to the most suitable metal for a fuse. Tin, lead, and copper are generally employed. Then comes the question as to whether a thin strip, a single wire, a number of single wires stretched parallel to each other, or a number of small wires twisted together, makes the most reliable fuse.

The purity of the metal is also of great consequence. In designing a fuse, the objects in view are:—

1. Safety to attendants and adjacent instruments from molten metal or splintered insulating material.
2. A positive break in the circuit when the fuse does melt.
3. An accurate knowledge of the capacity under the condition of its mounting.
4. Durability.
5. A safe, simple, and rapid means of replacing.
6. Mechanical strength, rendering it independent of skilled or specially careful handling.
7. Protection from other sources of heat from imperfect contacts, &c.
8. Compactness.

Taking a few common examples, they are mostly defective in one or two points.

The tin strip reduced in section at the centre is generally suitable for low tension work, but it is almost invariably unprotected, and frequently in such a position that it will blow right in an attendant's face if he should happen to close a switch on a "short circuit."

This type is the most durable, and the most accurately gauged, but if a large range of sizes is required it is a nuisance to have to keep so many spares, especially as they are usually of a particular pattern. A rapid replacement is managed by throwing over a link or inserting a plug to connect another fuse already mounted. Otherwise it is satisfactory.

For high tension work, there are quite a lot of examples that will not break the circuit in the case of a sudden "short circuit." Copper wire is generally most successful, since there is a less quantity of vaporised metal left in the path of the arc. In very small sizes, however, it is difficult to manipulate. Running in its normal condition, at a high temperature it deteriorates rapidly. Again, with a variety of fittings and mountings, the value for any particular gauge alters considerably. Where the balance is held in favour of copper, there should always be an easy means of inspection at any time. Either a transparent shield should be used or a duplicate system employed, which will allow a fuse to be removed and examined without interrupting the supply. One well-known fuse consists of a length of wire soldered at either end to plugs having ebonite handles. The mechanical weakness of this arrangement may lead to serious accident. The operator gets one plug in, then, perhaps, breaks the wire, and the live end sags down and touches his hand. Besides this, there is the inconvenience of having to solder the wire to the plugs. Another has a wire fitted into a gauge glass, sealed at the ends, and half full of a liquid. These have been known to explode with great violence. Let us hope that they have long since joined the ranks of "our old type."

A lead wire encased in an India-rubber tube, or a copper wire in an asbestos sheath, have been used with success as far as the break goes; a wire in a glass or earthenware tube, with the ends open, is reliable if of sufficient length. One of the most recent designs has many novel features. The holder is in the form of a drawer made of earthenware, having a partition down the middle lengthwise. The fuse is a short length of wire, strained over the partition by means of two springs, the current being conveyed through flexible conductors from two wedged contact pieces projecting from the back end of the drawer. When in use the drawer is filled with a special oil and pushed home, so that the wedges enter spring jaws. When the fuse wire melts, the springs carry the ends down under the oil, and so extinguish the arc. The makers claim that with this fuse 500 amperes at 2,000 volts can be broken without any hitch.

The percentage of error in adjustment must be rather large, since it would take some time to warm up a large mass of earthenware and oil, and again, the unknown tension of the spring introduces another source of error. The fuses are arranged in duplicate for inspection and rapid replacement and are extremely compact.

Ammeters.

Ammeters for the switchboard should be altogether different from laboratory instruments. The scale should be more accurately readable at the lowest part, if there is any difference. On a rising load, one cannot run too close to the capacity of a machine, while it is of the highest importance that one should know when the load has fallen sufficiently when switching out a machine. Again, when used on circuits, for perhaps 20 hours out of the 24, they are only indicating on the lower part of the scale. In practice they are often subjected to powerful external influences, since it is generally convenient to fix them close to the main omnibus bars. They should, therefore, be specially protected from such disturbances. The moving parts should be strong enough to stand excessive currents passing momentarily, and for many cases the movement should be damped.

An ideal instrument, if not quite dead-beat, might have a damping arrangement adjustable, so that the necessary amount could be applied under peculiar circumstances. An arrangement of terminals such that a standard instrument could be connected in series by means of flexible leads to enable the instrument to be checked while in position would be very convenient. Where a glass cover is used, it should be far enough away from the pointer to minimise errors due to static charges on the surface.

The Edgewise pattern is becoming popular now for two reasons; it is more compact as a switchboard fitting, and when fixed in rows, and the index of each standing at a different value, you get a curve formed. The shape of this curve becomes more or less familiar to the attendant, so that he more readily notices a change which may point to an irregularity in the outside system. Ammeters for the exciting circuits of the machines are usually only required for alternators. To make intelligent use of these, they should be easily readable through the range of the rheostat. They need not be readable below the minimum current required for excitation. They should be very accurate, well shielded from external influences, dead-beat, and strong enough to stand rushes of current when the field is switched on or off.

It is impossible to pass over the subject of ammeters without drawing attention to the Weston instruments. To those not familiar with these, a summary of their advantages may be of interest. Unfortunately they are only suitable for continuous currents. The scale is perfectly uniform throughout the range. The action is remarkably dead-beat. The accuracy is very high, it is independent of external influences, and the calibration is not impaired by comparatively rough usage. The current measured does not pass through the instrument, so that it may be used on any part of the board, the connections being two small wires. It is really a voltmeter, measuring a minute difference of potential across a shunt which is placed in the main circuit. Any number of shunts can be connected by means of small plugs to one instrument. A pretty device sometimes used with these ammeters is a luminous scale. The scale is translucent, the gradation lines and figures being opaque. A small lamp fixed behind shows up the reading boldly, so that it may be seen at a distance. The recording ammeter is rarely used, and it is, perhaps, an unnecessary refinement.

Integrating meters, ampere-hour, or wattmeters are hardly switchboard apparatus at present. They certainly would be useful adjuncts, and will probably become general. The usual form of case may be an objection. If the makers would turn out something all over lacquered brass and a reasonable shape, there might be a development in this direction. The same remarks on ammeters with reference to calibrating with a standard instrument might be applied here. The roller form of register instead of dials, in a large size, which could be made of aluminium, would be an attractive feature.

Voltmeters.

It is most essential that voltmeters should be accurate instruments. They must be sensitive to very small changes, and for some classes of work dead-beat. They should be free from temperature errors, and capable of continuously indicating the normal pressure for very long periods. They should always be protected by fuses easily accessible. Remarks on ammeters with reference to static charges on glass covers are applicable in some cases.

There are three distinct classes of voltmeters in every day use, electro-magnetic, electrostatic, and those depending on the expansion of a metal due to heat. The electro-magnetic are not available for alternating currents generally speaking, and except for the purpose of recording instruments, where some power has to be expended in overcoming the friction of the pen on the paper, they do not possess many advantages. The Weston instrument, however, from its dead-beat action and extreme accuracy, is again a favourite. As a voltmeter it can be fitted with a luminous scale, and it is usually provided with a movable index in the shape of a disc, which eclipses a circular aperture in the pointer. This form of index is very easily seen from a distance. Electrostatic voltmeters are useless for recording, and some forms are liable to stick, owing to the very small forces which actuate the pointer. They can, however, be used for alternating and continuous currents, and they consume a minimum of energy. They are most commonly employed for high tension work. Some engineers object to a dangerous potential across an instrument, especially as it has to be observed closely, and frequently tapped to ensure a correct reading. A small sparking gap has to be introduced to protect the instrument, and with concentric mains a momentary rise of potential is common and causes the fuses to blow.

The familiar "Cardew" is a most useful instrument, being applicable for continuous and alternating currents, and is very dead-beat in action. It gets out of adjustment rather too easily, however, and is an awkward shape to accommodate on a switchboard. The horizontal pattern is much steadier than the vertical owing to the steadier rate of cooling. The consumption of energy is rather heavy. In spite of its many defects it is very popular, probably its wide open scale and sensitiveness compare very favourably with rival instruments.

Recording voltmeters are developing, and may now render faithful accounts of electrical pressure. But from some points of view they are still imperfect instruments, since they may sometimes ignore the willingness of the spirit, whilst testifying to the weakness of the flesh. Where these instruments are used, the temptation to tamper with them should be removed, and the interpretation of the charts humane.

Rheostats, Multiple Switches, and Field Switches.

Rheostats are often suggestive of the skeleton in the cupboard. They are unsightly, and the connections are frequently clumsy, even though they may be sound. The choice of resistance material is a matter of great interest. Some alloys possessing excellent qualifications under laboratory tests have been found to have become rotten and brittle after a few years use, or they may suffer mechanical injury during construction, either from bending, &c., or heat applied for soldering. Radiating surface should constitute one of the principal features of the design, ventilation being not an unmixed blessing, as the more air you get through the rheostat, the more dirt and dust is deposited. Compactness is desirable where it can be obtained without sacrificing other advantages. The displacement due to the expansion of the metal while hot must be provided for, and in forms other than the spiral, this is rather an awkward matter. Spirals of wire are unsatisfactory, since they are liable to shake together and interlock if accidentally displaced. They accumulate a lot of dirt, are inconvenient to clean, and also involve comparatively confused connections to the multiple switch. Where a rheostat is only in the field circuit of an exciter and consequently small, it may be wound on a block of slate having a sliding connection along one edge. The slate absorbs a good deal of the heat, which can then radiate from the larger surface. It is objectionable to have the contact on the actual wire, as the wear and any slight sparking might in time cause the wire to break. A great advantage, however, can be claimed from the fact that such an arrangement may be fitted on the board always in sight and kept thoroughly clean. An improvement on this form and suitable for larger work is effected by having special contact pieces fitted, and in the use of several small wires in parallel, whereby a large radiating surface is gained. Tubular resistances would be better still, introducing at the same time additional mechanical advantages.

With reference to multiple switches, besides ample current carrying capacity, there must be exceptional provision for wear, as this may be very heavy. Circular switches, or linear motion derived from a screw, are most usual, but as there is a chance of the operator forgetting for the moment which way to turn the handle, it is preferable, in the author's opinion, to have a lever working through a quadrant in a verticle plane at right angles to the board, the connections being so arranged, that the rising of the handle raises the voltage of the machine.

It is sometimes necessary to make fine adjustments, and occasionally large alterations rapidly, so that a good regulating switch should have two handles, one having a number of intermediate steps between any two steps of the other.

Field switches should always be so arranged that they short-circuit the windings at the instant of cutting off the current. The author is acquinted with two designs, one by Messrs. Siemens, the other by the Electric Construction Company, which are well suited for this duty.

SYNCHRONISING APPARATUS.

In alternating current stations this apparatus is of first importance, and should be the object of the designer's special care and foresight. The possibility of a mistake on the part of the operator should be thoroughly investigated. The risk of breakdown in any part of the apparatus having been reduced to a minimum, provision should be made for replacing any defective detail within a minute or two, with no possible chance of reversing a connection, or there should be a simple method of throwing a spare set into circuit. There have been three or more methods suggested for synchronising. First, two lamps, or one lamp and a voltmeter, in series, off the secondaries of two transformers in series, the primaries being one on each of the pair of leads required to be synchronised. Second, a similar arrangement, having a telephone or buzzer to indicate the flow of current through the secondaries. Third, gold-leaf electroscope which can be used direct on 2,000-volt mains. The first method is almost always employed, and it has the advantage of being easily seen by the driver, enabling him to adjust the speed of his engine. This information can also be obtained by lighting the station with alternating current arc lamps. When the armature is at the correct speed, the coil holders appear to be stationary, or revolve very slowly forward and backwards as the speed is too high or too low. It might be almost worth while to switch on a lamp in broad daylight, when synchronising, for this purpose. Where alternate current arc lighting is adopted a gold-leaf synchroniser could be used. It is more secure from breakdown for having no transformer. It is very dead-beat, but at present it has not been developed as a switchboard instrument, and requires modification to preserve the extremely high insulation necessary. While on the subject of synchronising, it is instructive to notice that in English stations an artificial load on the incoming machine is considered unnecessary, although usually employed on the Continent.

In one English station it has been found advantageous to parallel machines through an impedance coil, and then short circuit the coil in two steps. As an extra precaution the paralleling of all machines, up to 400 kw. capacity, is done through a 20-ampere fuse, and this fuse is not blown more than once a month. (It may be mentioned that the armatures are of the coreless type.)

Having discussed the details, the general arrangement and construction of the board may be criticised. Slate or marble are usual as a base, but all holes should be bushed with ebonite, and ebonite plates fixed under all instruments for high tension work. There is a skeleton form, however, made of a lattice work of wood or angle iron, on which the various instruments are mounted. This form is highly efficient from many points of view, but in appearance it is untidy, and it occupies a good deal of room. A recent development consists of a number of cells, made by vertical slate partitions fitted into slate shelves, which are built into the wall. In this arrangement there is, of course, no back, the connections being visible from the front, and carried up through a vertical series of cells.

The commonest form of board is constructed of slate slabs, or panels, having the instruments on the front and all connections at the back. It is the back of such boards that should be most closely watched. It is often necessary to change an instrument, or connect a new machine or feeder, and with high tension current at all points such work is frequently attended with great personal risk. Accumulations of dirt and dust have also to be removed periodically.

Such boards, if designed in a standard panel form to permit extensions, should also have a standard system of back connections suitably protected, and in no case should miscellaneous cable and wire connections be allowed.

On double-pole boards the opposite poles should be far apart, either horizontally or vertically. For the arrangement of omnibus bars and varieties of combinations some reasonable limit should be fixed.

Breakdown terrors are usually more prominent in the minds of high tension engineers. They may stimulate more careful design, but there is also a tendency to run to seed in a progression of combinations. It may be reasonable to have a means of dividing the main omnibus bars, and perhaps have a spare set, sometimes called "hospital bars," for the purpose of connecting any particular circuit or any particular machine.

With reference to the relative position of the apparatus there is a decided preference for the complete set belonging to one generator, or one feeder being in a vertical line, well marked. It is also advisable to have the lines as close as possible, in order that the effect of any adjustment can be watched in the other lines. This principle is so important that where some parts of the apparatus are necessarily large, it might be worth while adding auxiliary gearing to permit of concentration. It is, of course, essential that the handles of all the controlling gear should be within easy reach, and that the indications of all instruments should be accurately readable from a convenient position.

A necessity or temptation to lean or stretch over any portion of the board should never exist.

It seems almost absurd to mention such an obvious precept, yet it is common enough to find a clock which has to be wound periodically mounted on the top of a switchboard. There are boards protected on the front, but this rather encourages carelessness, and is often at the expense of safety at the back. By all means guard against every conceivable accident, but under the roof of a central station a board should be assured from wilful misuse or grossly ignorant handling.

A main switch, fuses, or other safety device, and ammeter, are among the first requisites of a panel; then, perhaps, there may be plug connections, synchronising connections, field switch, and rheostat switch. Voltmeters are usually common to the whole board, and here a suggestion may be borrowed from an American practice—in that of mounting a voltmeter on a swinging bracket from the end of the board. It can then be moved to show to the best advantage at that part of the board where an adjustment is being effected.

Field switches may be advantageously mounted on the machine; by this arrangement there is a saving of conductors, and the man who lets down the brushes may be more confident that the machine is not excited at the time. For continuous current machines the rheostat, and multiple regulating switch, might also be mounted on the machine, or on the wall close by, thereby saving long conductors. Since the electrical pressure regulation is shared between adjustments of exitation and speed, both may be fittingly performed by one man, preferably the driver or dynamo attendant, whose attention can thus be directly called to the brushes at every alteration. Further, it can be urged that fire risks are minimised by distributing the rheostats, and situating them away from the wood platform or other such work in connection with the switchboard. In the case of alternating current machinery, the rheostat switches at least must be on the board, or close at hand.

But there are some alleviations to compensate for the fire risks involved. Alternating current usually means high tension, and the heat generated is of use in keeping the board at a slightly higher temperature than the surrounding atmosphere. There are occasions, when there is a fog, or perhaps in the event of a mishap with steam connections, that this higher temperature may save condensation and consequent troubles.

One of the most pressing considerations in connection with the switchboard, as a whole, is the efficient protection from dust and accumulations of dirt, especially at the back. Not only should elaborate precautions be taken, but an easy and safe means of inspection and cleaning should be a prominent feature of the design.

From an æsthetic point of view, a little license can be granted if all details are well designed. Wood mouldings and panelling add greatly to the general appearance. Some engineers severely cut down anything that is inflammable; this, like everything else, can be carried to excess. When one considers the proximity of such material to an open fire, in an ordinary dwelling house, and the small risk one attaches to it, a little ornamentation on a switchboard appears to be reasonable. There is no necessity, however, to make a switchboard a subject for rococo decoration, and, as mentioned before, there are fitter places for a clock than in a surmounting scroll.

With a view to standardisation, another suggestion hails from America. One of the largest firms manufactures unit panels always on a standard size of slate. They make 14 different capacities on a panel 48 inches × 16 inches × 1¼ inches thick, and a blank panel 28 inches × 16 inches × 1½ inches to go underneath. They are bolted on to steel frames and adapted for unlimited extension. The space required for a switchboard is not of such great importance if correctly estimated when designing the buildings. Too often, however, it has to go somewhere between two windows, in a cramped position, with little or no room for extensions.

The best position is probably on a gallery extending down the length of the engine room, except in belt or rope driven stations, in which case it should be parallel with the drives to be safe, in the event of an accident with the gearing. An elevated position such that the operator can see and signal a driver at the stop valve of any engine is about the ideal.

Though perhaps a little foreign to the subject, a system of engine-room signals might be conveniently touched upon here. It is too small a matter to be treated on under its own heading; but, at the same time, it is important in the administration of duties from the switchboard. In large concerns a well organised system is indispensable, and in small stations, therefore, unorthodox signs should be considered as bad form. The practice of shouting and cat-calling about an engine room, though it may betoken hearty goodwill and enthusiasm among young assistants and pupils, is, to say the least of it, undignified; such cries should be reserved for personal accidents. A regulation whistle or bell, whichever can be more clearly distinguished from the usual hum, should serve to call the attention of drivers. The number of a machine can be indicated by displaying a tablet having both sides painted the same. If the board can be seen from every stop valve, alterations of speed can be signalled by moving an extended hand and arm "up" or "down," the driver signalling the normal speed by moving his hand rapidly back and forwards in a horizontal plane. When the view is blocked, different toned bells, or a number of strokes may be employed, but it is remarkable to find how easily such signals can be forgotten, or confused, after being in daily use for months. Another method is to illuminate a small window, having a word painted on it, by means of a small lamp. Almost any method will answer the purpose provided that it is universal.

Turning once more to the question of standardisation, manufacturers have now had the opportunity of gleaning from innumerable specifications, and of silently witnessing some failures. Perhaps a psychological treatise on the switchbard attendant is still required.

There are, without doubt, some curious instances of irregularities due to absence of mind or fatigue. It is not at all uncommon to see a man feel the bearings and fill the oil cups of a standing machine; but when it comes to the switchboard attendant signalling "raise speed" on a particular engine, the driver adjusting the governor of a *standing* engine, and the attendant signalling back "all right," the subject becomes distinctly interesting. Then there is the man with the laboratory training, who taps every instrument, including the clock and the almanack, before taking a reading. Fuses and plugs have been pulled out while carrying currents. There was a story once of the exciting current being switched off an alternator while running in parallel. Possibly designers have already, or can easily obtain sufficient information of this description for their guidance.

Once launched on this fascinating theme ideas and suggestions spring like mushrooms. In the interests of science let us suppress the prolificacy of imaginations, born of watching and wakefulness, in the midnight hours.

Leave such work to professional designers who regard inspirations in the positive degree, and to men who live for "estimating," before whose searching gaze the colours and glories of originality pass and die away.

The author has endeavoured to point the necessity of good standard work for switchboards, and to discourage the individual of designing propensities among "Resident Engineers." He is aware that much has been done already towards establishing a standard, but has recently received replies to inquiries from several large manufacturing firms, "we have no standard, as we find all specifications differ."

It should be reserved for the resident or consulting engineer to judge, a representative body of engineers to frame rules and regulations, and for designers and manufacturers to perfect details and study economical production.

In conclusion, the author desires to express his thanks to the gentlemen and firms who have rendered him liberal assistance in the preparation of this paper.

SINGLE v. MULTIPLE GENERATING STATIONS.*

By JOHN F. C. SNELL, Borough Electrical Engineer, Sunderland.

THIS question is one by which doubtless many of us will be met, especially those engineers in charge of direct current central stations, though the question will doubtless also affect to a less degree those supplying alternating current. There is no doubt that too little care has been taken in many cases to gauge the extent of the demand which will be made upon supply stations, and one finds small sites adopted in many cases, or small stations put down without seemingly any regard for future extensions or future uniformity of design. While, on the one hand, it is imperative for the well being of these undertakings to keep down the capital cost per kw. installed, on the other hand, it is foolish and ill advised to pay no heed to the future, and to design the station initially, so that extensions may not be made systematically, and the result be a credit to the designer in the future, and, at the same time, economical to the municipality which he represents.

One cannot overlook the insignificance of many of our stations at the present day compared with, as the author thinks, the dimensions they must attain in the not remote future, and the question which each engineer will have to consider, will be, shall the whole town plant be centralised upon one site (which in most cases would have to be extra-mural) or shall there be several supply stations at different points? The author commenced these notes before the question was raised, at the late Parliamentary Committee and before it had begun its deliberations, and it is interesting to note, that while engineers generally admit the safety of extra high pressure supply, many of the most eminent admit that multiple stations have great advantages. The whole question is determined by the following points:—

1. The critical limit of H.P. installed from the point of economy.
2. Economical generation.
3. Efficiency of distribution.
4. Load factor.

Critical Limit of H.P.—This has been satisfactorily determined by Dr. Alexander Kennedy in the discussion on Mr. Ellington's paper on hydraulic power supply, read before the Institution of Civil Engineers in 1894. The Professor there states that he has found this critical limit to lie somewhere between three and five thousand H.P. installed (Mr. Ellington's limit being much lower) and once this limit is reached, it is just as economical to build another station, as to go on increasing the capacity of the first. This point being conceded, the questions of site, nuisance, and economical generation will be considered below. The author's opinion is, that given sites obtained with economy and carefully chosen, that this principle of multiple stations is the right one, inasmuch as other factors, such as additional safety and reduced capital outlay on mains, and increased efficiency in distribution are thereby obtainable.

Economical Generation.—It is impossible, of course, to lay down any standard on which a town supply can be based. But no doubt the ideal to be aimed at is a direct current system, with its simplicity, availability for power purposes, possibility of storage (which we may hope will yet greatly improve) and its undoubted reliability; condensing plant with its added efficiency, reduced charge for water and boiler cleaning; and a convenient position for economically obtaining coal. It is impossible, except in rare cases, to obtain these advantages as it were naturally, *i.e.*, to find a site, at once alongside of water, and a railway siding. By far the greater number of towns will have to adopt auxiliary means for cooling circulating water, if they must needs obtain the advantages of condensation, and it would therefore seem that in many cases it is unnecessary to build stations outside a town, the only factor against this being the increased cost of the sites in more central positions, but which may well be outbalanced by the cost of mains to various sub-centres, when one generating station is adopted. In the City of London no doubt, the case is a specially peculiar one, but in the other large cities and towns there are plenty of available sites which would be easy to obtain, where the station may be practically erected *on* the mains it supplies. The question of a slight charge on the coal for cartage, or even the much more pronounced one of condensation, may be much outweighed by the inefficiency of the distribution. That a site situated by a river, for example, where surface condensation may be obtained, is one of the greatest blessings that a station can have will be admitted, but not so if a system has to be adopted which entails an inordinate price for trunk mains and repeated transformation.

Distribution.—It may be taken as an axiom, that simplicity of distribution is desirable, and even necessary, and we shall find that out more and more as time goes on, also that the lower the pressure adopted, consistent with economy, the safer and more reliable the supply. One does not want to rake up the old discussion of the pros and cons of alternating and direct currents, but let these remarks apply to all stations of both classes; therefore, from these points of view alone, multiple stations with simple radiating feeders appear to provide the simplest system obtainable. It cannot be overlooked that the amount of conductors radiating from one huge extra-mural station, would sometime become enormous, and expensive culverts would have to be constructed.

Capital Costs.—Multiple stations are not any dearer to construct than single generating stations, for if one analyses the costs of one of the London companies, or municipal towns having multiple stations, and bears in mind the relative miles of streets covered by their distributing mains, one will find very little difference in the cost of the two systems at this earlier stage, and one may venture to say that the difference as the load increases will be in favour of those stations which are fixed directly on the centre of gravity, as it were, of the system which they supply.

Load Factor.—There does not seem to be much in this point. If anything there is a chance of a better load factor at several stations than with one large and distant one. Take a system which is supplying light and power, and supplying tramways, there can be no doubt that the system will have a better efficiency of distribution when several stations are erected; will be better able to deal with the requirements of the tramways and leakage; and better able to solve the problem of the decreasing space in the streets available for mains. The load factors of Glasgow and Liverpool, with multiple stations, or at Westminster, are as good as towns of equal importance where the whole supply is from one station, and the proportion of maximum load to plant installed much the same. So there is not much in that argument against multiple stations.

Nuisance.—Objections which may be raised to intra-mural stations are:—

1. Cartage of coals and ashes.
2. The absence of natural means of condensation of steam.
3. Smoke nuisance.
4. Vibration.

(1) The extra 8 or 9 per cent. payable on coal for cartage (as may happen in the case of multiple stations), may be much more outweighed by the decrease in efficiency of distribution when the station is outside the town, added to which must be the interest on the capital cost, which the extra mains entail.

(2) *Condensation.*—This has been touched on before, and, as has been said, probably the majority of stations in future will have to provide artificial means for dealing with the circulating water if condensation of steam is to be adopted. Those stations which have some natural source, such as a river or the sea, will no doubt have the advantage, and he would be unwise who would omit to sieze these opportunities, if they are at all possible. The saving which may be obtained from the reduced consumption of steam, and consequently of coal, the absence of any charge for feed-water, and the less cost of cleaning the boilers are the advantages. Doubtless, therefore, there are cases where the economics of this problem can be better met by centralising the plant (probably in the future this may mean three-phase plant), where this great engineering advantage of condensation can be obtained, and the supply re-distributed from multiple sub-stations.

Vibration.—This point which has been raised as a deterrent to the adoption of stations inside certain towns is one which, with care in dealing with the foundations and formation on which the station is erected, and by the adoption of three-crank engines, can be neglected. Atmospheric exhaust vibration is a matter which can be easily got over by exhaust silencers, or, of course, by adopting condensing plant.

Smoke Nuisance.—This point is mentioned because often brought forward as an argument for extra-mural stations. One may confidently say that in these days there are few of us who would care to admit that our stations would be complained of from this point, and with careful stoking and management the smoke nuisance is more visionary than real.

To briefly summarise, the actual problem we are confronted with, is that a station already exists, and we have to extend with both financial and engineering success, and our respective committees will not care about large alterations being ultimately made by the substitution of existing plant by other systems. The most natural method therefore seems to be this, to prospect new areas by high tension direct current machinery, where possible, with sub-stations feeding into low tension networks, the latter so designed that ultimately they may become part of the general network into which the second or more stations will ultimately feed, these taking the place of the temporary sub-stations.

This paper contains nothing new, and is intended merely to be a basis on which the arguments for and against the principle enunciated may be thrashed out, and I must apologise to the members of the Association for what may well be considered a plagiarism.

* Read June 9th.

MANAGEMENT OF ELECTRICAL UNDERTAKINGS BY LOCAL AUTHORITIES.*

By Councillor HESFORD, Ex-Chairman of the Electricity Committee of the Southport Corporation.

IT calls for no great demand upon our credulity to-day to assume that electrical undertakings can be efficiently administered and profitably managed by local authorities.

* Read June 8th.

We have evidence of this sufficient to convince the most sceptical, even Government departments. Yet, with such evidence plainly before us, the anomaly remains that of the total number of provisional orders annually obtained, many drift into and dwell for years in the regions of the doldrums. Here pessimistic majorities love to dwell until leavened by the optimists when the good ship soon finds its way into the trade winds. Having arrived in such active sphere, committees generally exhibit a desire to understand something of the work they are called upon to do. Nay, their zeal is generally worthy of emulation by every manufacturing committee of corporations. Some are even as jealous as the boy who took the bellows to pieces to see from whence the wind arose. It is a new thing, is a common remark, and who does not like to see and hear of something new.

Having taken their decision to establish a station, alas, difficulties face them at all points. Shall an engineer be at once engaged to design and subsequently work the station, or is it better to call in the advice of some consulting engineer to advise and plan. To approach the makers of machinery at this point, as private individuals do in building factories and works, is rank corporate heresy. On such a mementous question members seek advice from those of their friends who have already gone through the mill. But here diversity of opinions is the bewildering fruit of their efforts. Every committee know what they want. It is a station and system of distribution that shall be second to none. It must be planned for utility and convenience, and meet the unknown wants of futurity. Its machinery should be designed to adapt itself with precision and success to all the varying requirements, work at a cost that shall top the record, and be obtained from the lowest tenderer. These are the ideals, and the question is how to get them.

Friends tell us privately that consulting engineers are divided into schools, and that somehow or other their district will be found to be well suited to the particular system that the engineer called in generally advises. The advantages of such system are explained and made manifest, whilst the disadvantages of others are clearly portrayed.

Having read or remembered something of the battle of the gauges fought by railway engineers in the first half of this century, and its termination by the evidence of convenience, members of committees subside into despair of being able to give a clear reasoned decision on any system. In this condition the influence of persuasive oratory generally prevails and soon seals their capture.

An engineer is engaged and a suitable system declared.

Should the committee continue in the jelly-fish condition produced by abundant and earnest advice of opposite polarity, they will be spared the distractions of listening to the arguments of Lancashire *versus* water-tube boilers, or high speed *versus* slow speed engines, one advantage of being in a plastic condition of mind. The station being now completed, committees for a time at least are rid of their perplexities and difficulties. This is for a short time only. Errors in design and equipment soon make themselves apparent. Our buildings are too narrow or too short is a frequent cry. But that much belauded day plant is the dilemma of most committees. Having been at work a year or two it leaks out gradually that the small unit specially advised for economical day load work is too small, and of insufficient power in some cases to energise the transformers alone.

We are advised to sell them, but to whom? If the Asiatics could be induced to take them as readily as they take modern rifles, what a relief to corporations and benefit to the buyers it would be. The advice is frequently given to sell this or scrap that, often advisable and perfectly sound from a business point of view, must or ought to bring to every committee the concomitant duty of making a reserve fund, out of which the unpaid sinking fund on such plant can be met.

But the primary and foremost duty of committees having stations under their control, ought to be the production of electrical energy at the lowest possible cost. None need be at loss for a standard whereby to measure such costs. With the excellent and up-to-date tables in *Lightning* the failings of every station becomes apparent. Certainly few, if any, can excel in every item of costs in the group into which they as measured by output fall. All can, however, try to stand well by comparison where skill and forethought in design and equipment, as well as management make themselves felt.

The policy of willingness to lay cables to supply proposing or likely customers has hitherto been attended with general success. Of the day when it will become the poor man's light, we all anxiously await the dawn. Whenever the cost of distribution can be cheapened considerably that day will have arrived. Everyone connected with electricity committees remarks on this at present very costly process.

Street Lighting.—Electricians all advise, and wisely no doubt, the lighting of our streets with electricity. What a smug satisfied look would pass over the face of every corporate electrical engineer if he could obtain it.

The nice 3,000-hour load factor would delight him. How is this desirable change to be brought about. The prize is worth every effort. But all here know that corporate gas committees are tough thick-skinned gentlemen. The one lever that would be rapid and successful in gently lifting them from their commanding position is the one of less cost. Bring that about by whatever means you like, and the object of our desire is attained.

Charging.—No paper on management would be complete without reference to the prices charged. In this matter corporations stand well in comparison with private companies. By a large and constantly increasing number the Wright system of charging is finding favour. Personally, I am strongly in favour of retaining the maximum price, intact, setting the time limit of such price to suit the circumstances of each locality. For all energy consumed beyond the time of maximum price, I would drop it to the lowest possible charge consistent with covering all charges.

A reserve fund I deem a necessity.

In a word my policy would be one of charging the lowest price the system will bear, rather than the one that generally obtains in the gas world of charging the maximum that the public will quietly consent to pay. In conclusion, as an earnest member of committee, let me add that it will be the opening of a grand day for the popularity of electric lighting, when the greater portion of the capital, energy and resource now expended by electricians on various schemes for improving steam engines and boilers, shall be spent on the cheapening and perfecting of the means of distributing energy for lighting purposes. An average of from £8 to £10 per connection is a very heavy capital charge to carry.

The interest and sinking fund on this amount is equal to one-third the annual cost of light in cottage houses.

Nor as a member of a corporation can I ignore the fact that the calamities that we were almost passionately pressed to anticipate and guard against by the expenditure of capital on duplicates have not generally shown themselves in practice.

Accepting the press as my authority, the major portion of failures in lighting have occurred in consequence of weakness or defects in the distributing plant.

Our boilers, steam pipes, and engines have not failed so often as the underground portions of our systems. It is on this portion of the plant that members of committees entertain a fear, that is fruitful of halting and indecision.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

THE DESIGN OF ELECTRIC RAILWAY MOTORS FOR RAPID ACCELERATION. By Prof. CHARLES A. CARUS-WILSON, Member. Read May 26th, 1898.

(*Continued from page* 785.)

From equation 16 we find the accelerating current to be 30 amperes; so that the total current at starting is 45 amperes, assuming that the induction factor remains constant throughout. These results are shown in fig. 5. Horizontal ordinates represent time in seconds, and vertical ordinates speed in feet per second, and also amperes.

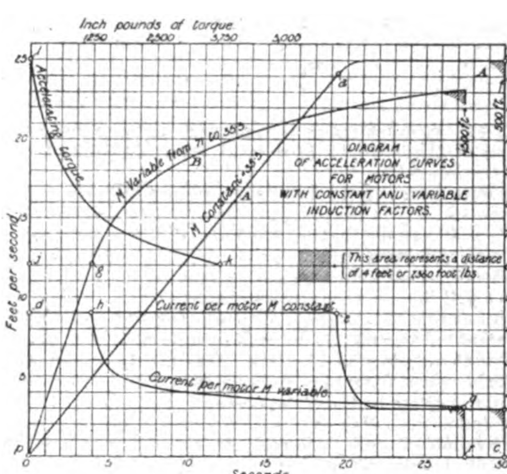


FIG. 5.

The acceleration is 1·25 f.p.s. per second, and can be kept constant until the starting rheostat is all out. The speed at which this takes place can be found from equation 6, by inserting the known value of $\frac{M\ v}{d}$, and putting $E = 500$, $R = 0{\cdot}6$, $C = 45$. We find that the speed is 24·2 f.p.s., or 97 per cent. of the final speed. The error involved in assuming that the acceleration is constant up to full speed does not amount to 1 foot of distance. From the figure we see that half the distance is covered in 20 seconds during the process of accelerating, and the remaining 250 feet is covered at full speed in 10 seconds. The whole area of the curve $p\ a\ b\ c$ represents 500 feet.

The maximum current, 45 amperes, is constant up to the point a, when the starting rheostat is all out. This is shown by the current-curve. At the point e on this curve, corresponding to the point a on the acceleration curve, the current will rapidly diminish; the form of the curve has been calculated and plotted in the figure.

We must now consider the influence of series winding on the curves of current and acceleration. In fig. 6, let values of the current be measured horizontally, and values of the induction factor be measured vertically. Take $a\ h$ equal to 15 amperes, and set up $h\ b$ equal to 35·5 on the vertical scale. Then b is a point on the induction curve of the motor. For, whatever are the values of M for large currents, the value of M for 15 amperes must be 35·5 in order that the motors may run at the required rate at full speed.

Take $a\ g$ equal to the maximum current, 45 amperes. Produce $a\ b$ to cut a vertical line through g in c. The greatest possible induction factor the motors can have at 45 amperes is given by $g\ c$, equal to 106 on the M scale. For the induction curve of a series-wound motor cannot be convex to the axis of current, though it may be a straight line passing throughout the origin if no part of the iron in the magnetic circuit is magnetised over the bend of the magnetisation curve. We have shown in this case that the induction curve must pass through the point b; hence the greatest possible value of M for these motors is found by making the induction curve a straight line passing through b, giving us a maximum induction factor of 106.

Our calculations hitherto have shown us that the motors must have an induction factor of 35·5 at 15 amperes, and that the maximum current at starting must be 45 amperes. We have not, however, determined the value of the induction factor at 45 amperes. All we know is that if M is constant, and equal to 35·5 for all currents, we shall cover the given distance in the given time.

It is clear that there are an infinite number of possible induction curves, all passing through the point b, having different values of M for 45 amperes, all less than 106. Any one of these curves would

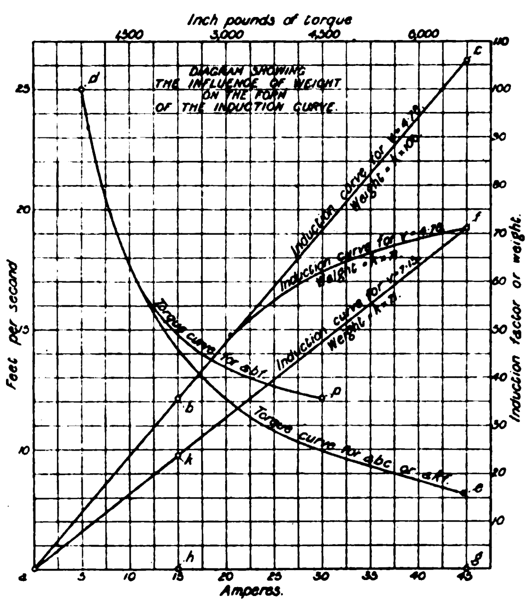


FIG. 6.

comply with the specification as to time and distance, but we shall see that none of them would be so good from the point of view of economy as the line $a\ b\ c$.

When the maximum current to be carried by a motor is fixed, the weight increases nearly in proportion to the induction factor for that current. We shall assume that for any current the weight is given by k times the induction factor for the current, where k is some constant. Hence, of all induction curves that might be chosen, that given by $a\ b\ c$ will involve the greatest weight.

Let us suppose that the practical considerations of space and cost limit the weight of the motors in this case, so that the maximum value of M for 45 amperes is 71—twice that for 15 amperes. The induction curve must then pass through the points $a\ b\ f$; let the curve $a\ b\ f$ in the figure be the curve chosen.

From the induction curve we can construct a curve giving the total torque available for all purposes. In the figure this is drawn at $d\ p$, horizontal ordinates giving torque in inch-pounds on each motor axle, and vertical ordinates speed in feet per second. By deducting from the horizontal ordinates of this curve the torque required to overcome the retarding forces we obtain a curve of torque available for acceleration. This curve is reproduced at $l\ k$ in fig. 5; it cuts the speed axis at 25 feet per second.

We can now construct the acceleration curve for the series-wound motors. The maximum total torque is 4,500 inch-pounds; deducting 750 inch-pounds for the retarding forces, assumed to remain cons'ant at all speeds, we get an initial acceleration of 3·12 f.p.s. per second —more than twice that obtained when M was constant. The speed of the car when the rheostat is all out is 12·1 f.p.s.; this speed is reached in about 4 seconds, and is shown by the point g. From p to g the acceleration is constant. The form of the acceleration curve beyond this point has been found by graphic construction, and continued up to the point at which the area, as obtained with a planimeter, is equal to a distance of 500 feet; this is at 27·5 seconds from the moment of starting.

The current curve has also been drawn. The maximum current is passing for 4 seconds, after which time the current decreases; the value at any time being obtained from the acceleration curve by using equation 6. An examination of the curves in fig. 5 shows that the effect of increasing the induction factor by series winding has been to decrease slightly the time required to cover the given distance, the saving of time in this case being 2·5 seconds.

If we compare the acceleration curves for the constant and variable induction factors, we shall see that the series-wound motor gains in distance up to the point at which the curves cross one another, and after this point loses in distance. If the distance gained is equal to that lost, there will be no difference in the time required to cover a given distance. This may often happen. The form of the acceleration curve depends upon that of the curve of accelerating torque. If this is nearly straight between k and l, the acceleration curve will rise up steeply, and the gain in time may be considerable. If, on the other hand, the torque curve is very much bent, the acceleration curve will bend over rapidly, and the series-wound motor will take a longer time to cover the given distance than one with constant induction factor.

The form of the torque curve depends on that of the induction curve. Hence, the straighter we can make the induction curve the shorter will be the time required to cover the given distance.

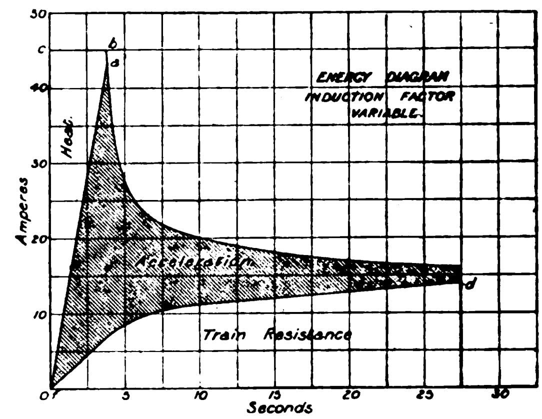


FIG. 7.

A ratio of maximum to minimum induction factor of two to one is very commonly obtained, and in such a case the series-wound motor may show a gain of 5 to 10 per cent. in the time occupied. We have, then, a reason why the induction curve should be as straight as possible.

The energy expended in covering the given distance is shown in each case by the area of the current-curve. A glance at the diagram is sufficient to show how great a saving is effected by the use of the series winding.

The two current-curves have been reproduced in figs. 7 and 8. If we multiply the vertical current ordinates by the tension of the line, we may take these to represent watts instead of amperes. At the point f the whole of the energy is being expended in heat. The heat loss at any point may be calculated by finding the speed and the resistance in the circuit, and then multiplying this by the square of the corresponding current. If the heat watts is divided by the tension of the line, we obtain the part of the total current that represents the loss due to heat.

When the current representing the heat loss has been deducted from the total current at any instant, the remainder represents the expenditure of energy in producing acceleration and overcoming train resistance. The proportion of these two can be obtained from the curve of total torque, since that tells us how much is being used for accelerating, and how much for overcoming train resistance at any speed.

The curves $o\ a$ and $o\ d$ in figs. 7 and 8 have been constructed in this way, thus dividing the whole area into three portions, representing respectively the energy used in heating, in accelerating, and in overcoming train resistance.

In comparing the two diagrams we see that the areas giving the energy used in overcoming friction must be the same; for the distance

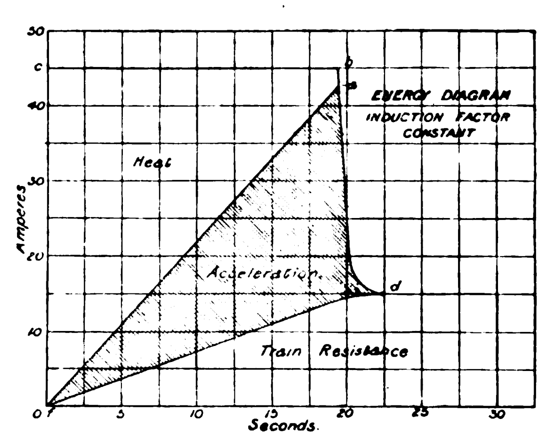


FIG. 8.

is equal, and so is the frictional resistance to motion. In this case the energy thus expended is, by calculation, 109 thousand foot-pounds.

Since the final speeds in the two cases are respectively 25 and 23·2 feet per second, the kinetic energy for the motors with constant and variable induction factor will bear to one another the ratio of the squares of these numbers. The values are, by calculation, 109 and 86·7 thousand foot-pounds. There is thus a small gain in favour of the series-wound motors, owing to the fact that the final speed is less than with the motors with constant induction factor.

It is, however, when we come to consider the areas representing the heat loss that we see wherein lies the great advantage of the series winding. The energy expended in heating with the motors having constant M is more than five times that expended with the series-wound motors, the actual values being 32·2 and 169 thousand foot-pounds respectively.

Examination of the diagram shows that the area giving the heat loss is very nearly one-half of the area of the current-curve up to the point at which the starting rheostat is all out. Now, the effect of the series winding is to reduce the time during which the starting rheostat is in the circuit. And this reduction is brought about in two ways. First, the speed at the point when the rheostat is all out is reduced in direct proportion as M is increased. Second, the increase in the initial acceleration sets back this point still further. Thus, in fig. 5, the point a gives the moment when the rheostat is all out with constant M. The speed is 24·2 f.p.s. If M at the start is doubled, owing to the use of series winding, the speed is reduced to 12·1 f.p.s., and the point g then still further set back, so that the time is reduced from 20 seconds to 4 seconds.

Since the speed when the starting rheostat is all out varies nearly inversely as M, and the initial acceleration varies nearly directly as M, the area giving the heat loss varies nearly inversely as the square of the induction factor at the moment of starting.

By increasing the induction factor indefinitely we could reduce the heat loss to that due to the resistance of the motor only; in other words, we could do without the starting rheostat altogether. The reason why we are unable to do this is because the maximum possible value of M is determined by the form of the induction curve. Thus, we have seen in fig. 6 that in this case the greatest possible value of M is 106. If the weight involved in using this value of M were not an objection, we could reduce the heat loss to 13,000 foot-pounds. Such a value for M would, however, be inadmissible, on account of the cost of construction and the space taken up, and we have to be content with a loss two or three times this amount.

A reference to fig. 5 shows that the points, such as a and g, where the rheostat is all out lie on a curve passing through the origin. This curve is nearly a parabola, whose horizontal ordinate varies inversely as M^2. It is thus evident that, the more the heat loss is reduced, the greater will be the increase in M required to effect any further reduction; so that there is a point at which it is not worth while increasing the weight of the motor, the saving effected not being large enough to compensate for the disadvantages of the heavier motor.

The following table shows the expenditure of energy in foot-pounds in the two cases:—

	Constant induction factor.	Variable induction factor.
For acceleration	109×10^8 ...	$88{\cdot}7 \times 10^8$
For train resistance	109×10^8 ...	$109{\cdot}0 \times 10^8$
For C^2 R loss	169×10^8 ...	$32{\cdot}2 \times 10^8$
	387×10^8	$229{\cdot}9 \times 10^8$

The expression "train resistance" means here all forces opposing the motion, including those due to the friction of the gearing and the torque lost in the motor itself.

Referring once more to fig. 6, we have seen that the induction curve of the motors must pass through the point b, and that if the maximum value of M is limited to 71 the induction curve must be bent so as to pass through the point f.

If now the velocity ratio employed can be increased, in the ratio of 71 to 106, or—what would come to the same thing—if the diameter of the driving wheel can be decreased in the same ratio, the induction factor at 15 amperes must be reduced to 23·8, so that the final speed may remain unaltered. Let $h\,k$ equal 23·8 on the M scale. It follows that a straight line through a and k will cut the vertical line through g at f, where $g\,f$ is equal to 71 on the M scale.

We have thus made our induction curve pass through the point of maximum M for 45 amperes, and $a\,k\,h$ is the best induction curve from the point of view of economy. We have done this by simply increasing the velocity ratio and altering the inclination of the induction curve to the axis of the current. This inclination will depend upon the permeance of the air-gap if the iron circuit is unaltered. Hence, by rightly proportioning the gap and the velocity ratio, we can obtain results approaching very nearly to the greatest possible economy.

Since $h\,k$ in fig. 6 is equal to $0{\cdot}1747\,\frac{e\,t\,d}{\mathrm{D}\,v}$, and $a\,h$ is equal to $2{\cdot}03\,\frac{\mathrm{T}\,\mathrm{D}}{e\,t}$—T being the retarding force in pounds at the car axle—the tangent of the angle $k\,a\,h$ is given by

$$\tan k\,a\,h = 0{\cdot}086\,\frac{e^2\,t^2}{\mathrm{T}\,\mathrm{D}^2}\,\frac{d}{v} \qquad (18)$$

Hence we can write,

$$p\,\mathrm{A}\,\mathrm{S}\,g = 685 \times 10^4 \times \frac{e\,t^2\,d}{\mathrm{T}\,\mathrm{D}^2\,v} \qquad (19)$$

where p is the numerical constant defined on page 1, A is the number of surface conductors, S is the number of turns per pole in the series winding, each carrying the whole current, and g is the permeance of each polar gap in centimetres.

It will generally happen in practice that the weight limit requires a velocity ratio that is unattainable even with the largest values of d. We have here a difficulty that influences greatly the design of railway motors when spur gearing is employed, namely, the limited clearance between the gear wheel and the ground. We have to get the largest value of v with the smallest value of d. It is obvious that the greatest possible ratio of v to d is determined simply by the clearance.

(To be continued.)

ELECTRICITY AND THE WAR.

The interest in the war is well maintained in the columns of our American electrical exchanges. We have already stated the opinions of two journals regarding the probable effect of the war upon the electrical business in the States. It was considered that the war would place the electrical trade in a bad way eventually. The New York *Electrical Review* seems to take an entirely different view. It says that the only apparent effect of the war on the electrical industry in the United States has been to set the majority of the manufacturing plants running day and night. The wire and cable companies are overburdened with orders, chiefly from the Government. Makers of dynamos, motors, searchlights, ship-lighting sets, and small supplies are also unusually busy. Many of these companies are working short-handed in their administrative forces, owing to the fact that a considerable number of their people have volunteered their services to the Government in various capacities. The war will result in profit to the electrical industry, and the electrical fraternity has been and will be of invaluable assistance to the Government.

It is interesting to note that among the officers attached to Dewey's squadron was Lieut. Bradley Fiske, who is well known to the electrical fraternity as the inventor of the Fiske range-finder, and for his electrical work in other directions. Lieut. Fiske was on the *Petrel*, and it was his ship to which the task was assigned of destroying the remnants of the Spanish fleet after the battle was over.

It is to be hoped that the volunteer electrical corps, which is being rapidly organised by Capt. Eugene Griffin, Dr. Louis Duncan, Lieut. F. J. Sprague, Lieut. O. T. Crosby, and others, will not be placed on the same footing as other volunteer corps recruiting for other purposes. The electrical volunteers' immediate superiors will be men in his own line of work, whose ability he recognises. Our New York namesake remarks, "The volunteer electrical corps does not and need not know military tactics—it must and does know how to handle a pair of pliers."

In connection with the war news it is interesting to print the following telegram sent by President McKinley to the Electrical Exhibition, on its opening in Madison Square Garden, New York, early last month:—

"It gives me pleasure to open the Electrical Exhibition in Greater New York, and to participate in this demonstration of the latest method of transmitting, recording, and publishing by means of electricity. I congratulate you upon the achievements of American genius. I am glad to know that the resources of the wonderful electrical arts have already been so far advanced in the United States, that American electrical goods are welcome the world over."

In regard to the action of Admiral Dewey in cutting the telegraph cable at Manila, the New York *Electrical Engineer* says: "He cut the cable, but what a grand thing it would have been if he had had with him some good cable men who could have taken hold of the cut end and kept one of his ships in touch with the outer world." The battle of Manila offers an illustration of the wisdom of having experts in telegraphy and electrical engineering attached to every army or fleet. "If the electrical end of Commodore Dewey's establishment had been cared for as scrupulously as its strictly fighting end, he could have made his victory even more complete in its moral effect by showing the Spaniards the hopelessness of a war against so ingenious a people as ours. There is one brilliant electrical engineer with the Dewey fleet, Lieut. B. A. Fiske, but he is helpless while the cable lies at the bottom in deep water, for of all the ticklish things to hold and raise a heavy cable is about the worst."

On the legality of Admiral Dewey's act, the *Western Electrician* says:—"It is generally held that all nations reserve to themselves the right to cut submarine cables in wartime as a military necessity or belligerent right, but it is possible that a civil claim for damages to the service may be admitted."

At the request of Lieut. Maxfield, U.S.A., the Government censor, all the foreign employés in the offices of the United States and Hayti Cable Company in New York have been "laid off" from the company's service, their places being filled by native-born American citizens.

HEAVY MOTOR VEHICLES AT LIVERPOOL.

Not much attention has been accorded to the trials of motor vehicles made recently at Liverpool by the local Self-Propelled Traffic Association, the object being to arrive at a type of heavy motor waggon suitable for trade requirements in and around Liverpool. Though entries were numerous, only six British vehicles were entered, and all the Continental vehicles were excluded by the 3 tons limit of the Light Locomotive Acts of 1896. Only four vehicles finally competed, yet they attracted a good deal of local interest, and numerous light motor vehicles were employed in carrying judges and others over the course.

All the competing vehicles were steam-driven; there were no oil or electrical vehicles, though oil was represented well among the light attendant carriages, all of which were sent by the Daimler Company of Coventry.

Two exhibits came from the Steam Carriage and Waggon Company of Chiswick. No. 3, of Class II, which comes under the figures of minimum load 5 tons, minimum average speed 4 miles an hour, minimum platform area 110 square feet. It was carried on 6 wheels, and is described by the *Times* correspondent as resembling a traction engine with attached waggon. It and its smaller companion, No. 4, had water-tube boilers and an air condenser. Vehicle No. 1 was sent by the Liquid Fuel Company, of East Cowes. It was entered under

Class I., minimum load 2 tons; minimum speed 6 miles per hour; platform area, 60 feet. It ran 35 miles in 5 hours inclusive of all stops, a very creditable performance.

The Lancashire Steam Motor Company, of Leyland, were the owners of the fourth vehicle, which carried 4 tons, and was built for 6 miles per hour, and was carried on 4 wheels with a steel frame, and the boiler is below the platform. Its steel tyred wheels gave a deal of trouble, so that on the third day it did not turn out. Gradients of up to 1 in 20 were found on the various trial routes selected, and a report is promised at an early date. Present appearances point to the heavy motor car traffic being monopolised by steam-driven vehicles, whereas for light cars oil motors seem best, though for city work on smooth pavements electricity holds the place, as evidenced by the London electrical cabs, which still seem to be running satisfactorily and regularly, being daily in evidence all over the city and west end.

Had it not been for the hampering restrictions regarding road locomotives, the motor vehicle industry would to-day have been in a flourishing condition, and it would not have passed through the undesirable phase of company promoting, which has so much retarded honest development.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1898.

Compiled expressly for this journal by W. P. Thompson & Co., *Electrical Patent Agents*, 322, *High Holborn, London, W.C., to whom all inquiries should be addressed.*

11,570. "Improvements in or connected with electrolytic cells." G. Bell and G. W. Bell. Dated May 23rd.

11,579. "Improvements in electric signalling on railways." J. W. Wadkin and D. J. Jarvis. Dated May 23rd.

11,604. "Improvements in or connected with the electro-metallurgic production of iron steel and their alloys with chromium tungsten, nickel, manganese and the like." E. Stassano. Dated May 23rd. (*Complete.*)

11,609. "An improvement in electrical fuses and cut-outs chiefly applicable to the bridge fuse." A. W. Sowry and H. E. Munslow. Dated May 23rd.

11,610. "An automatic electrical temperature indicator." A. H. Wood and D. M. Hayllings. Dated May 23rd.

11,627. "Improvements in electric cables." W. S. Smith. Dated May 23rd.

11,640. "Improvements in accumulators or secondary batteries, and apparatus for their manufacture." F. Heimel. Dated May 23rd.

11,678. "Improved apparatus for use in the electro-deposition of metals." W. Dunn and W. J. Twining. Dated May 23rd.

11,723. "Improvements in and relating to the making and breaking of electric circuits." J. A. Steven and C. Hamilton. Dated May 24th.

11,730. "Smethurst concentric ceiling rose." A. A. Smethurst. Dated May 24th.

11,731. "Improvements in the globes of electric incandescent and similar lamps." English Industrials, Ltd., and G. E. Heyl-Dia. Dated May 24th.

11,732. "Improved means for measuring current or voltage in electric lamps." English Industrials, Ltd., and G. E. Heyl-Dia. Dated May 24th.

11,757. "An improvement in jointing or junction boxes for connecting, distributing, and the protection of electric wires." T. McEwan. Dated May 24th.

11,773. "Improvements in connection with permanent magnets." C. Thompson. Dated May 24th.

11,783. "Improvements in and relating to conductors for electric railways." H. H. Lake. (W. A. P. Willard, jun., United States). Dated May 24th. (*Complete.*)

11,858. "Improvements in the manufacture of elements or plates for secondary batteries or electric accumulators." F. King. Dated May 25th.

11,860. "An improved means for making and breaking electric circuits." A. W. Saubbrey. Dated May 25th. (*Complete.*)

11,880. "Improvements in, or relating to, coils for heating by electricity." A. Cleaver. Dated May 25th.

11,906. "Improvements in, or relating to, fuseboards." A. Vandam and T. H. Marsh. Dated May 25th. (*Complete.*)

11,917. "Improvements in means for silvering or plating the glass bulbs of incandescent electric lamps, or the like." F. Fanta. Dated May 25th.

11,922. "Improvements in electric lamps." A. A. C. Swinton. Dated May 25th.

11,924. "Improvements in electric lamps." W. Peto. Dated May 25th.

11,926. "Improved circuit connections for continuous current shunt machines." A. Sengel. Dated May 25th.

11,936. "Improvements in electric arc lamps." R. Gaynor. Dated May 25th.

11,989. "Improvements in, and relating to, telegraphic transmitting and recording or receiving apparatus." J. C. Mewburn. (B. Hoffmann, France.) Dated May 26th.

12,011. "Improvements in electric gas-igniters." F. Dreimel, J. Lehmann, and A. Sylten. Dated May 26th.

12,013. "Improvements in printing telegraphs." L. Kamm. Dated May 26th.

12,016. "Improvements in systems of electrical control." H. H. Leigh. (F. J. Sprague, United States.) Dated May 26th.

12,019. "Manufacture of active material for accumulator batteries." H. Tobler and J. H. Graeber. Dated May 26th. (*Complete.*)

12,049. "Improvements in electrical resistance coils." S. W. Outtriss. Dated May 26th.

12,092. "Improvements in electric bells for cycles." A. R. Gould. Dated May 26th.

12,106. "A new or improved electrical appliance for curative or remedial purposes." H. Krauss. Dated May 26th.

12,172. "Improvements in electric arc lamps." K. Panian and M. Bernhard. Dated May 28th.

12,175. "A new or improved composition for the manufacture of carbon pencils for arc lamps, incandescent filaments, and the like." C. Schnabel. Dated May 28th.

12,190. "An improved chemical composition intended for the manufacture of mantles or blocks for use in electric arc lamps." P. Mersch. Dated May 28th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free*, 9d., (*in stamps*).

1897.

17,924. "An improvement in field magnets for electric generators and motors." C. Tuson. Dated July 30th, 1897. This invention relates to the construction and winding of a field magnet, so that the coils employed can be easily wound ready to be put in place. A hollow cylinder of steel is made with deep recesses in its ends, leaving an internal shell cut away at each side to leave opposite pole pieces. Two insulating wires are wound, each forming a complete ring. Each of these rings have their sides introduced at both ends into the recesses and are passed through the cylinder. They cross each other on each side of the cylinder and when electrical currents are passed through the rings the cylinder is rendered magnetic, and the inner face on one side being of one polarity, and the opposite face being of the opposite polarity. 1 claim.

18,276. "Improvements in electric lamps for miners' use." H. H. Lake. (Communicated by O. Siedentopf.) Dated August 5th, 1897. This relates to a novel arrangement of terminal openings, and of protecting the dome; covering the lamp bulb. The protecting dome is of glass and is hinged upon the casing of the lamp in such a manner that it swings downwards when opened, so that the lamp can be readily replaced. It also covers the terminal openings for charging the secondary battery in the lamp; as they are arranged upon the front of the lamp so that when the dome is closed the contact pieces are prevented from becoming dirty. 2 claims.

1,996. "Improvements in electric rollers for therapeutical and massage purposes." J. W. Gibbs. Dated January 25th, 1897. Date applied for September 22nd, 1896. This invention is an electric roller consisting of a central body provided with axial bearings for the handle. There are a series of contiguous generating face-plates, as copper and zinc, around the centre of the body. The face of the roller is smooth and a circuit is established by the moisture of the body upon application. 2 claims.

13,268. "Improvements in electric mountain railways." E. Andre. Dated May 28th, 1897. This relates to a device for increasing the tension of the dynamo during the down journey without dangerously increasing the speed of the car. There is an arrangement enabling the motor to act as a dynamo, irrespective of the kind of current used, and to impart current to the line wires by increasing the number of revolutions. There is also an additional dynamo adapted, to be connected up with the motor in series, in order to increase the tension of the latter by means of its own tension and to act at the same time as a brake. 2 claims.

17,824. "Improvements in electric alarms for cars." A. Nathan. Dated July 29th, 1897. This invention consists of a vertical shaft, at the upper end of which is pivotally connected a spring-supported lever, provided with an arm directed downwards, mounted on the shaft, below the lever is a vertically movable disc supported by springs. To this disc there is fastened a tubular insulating sleeve, which is free to move up and down the shaft with the disc. At the bottom of the sleeve is fastened a plate. Below this is another plate mounted on the shaft by an insulating sleeve rigidly fixed. There is an electric bell in circuit with these plates, and when the lever is pressed down the plates touch, which closes the circuit and operates the alarm. 3 claims.

5,131. "Improvements relating to electrical resistances." E. W. Bowles. Dated March 25th, 1897. This relates to liquid resistances to prevent waste of electro motive force when resistance is not required. The resistance is short-circuited by adapting to the appliance which carries the movable pole plates, contact pieces, which, when the pole plates are together, come into electrical connection with the fixed contact pieces in the circuit, and bridge over the space between such contact pieces. 1 claim.

THE

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LETTING OFF STEAM.

THERE was decided in Mr. Justice Bigham's Court last week a case of much interest to steam users, and as it is reported in another part of this issue we purpose devoting a little of our space to commenting upon this action in particular and to technical law cases in general. Naturally one would gladly welcome any new process which would reduce the coal bill, provided all other things are equal, and when an inventor comes forward claiming to evaporate some 75 per cent. more water per pound of coal than is effected in every day practice, and produce a horse-power-hour with less than half the coal we are at present compelled to consume, the prospect is an alluring one to company promoters.

The mysterious Guittari concoction which since 1896 has been threatening to revolutionise present steam practice is described in Specification No. 5,393 of the above-mentioned year, and briefly the process is as follows:—

"The invention has for its object to lessen the consumption of fuel in the generation of motive power by the employment in the boiler of water impregnated with a compound of carbonic acid gas, whereby the generation of pressure is rendered possible with an expenditure of heat energy very much below that by which it would be possible to generate steam in the ordinary way. The use of carbonic acid gas alone for this purpose would not, however, be practicable, as the gas would be quickly driven off from the water on the application of heat, with the result that the gas would become lost and the water be left in its natural condition. The invention consists essentially in the addition to the water of a compound resulting from the combination of carbonic acid gas and a re-agent, whereby the separate evolution of the carbonic acid gas is prevented, and the condensation of the combined gases and vapours after doing work is rendered possible without loss. This re-agent is ethene chloride, commonly known by the name of Dutch liquid." The impregnated water is then supplied to the boiler, the steam generated is used in an engine, passed through a surface condenser, and the ejected liquid used over and over again.

We regret that we are not at liberty to publish the plaintiffs' report *in extenso*, but we may state that the plant on which the tests, referred to in the lawsuit, were carried out consisted of a 10 H.P. nom. Colchester horizontal compound engine with surface condenser. High pressure cylinder 6 inches diameter, low pressure cylinder $10\frac{1}{2}$ inches diameter × 14 inches stroke; fly-wheel 5 feet diameter and 8 inches wide, with water space under rim; speed, 155 revolutions per minute.

Two locomotive multitubular boilers, each with 38 tubes 6 feet 4 inches long × $2\frac{1}{4}$ inches diameter; heating surface, 164 square feet, each boiler with grate area of $5\frac{1}{2}$ square feet.

The fire-boxes of both these boilers had, however, been bricked up so that the grate area was approximately 2 feet × 1 foot 6 inches = 3 square feet in each. One was charged with plain water, the other with Guittari's patent mixture.

During the progress of the trial before Mr. Justice Bigham, the report of the syndicate's consulting engineer was handed to one of the witnesses, the data of which contained two items of the utmost significance. One was that 16·3 lbs. of Guittari mixture had been evaporated per pound of coal; the other that 1·4 lbs. of coal produced a brake H.P.-hour. The tests of the plaintiffs, however, with Guittari stoking, gave 9·7 lbs. of water and 3 lbs. of coal! How are these descrepancies to be explained away; especially when we are assured that tests made by another well-known engineer, previous to those of the plaintiffs, and who was called on their behalf, gave substantially the same results as theirs! It is a well-known fact that if every heat unit in the coal could have been given to the water, 16·3 lbs. could not possibly have been turned into steam, and when we consider that not more than 70 per cent. of the heat was utilisable for that purpose, the figure obtained by the plaintiffs seems to be a reasonable one. Moreover, when questioned by his Lordship, this gentleman stated that he could not say whether the process was worth anything or not.

Guittari himself, a skilled stoker of the Italian Navy, it is said, could doubtless have thrown some light on the matter, but at the critical moment he was *non est*, and so the secret of the marvellous properties of his invention was left untold.

His Lordship, in his masterly summing-up, gave a brief extract from a report made by the plaintiffs in 1896 for a Mr. Belcher, but had he read a little further he would have noticed the plaintiffs concluded that although in the plant submitted to them at that time (a very small vertical boiler, which Guittari stoked, and an engine which developed between one and two H.P.) the patent liquid seemed superior to plain water, yet the results fell far below that of good steam practice with plant of moderate capacity. Still, the learned judge dismissed this point, and rightly so, as having no real bearing on the case at issue.

One factor which had a very important bearing on the result, was the correspondence between the parties previous to the experiments, the plaintiffs insisting on having a free hand and entirely repudiating the suggested methods of operation put forward by the defendants.

The tests were carried out with about equal brake loads upon the engine, and with equal grate surfaces for each experiment, but even without the plain water test the Guittari result of 3 lbs. of coal per H.P.-hour, with an evaporation of about 9¾ lbs. of water or mixture, was sufficient to prove the mixture to have no advantages, and on this the learned judge spoke very strongly and to the point. Even had an advantage been shown for the mixture, of what value can a process be which must be stoked by the inventor? There is but one Guittari, but there be many boilers.

One of the points in dispute was with reference to the use of an assisted draught, and in addressing the jury, the defendants' counsel laid very great stress upon this point.

Counsel did not apparently secure a full grasp of the purport of the assisted draught, which no doubt would be that it enabled a more rapid combustion to be secured. Instead, he grasped the idea that more air could thereby be put through the furnace, and went on to say that the more air that could be put through the furnace the better would be the results obtained; that air was equivalent to so much fuel, and saved the employ of so much coal, and therefore by multiplying the indraught of air the boiler power was so much multiplied. It was equivalent, said the learned gentleman, to a grate and half, but by what occult method of calculation he arrived at this result we know not. There was not the slightest allusion to the air giving power to burn so much more coal. The argument was perfectly clear and distinct that it was as a fuel the air or oxygen must be considered. We confess we were astonished. We had not thought it possible that so elementary a fact could have been so misunderstood, or that such an entire absence of technical knowledge existed anywhere among a body of men at the English Bar, including, as it does, so many men of really scientific attainments. Such an argument by a ready speaker put in a plausible manner before some juries composed of men of the same unfamilarity with the most elementary science of every-day life might work the gravest injustice if the case really turned on the point.

Fortunately in the case at issue the result did not depend on this, and the learned judge did not think it necessary to allude to it except in a very brief way, but evidently he was fully cognisant of the fallacy, and could have corrected the error had it been necessary so to do. It is often an extremely difficult matter to put facts in a manner that a jury will comprehend, and it becomes the more so when cross-examining counsel put questions that cannot be answered, which have not in them the scientific basis on which to build a reply.

Questions are sometimes quite irrelevant, and often absurd. We think non-technical counsel ought to avoid such cases as involve technical details, and we are a little doubtful as to whether jurymen ought not to be selected to some extent by their qualifications in technical cases.

An Interesting Experiment.—Mr Henry N. Warren, writing in the *Chemical News*, Vol. lxxvi., p. 200, claims "the production of electrical energy by the direct action of the atmosphere." The experiment by means of which he demonstrates this may be described as follows:—Plates are prepared of a special porous compressed graphite, and about one-quarter of each plate is rendered active by immersion in platinic oxalate, drying and igniting in an atmosphere of hydrogen. In contact with a solution of ferrous sulphate, the platinum surface induces oxidation of the iron by the oxygen of the atmosphere. Several of these plates are attached to a circular lead beam, which surrounds a porous diaphragm containing as negative element a rod of amalgamated zinc, the carbons being so arranged as to allow the platinised portion to project above the solution, which consists of strongly acidified ferric sulphate. On completion of the circuit, a powerful current is at once generated, and continues until the complete reduction of the ferric salt has taken place, which naturally terminates the action. On now withdrawing the zinc, the platinum surface condensing the atmospheric oxygen steadily re-oxidises the ferrous salt, and thus renews the action when required.

THE MUNICIPAL ELECTRICAL ASSOCIATION.

Probably the most important point raised by Mr. Gibbings in his Presidential Address was that relating to the standardising of plant, and the remarks made were singularly opportune, because they paved the way for Mr. Wordingham's paper on the "Uniformity of Plant." As the President pertinently remarked: "In the first place each manufacturer has his own particular type and sizes of plant and apparatus; each consulting engineer has his own ideas of speeds, periodicities, and systems of supply, and each borough electrical engineer has probably more 'fads' than all the rest put together." This is a frank avowal of the difficulties that have hitherto retarded the adoption of a system of standardisation, and certainly bespeaks a desire to remove some of the obstacles that have formerly stood in the way. No doubt much difference of opinion exists on many of the topics raised by Mr. Gibbings, and the following paragraph taken from the address sets forth one of the most debatable subjects in municipal supply:—

"My own opinion is, as regards the supply of electricity, that at present there is only one wise course for us to pursue. We are bound to act in the interests of our clients rather than to subserve the interest of the public generally. Only in that way shall we enlarge the constituency of our customers and thus be moving in the direction of a cheaper supply. In a certain city, which owns the gasworks, it has long been the practice to supply all the gas for the public lighting of the streets without making any charge whatever upon the rates. The whole cost has, in fact, been treated as if it were part and parcel of the costs of production for private consumption, thereby, of course, raising the price per 1,000 cubic feet charged to private consumers. Street lighting is undoubtedly a public necessity and a general boon, but the gas consumer alone in this instance is mulcted in the expense. I do not know that any great injustice arises, however, for the gas consumers are almost co-extensive with the ratepayers. But I should certainly deprecate any attempt at present to supply electricity for street lighting purposes on the same basis. It would practically mean burdening a comparatively few, that is, the consumers of electricity for the advantage of all. The entire cost of the public lighting, including the capital cost of erecting lamp pillars, represents no inconsiderable sum of money, and the burden would simply be intolerable. In addition to this it would not be, as I have already stated, a sound commercial policy."

The foregoing is by no means the only important point raised in the address, and, however opinions may be divided on Mr. Gibbings's method of dealing with the difficulties, there can be only one opinion as to the practical and able manner in which the whole field of municipal electric supply is surveyed.

Our record of last week's proceedings practically ended on Wednesday night, which were terminated by the annual dinner, held at the Holborn Restaurant. On Thursday morning the members assembled to discuss a paper on "Uniformity of Plant," by Mr. C. H. Wordingham; "Appropriation of Profits and Repayment of Loans," by Bailie Wm. Maclay, and "Single *v.* Multiple Generating Stations," by Mr. J. F. C. Snell. Following the admirable practice of former meetings, the papers were generally either taken as read or the principal features of the paper were referred to. The first paper of the day, Mr. Wordingham's, is referred to at some length in another part of this issue, but it may be interesting to record some of the principal points of the discussion. At the outset the President made an interesting announcement to the effect that a joint committee of the Municipal Electrical Association and the Institution of Electrical Engineers had been formed to consider the subject of standardising plant. Mr. Dawbarn, of the Brush Company, was first invited to contribute to the debate, and expressed his gratification as a manufacturer that the subject had been raised. They were prevented at the present time from making for stock, and they could not make provision for the future. It would have a great effect on cost if they could make a large number of machines at the same time. He thought it would be of immense service to manufacturers if they knew that in this matter they had the moral support of the Association. Passing on to another phase of the subject, Mr. Dawbarn said that many stations in this country had been started with small units, but the later practice of using large ones was sound, though at the start they suffered from the disadvantage of being run at an inefficient load. Mr. Chamen (Glasgow) thought that there was a general consensus of opinion as to standards, the question was, how to do it. With regard to the voltage of lamps, he was employing 250-volt lamps in Glasgow. Although this voltage might not be convenient for interior arc lamps, they had to remember that the inclosed arc lamp was rapidly coming in, and he thought it possible for three of these to work on 250-volt circuits. By working at 500 volts (across the outers) it meant practically 50 per cent. difference in what they could do with copper. Capt. Sankey agreed that the standardising of plant was of the greatest importance, and the suggestion proceeding from the Association was excellent. He spoke in favour of a standing committee of the Association to which questions of voltages could be referred. Mr. Robt. Hammond, as a consulting engineer, welcomed the movement most heartily. It was their duty to pay the least amount for good plant, and that can only be arrived at by standardisation. He had been much struck, when visiting the works of the Westinghouse Company in America, to see rows and rows of engines in stock. They had worked up their business by the facility with which they could supply engines from stock. He looked forward to the days when those concerns would be most successful who stocked. The question of pressure was the least part of the subject, but the size of plant ought to be capable of settlement. He expressed his dissent with the division of initial plant into sets; they had not in the past considered sufficiently the question of space. With regard to the periodicity question, what were they going to do with the works at present in existence. Mr. Snell (Sunderland) said, though engineers would like standard practice, they could not get it. Mr. Boot (Tunbridge Wells) referred to the financial difficulties of altering present plant to a standard. Mr. Cottam (Hampstead) raised the question whether they would not stifle progress by saying that they would make everything uniform; had they arrived at the stage when that could be done; local conditions very materially affected the question. Mr. Gibbings said there was a good deal of misconception as to the lines on which they proposed to go; it was impossible to standardise the whole system of plant; they could only attempt to standardise periodicities, horse-powers, and so on. Mr. Wordingham in replying on the whole discussion said he was prepared to admit that they were influenced by individual circumstances. He fully recognised that the question of lamps was a matter for argument, and could only be settled by a thorough discussion. That Association could not deal with the matter, for they constituted only a small section of engineers. Replying to Mr. Hammond's point as to size of plant, he thought that the best way of spending money was by subdividing plant; the periodicity question would be settled because most single-phase alternating current machines would be scrapped within the next 10 years. He did not suggest that they should alter everything, nor did he put forward any hard and fast rules; it was only standardisation in the way of sizes, and on general lines that they could proceed.

The "Appropriation of Profits" was the subject of the next paper, and Bailie Maclay dwelt upon the principal points, more, as he said, with the idea of drawing out discussion. It may be mentioned that the paper which is dealt with in another part of this issue does not agree with putting profits from electricity works to the relief of rates, but to be devoted to the lowering the price of electricity. Mr. Councillor G. Pearson (Bristol) was not slow in responding to the worthy Bailie's challenge, and said at the outset he did not agree with it. He held that those upon whose credit money was raised should have a share in the business. In Bristol they had 50,000 ratepayers, and 1,000 electricity consumers, and not more than 1 ratepayer in 50 had the advantage of electric lighting. If they used the credit of these 50,000 ratepayers for establishing electricity works, they might reasonably ask those who paid for the luxury to pay a little more, and so reduce the taxation. Before going in for public lighting, however, he considered that reductions ought to be made to the consumer. Mr. Higginbottom (Manchester) disagreed with the disposal of profits set forth in the paper. If ratepayers found money for an undertaking, and a profit was made, they were entitled to receive an amount of that profit; if there was a loss on the undertaking it did not fall upon the consumer but upon the ratepayer. The speaker alluded to the protection accorded to the consumer by the Board of Trade.

Mr. Robert Hammond said one of the most difficult things in accounts was the very great difference that existed between the ultimate disposal of what some called profits and others gross profits. If every chairman of committee had the Act of Parliament in his head they would have accurate account keeping. He did not know till then that it was possible to evade the Act by supplying public lighting for ½d. per unit. He found in the case of Glasgow that they were only contributing 1 per cent. to the sinking fund, whereas in Manchester and Sunderland they had to contribute sufficient to repay the loan in 25 years. Leeds, however, which had applied for a provisional order to acquire the Leeds Electric Lighting Company's works had obtained permission to retain the loan for 40 years. They ought to consider that it was the general ratepayer who had to sanction the loan, and nothing pleased him more than to think that a small profit was going into his pocket. Mr. Barnard (Hull) pointed out that if they applied for a loan for machines they were given 15 years to repay, for mains 20 years, and if together 25 years. Mr. Arthur Wright said he once had the opinion that when they started the supply of electricity they were going to supply electricity to ratepayers. Some corporations got only 25 years to repay the loan, and he thought that ought to be the limit, because if they got 42 years they wanted a bigger depreciation fund. Returns to the ratepayers could be made in two ways, by handing over large sums, or building up a sound business, by lighting streets at cost, laying services and mains all over the town. That was a far sounder way of repaying the general body of ratepayers, than handing over sums of money year by year. Lowering the price did not necessarily increase the deficits, and might, in fact, increase the profits. The chief points of Bailie Maclay's reply were, that he was not there to show a bright and shining example. Things appeared to be different in Glasgow, for there was not a single occasion when they had a deficit; they gave something to the ratepayers, in fact, all they had to spare. They raised their money by issuing stock, and when their term expired they borrowed a fresh loan. He agreed with Mr. Wright on the subject of street lighting, they never thought of giving current for street lighting at less than cost.

The next paper was that of Mr. Snell's on "Single *v.* Multiple Generating Stations," but on account of the lateness of the hour, it was not possible to do more than hear a few opening remarks from Mr. Chamen.

The arrangements for the afternoon included a visit to the new works of Messrs. Willans & Robinson at Rugby, and it may be said without exaggeration that it constituted the most valuable object lesson in standardising that was provided during the Convention. Two special saloon trains were provided for the visitors who travelled to Rugby in almost Royal style. Messrs. Willans & Robinson's works are no doubt among the finest workshops in the country, and the excellence of the methods carried out here merit more attention than we are able to give at the moment.

The last day of the Convention was devoted to discussing Mr. Snell's paper, to which we have already referred, and a series of papers on electric traction. Those of Mr. R. C. Quin (Blackpool) and Mr. J. E. Stewart were taken first, and evoked a fairly long discussion. Mr. Rider brought out one or two good points; he objected to depending upon the tramcars for fly-wheel effect, on the ground that it was impossible to find a town where uniform motion of tramcars could be obtained, the speed and the power of the car were constantly varying. He did not approve of car mile, and he considered ton mile as bad; what they had to compare was the passenger mile. He was in favour of an entirely separate committee for a tramway, and the electricity committee should supply electricity to a tramway committee as to a separate consumer. Alderman Higginbottom, Bailie Maclay, and other speakers, followed, but perhaps their remarks will be more appropriate when we publish the papers.

APPROPRIATION OF PROFITS AND REPAYMENTS OF LOANS.

The paper contributed by Mr. Bailie Wm. Maclay, the Convener of the Electricity Committee of the Glasgow Corporation, deals with two subjects, viz., "The Appropriation of Profits and Repayments of Loans."

With regard to the first, Mr. Maclay points out that the policy of the Glasgow Corporation is not to make profits; and here he raises an issue which forces itself upon the serious consideration of all who are responsible for the conduct of municipal trading undertakings. Without doubt the success of those undertakings is generally judged by the amount that is annually handed over to the General Rate Fund.

With this view the policy of the Glasgow Corporation is in direct conflict. "We recognise," says Bailie Maclay, "the fact that not one of these departments exists to make profits as is the case with a private commercial concern—but that rather it has been called into existence for the benefit of the community as a whole," and in opposition to the principle adopted in Manchester, the Bailie further contends:

"That what has been taken from a . . . . consumer in excess of the cost of production and distribution, should be given back to him at once and directly through the department, in the form of a reduced charge in the immediate future. This meets all the wants of the case, and inflicts a hardship on no one. . . . . We hold," he continues, "that it is a sound policy to place as few restrictions on business as possible, especially in these days of keen competition. We maintain that if any of our commercial departments, originated solely for the good of the people as a whole, is compelled to keep the price of anything above the cost of production and distribution; then . . . . an artificial and arbitrary restriction is placed on the business of that committee."

Those who oppose this principle urge that as no municipal commercial undertaking can be conducted without some risk to the ratepayers, it is only fair that the consumers should, in addition to the actual cost of generation and distribution, provide, as a form of insurance, a margin of profit for the benefit of the general ratepayer. It is he whose credit enables the municipality first to borrow at a low rate of interest, and secondly, to arrange for repayment of the capital account over an extended period. It is he whose veto may operate in restricting extensions, and who must be conciliated as the sleeping partner in the concern by the enjoyment of profits, however moderate.

While fully recognising this principle, the Board of Trade, in framing the provisional orders issued under the Electric Lighting Acts, takes care that the consumer shall not be mulcted in an unreasonable sum.

Section 52 of the model order provides for the payment out of revenue of :—

1. Working expenses, *i.e.*, costs of generation and distribution.
2. Interest on borrowed monies.
3. Instalment of sinking fund.
4. All other expenses not properly chargeable to capital.
5. Reserve fund (which duly invested in Government securities shall at no time exceed 10 per cent. of the aggregate capital expenditure).

The net surplus then remaining must be carried to the credit of the local rate.

Here again, however, the consumer is protected, for it is enacted that if the surplus in any year exceeds 5 per cent. upon the capital expenditure, a reduction must be made in the charge to consumers. On the other hand any deficiency must be payable out of the rates.

So much for the provisions enacted by the Board of Trade. It will be seen that it is taken for granted that the price paid by the consumers should certainly be sufficient to do much more than Bailie Maclay, speaking on behalf of his Glasgow colleagues, suggests. Carried to its logical conclusion, his contention would only call upon the consumer to pay the "sheer" cost of production and distribution, which amounted in Glasgow last year to a trifle under 2d. per unit. An examination of the accounts, however, shows that though the principle enunciated by Glasgow may appear revolutionary, its method of application by the "cannie Scot" leaves the consumer worse off than he is, say, in Manchester, whose ways the Bailie holds up to reprobation.

To make this clear we set out in the case of Glasgow the sum received from the consumers in the year under review, and we add the figures supplied by Bailie Maclay showing how this sum was disposed of. In doing so we work out the ratios which the sums disposed of bear to the gross sum received.

GLASGOW.

Revenue	£30,000	100 00%
Costs of production and distribution ...	£12,000	40 00%
Depreciation	10,705	35 68%
Interest on capital	4,300	14 33%
Sinking fund	1,466	4 89%
Carried forward	1,527	5 09%
	£29,998	99 99%

Average price charged to consumers, 5·08d. per unit.

It will be seen that while only 4 89 per cent. of the sum contributed by the consumer is set aside for sinking fund, a ridiculously inadequate figure, at any rate as far as the generating plant and mains is concerned, more than one-third of the revenue drawn from him is put aside for depreciation, and finally, in flagrant defiance of the law, £1,527 is carried forward instead of being handed over to the General Rate Fund. Those who differ from the Bailie in his proposition that the profits belong to the consumer will smile at the summary way in which he has excluded him from all participation therein. Bailie Maclay points to Manchester as a typical example of how not to do it. Let us see how the Manchester figures compare with those of Glasgow.

MANCHESTER.

Revenue	£49,744	100·00%
Costs of production and distribution ...	£15 284	30 73%
Depreciation	3,344	6 72%
Interest on capital	7,171	14·42%
Sinking fund	7,133	14 34%
Reserve fund	6,812	13 69%
Handed to City Fund in aid of rates ...	10,000	20 10%
	£49,744	100 00%

Average price charged to consumers, 4·63d. per unit.

If the ratepayer-consumer compares the method adopted by Manchester with that adopted by Glasgow, of disposing of the revenue contributed by him, he will, we think, be disposed to pray for deliverance from his friends.

Possibly, however, it may be urged that Bailie Maclay, in referring to Manchester, used an unhappy illustration, and, apart from it, his main contention has still to be considered, *i.e.*, whether municipal works should exist primarily for the benefit of the consumers or the ratepayers.

Our own view is that the general ratepayer has a right to demand from the consumer some *quid pro quo* for the pledging of his credit. In ordinary commercial transactions a banker, for instance, would not hesitate to demand a substantial commission for guaranteeing a credit, and the general ratepayer whose pledge of the communal property enables the community to borrow at, say, 3 per cent., is surely justified in demanding that those who are thereby benefited shall contribute the same percentage on the investment as if it were made by a company.

If such a principle were not acknowledged, there would surely be a speedy end to municipal trading in this country.

Returning to Bailie Maclay, the Glasgow ratepayer has certainly no cause to complain that the burden put upon the electric light consumer is too light a one; indeed, some Glasgow consumers are puzzled to know why, on an almost identical output, his compeer at Edinburgh gets his electricity fully ½d. per unit cheaper, and why he is not supplied at a cheaper rate than that which Aberdeen can afford on a comparatively insignificant output.

Turning to the second part of Bailie Maclay's paper on "The Repayment of Loans," we find much interesting matter with regard to the rates fixed for the liquidation of the loans in connection with the police, sewer construction, street improvement, water supply and markets; but as similar information is not afforded in the case of the gas and electricity department, we are not able to say whether the rate proposed for future years for the electricity undertaking is an equitable one, though we must repeat our surprise at the lowness of the charge of £1,466 for redemption of a capital of over £140,000.

We venture to suggest that local authorities operating under the Electric Lighting Acts should adopt a uniform rate in respect of the sums set aside annually for the sinking and reserve funds, and as those who are compelled by the Local Government Board to repay their loans in 25 years have to provide annual instalments of about 3 per cent. sinking fund, we suggest this minimum figure as the basis for general adoption.

UNIFORMITY IN PLANT.

Of all the papers set down for reading and discussion at the meetings of the Municipal Electrical Association, the one which is, perhaps, of most general interest is Mr. Wordingham's paper on "The Necessity for Uniformity in Plant and Apparatus" (see page 854), as it deals with a subject which is of considerable importance to the advising engineer and his client, to the engineer who is responsible for the working of the plant, and to the manufacturing engineer who supplies it. We have quite recently, in the editorial columns of our issue of May 27th, dealt with some of the points brought forward by Mr. Wordingham, and after a perusal of the statistics given in his paper, we find that in such matters as frequency of alternating currents and voltage of lamps there is even a greater want of uniformity than we were aware of at the time of writing the article referred to. For instance, in Table A, giving the various pressures declared by 109 central stations, no less than 20 different pressures are found, of which eight are between 100 and 115 volts, and six between 200 and 230 volts; whilst from Table B we learn that 19 different periodicities have apparently been found necessary to satisfy the requirements of 58 alternating current stations. Again, from Table D we learn that in the 51 stations using continuous current there are 38 different sizes of unit, ranging from 10 to 1,500 kilowatts, and that 30 of these are for 200 kilowatts or less; and in the 58 stations using alternating currents there are 56 different sizes, ranging from 20 to 390 kilowatts. When one considers that machines of the same output in kilowatts may be required at different pressures, speeds, and frequencies, there is good reason to agree with the author of the paper when he speaks of the chaotic state of central station practice as regards standardisation.

Having quoted statistics to show the necessity of reform, the author proceeds to make various suggestions as to the standardising of apparatus. Commencing with the declared pressure, which is the most important point, since it affects both generating and receiving apparatus, the author suggests that 100 volts and multiples thereof should be adopted as a standard, as more stations are using these pressures than any other, and as they lend themselves very well to the various uses to which central station supply is applied. There is no doubt that for many reasons this would be a convenient standard, but the tendency of later practice has been rather towards 110 volts and its multiples, and we fancy that many advocates of this latter pressure will be found who will advance the arguments that it is as easy to get incandescent lamps of 110 and 220 volts as those of 100 and 200 volts, that two arc lamps will burn better on a 110-volt circuit, and that it would be a mistake to sacrifice the 10 per cent. higher pressure and 10 per cent. lower current, with the consequent saving in mains for equally good regulation of pressure at the consumers' terminals. With regard to consuming devices, we fully agree with the author of the paper as to the advantages that would be gained by adopting a limited number of standard candle-powers for incandescent and arc lamps, and of standard sizes of motors. The greatest difficulty would be experienced with the motors, as in this case the various requirements as to speed enter into the question, and the manufacturer would derive but little benefit from the fixing of standard outputs in brake horse-power, if these outputs are required at varying speeds. The point which is of most interest to the manufacturer of dynamos and motors is, we should imagine, that the output per revolution should be taken as the basis of any standardising of sizes, as this would enable him to keep to a small number of sizes of machine frame, and it is in this part of the manufacture that the multiplicity of sizes leads to the greatest increase in the cost of production.

The same difficulty occurs in the fixing of a series of sizes of generating plant, since the question of speed comes in in all cases where the engine and dynamo are direct coupled. At the present time there are already signs of a tendency to standardise so far as the output in kilowatts is concerned; but there are two distinct interests that have to be considered in this matter, viz., those of the engine maker and those of the dynamo maker. Now it is well known that the speeds at which engines of equal horse-power will be run by different makers vary very appreciably, and the question, therefore, arises whether the engine makers are to be persuaded to adopt a standard speed for a given horse-power, so that the dynamo makers can standardise the sizes of their machines; or whether, as is the case at present, the dynamo maker is to adapt his dynamo to the speed of the engine to which it is to be coupled, in which case he must be prepared to supply a different machine to go with each type of engine although they all give the same output in kilowatts.

With regard to the sizes of unit to be adopted, we think that in very many stations the mistake has been made of commencing with units of insufficient size; the reason being that more attention has been paid to obtaining such a subdivision of the plant as would give the most economical working during the initial stages of the undertaking than to fixing a size of unit which would suit the probable requirements after a few years' working. Mr. Wordingham seems to suggest six as the minimum number of sets which should be installed for a beginning, but we should prefer to start with a smaller number in any station where the probable ultimate capacity was much greater than the initial capacity; as otherwise the first sets would in a few years' time be found to be too small, and very probably would have to be taken out altogether and replaced by larger units. The statement in the paper that it is preferable to have reserve plant in the shape of machines which can be safely worked at 25 or 33 per cent. beyond their most economical load is one that we quite agree with, and is really only another way of saying that machinery should be employed which gives its most economical results at three-quarter load or thereabouts, a procedure we have advocated in these columns before now.

The question of standardising distributing plant is next dealt with in the paper, and the suggestion made therein, that a certain limited number of standard sizes of cables should be agreed on, is one which should meet with the approval of cable manufacturers; as, notwithstanding the large number of different types and sizes of cable described in their published lists, it is necessary, we understand, in very many cases to make special cables to meet the specifications issued for supply mains.

The whole question of standardising plant is, owing to the many interests involved, a complicated one, and will require a good deal of thrashing out; but we believe that much good would result from a thorough examination of it by a representative committee composed of those who have to use the plant and those who have to make it. We did not know, when we published the article already referred to and invited the attention of our readers to the question of standardisation, that we were so soon to learn that the matter was already under consideration; and we hope that the preliminary steps which have already been taken will lead to the appointment of a thoroughly representative committee, and that their deliberations will result in the adoption of more uniform requirements on the part of the users of electrical plant, as we consider that benefit will result therefrom to all parties, as the cheaper production and quicker delivery which should follow such a movement should still further develop the use of electrical apparatus.

WIRELESS TELEGRAPHY.

It is not surprising to find that the public interest in the Marconi system of wireless telegraphy is rapidly increasing, and demonstrations of a more or less public character are being constantly carried out. Some allusion has been already made to some interesting experiments on this system which were conducted some days ago between the House of Commons and St. Thomas's Hospital. One station was in the small smoking room just off the Terrace at the House of Commons, and the other was fixed in the treasurer's house at St. Thomas's Hospital, at the opposite side of the river Thames.

At the House of Commons end the instruments were placed in the small smoking room alluded to, and a wire was led through the window and attached to a short pole, which was tied to one of the lamp-posts on the Terrace a few feet from the window. At the hospital end the instruments were also under cover in an upper room, and the wire in that case was led from the window down to the top of a lamp-post about 6 feet from the wall of the hospital. We need hardly repeat here the method of sending signals, but we may mention that the time occupied in fixing both installations was under an hour, and immediately after, the Speaker, Sergeant-at-Arms, and other Right Hon. and Hon. gentlemen came into the smoking-room to see the first experiment.

Many messages were sent between the two institutions, and it is necessary to record that the first news of the resolution passed by the House of Commons in connection with the public funeral of the Right Hon. W. E. Gladstone was conveyed wirelessly to St. Thomas's Hospital in the terms of the following message sent by Mr. O'Malley:—"The House of Commons to-day solemnly and unanimously resolved that a public funeral be accorded the late William Ewart Gladstone, and a monument be raised to his memory in Westminster Abbey," which was suitably acknowledged from the hospital end of the wireless system. The various messages sent and received were all printed on tape, and afforded every satisfaction to those who witnessed the experiments at either end. Of a more practical nature, however, was a series of experiments which were carried out by the Wireless Telegraph Company on the 3rd inst. before Lord and Lady Kelvin and Lord Tennyson at their Alum Bay station, Isle of Wight. After inspecting the outside of the station, the visitors went into the operating room, where they carefully examined the instruments and witnessed the sending and receiving of several messages. Lord Kelvin sent messages wirelessly to Dr. MacLean, his chief assistant in the physical laboratory of the University of Glasgow, to Sir George Stokes at Cambridge, and to Lord Rayleigh and Mr. W. H. Preece in London.

The message to Sir George Stokes was as follows:—"Stokes, Lensfield Cottage, Cambridge. This is sent commercially paid at Alum Bay for transmission through ether, 1s. to Bournemouth, and thence by postal telegraph, 15d. to Cambridge.—Kelvin."

Lord Tennyson's message was to his nephew at Eton, and was as follows:—"Sending you message by Marconi's ether telegraph, Alum Bay to Bournemouth, paid commercially thence by wire; very sorry not to hear you speak your Thackeray to-morrow.—Tennyson." Lord Kelvin insisted on paying 1s. per message royalty for the use of the Marconi system on all the messages he sent, in this way wishing to show his appreciation of the system, and to illustrate its availability already for commercial use.

With the achievement of these striking results one ought not to wait long before a practical application is made of the wireless telegraph.

CONSULTING ENGINEERS AND PUBLIC COMPANIES.

Writing to the *Engineer*, a correspondent finds fault with our contemporary's commendation of Sir F. Bramwell's action in the case of the Hydraulic Joint Company. He thinks that an engineer ought not to step on one side to tell anything beyond the narrow rut in which promoters wish him to carry out his tests. As we have already said, we do not know that an engineer need particularly concern himself with patent rights of a matter upon whose mechanical merits he may be reporting. We do not like the tone of the letter; nor do we think the writer has picked his illustrations at all well. He cites a case of an engineer testing an American machine, and reporting favourably upon it in ignorance that there was already a better English machine in the market, and he asks us to judge if the engineer was to blame. This is not a case in point. The man reported favourably on a good American machine. It was used in some special trade apparently, and the engineer could not necessarily be expected to know there were better English machines. But if he had known and was honest he would have informed his employers of the fact. Possibly they knew, but it is equally possible they did not know.

Let us quote a case ourselves. The owners of a patent wanted certain comparative tests. Having got them they objected to pay the fees on the ground that the tests were not conducted on the lines they desired. The particular point of dispute was the employment of the patentee to perform one particular and essential function, both on the new process and on the old. It had already been declared that the new process effected a saving of so much per cent. as compared with the old process.

The testing engineers refused to lend themselves to this, as the results obtained would have been simply equivalent to a record of two performances of one man, conducted in one case to the best of his ability, in the other as he deemed fit. The case went to the Courts, and the verdict was for the engineers, who were practically commended for not allowing themselves to be tied by a promoter's chain.

Most engineers will be familiar with the facilities afforded by promoters' plant for misleading mechanical tests. It is to be regretted that too many engineers satisfy any qualms they may feel by adding some remark inconspicuously in their report which will not appeal to the lay public.

The *Engineer's* correspondent thinks an engineer is an over-scrupulous fool who does not allow himself to be a medium for gulling the public. Why should he care for the public, who will certainly not care for him when he comes to beggary through his honesty? This is all very well. Because the public is a "hass," the engineer is to be free to be a rogue. This is not satisfactory. But out of the 20 millions of the public, there are peradventure 10 righteous men. Is the engineer to assist to defraud the 10 righteous, simply because he has a poor opinion of the 19 and odd millions?

The letter we criticise simply begs the whole question. We have already stated that an engineer must be allowed to judge each case by itself. We would add a further suggestion that, for the guidance of all testing engineers, the various engineering societies should combine to retain the services of some independent man or men to whom, in a difficulty an engineer could go for advice if he has doubts as to the propriety of the course he should take, in any case where he feels a temptation to be, in the words of the *Engineer's* correspondent, "too honest."

A POWERFUL ELECTRO-MAGNET.*

M. SAGNAC exhibited to the Society a new electro-magnet for the production of very intense magnetic fields, constructed from the designs of M. Pierre Weiss. Most electro-magnets now in use are of an old type which has not changed since the time of Ruhmkorff, and notwithstanding their admitted excellence, are inferior to those designed from the now recognised properties of the magnetic circuit.

M. du Bois showed this from theoretical considerations, and verified his conclusions with a powerful annular electro-magnet weighing 270 kg., and absorbing 6·5 horse-power. With this he obtained the most intense field yet reached, a field of 38,000 units. The new instrument shown to the Society gives comparable results, though it is much less cumbrous and costly, weighing only 100 kg. and absorbing 2 horse-power.

The rectangular magnetic circuit is arranged to saturate the poles only. The use of but a small excess of section in the part of the circuit which is distant from the poles effects a notable economy in the ampere turns, because the permeability increases very rapidly below the saturation point.

Ease in adjustment of the pole-pieces is of some importance. The adjustment is made by an arrangement like the back centre of a lathe, so that either pole can be advanced or withdrawn with precision, while the construction is sufficiently strong to prevent any flexure. The rectangle forming the magnetic circuit is suspended horizontally by two strong bolts to an oak frame, leaving the space below the poles available for the other apparatus. The field obtained varies with the form of the pole-pieces. At the common apex of two conical armatures it is infinite, but decreases as the cones are more truncated. With cones truncated so that the small base is 1 cm. in diameter, $\mathfrak{H}$ = 30,000 units.† But the true measure of the quality of the instrument is the intensity of the magnetisation of the pole-pieces necessary to produce a given field.

$\mathfrak{I}$ = 1,630 is the figure deduced from M. du Bois measurements on his more powerful apparatus. Knowing this, one can calculate the field to be obtained with any cones; for instance, with a space 1 mm. × 2 mm., the apparatus would give 44,000 units. With the aid of M. Weiss's electro-magnet, M. G. Sagnac performed before the Society the experiment by which M. A. Cotton showed the change produced in the wave length of sodium light by a magnetic field. The edge of a yellow sodium flame A, observed against the back-ground of a similar flame B, is seen to be black if the flames are suitably arranged. This is due to the fact that the sodium flame is surrounded by a zone some millimetres thick of non-luminous or slightly luminous gas containing sodium vapour, which absorbs the light of the lines, D_1 D_2. M. Cotton has remarked that this black border, first noticed by Crookes, only appears if the lines, D_1 D_2, in the flame B are very narrow. The border disappears completely if B is a brilliant flame containing much sodium, and giving broad D lines. It can be shown in other ways, that the edge of the flame gives two very narrow absorption lines, D_1 D_2. They are so narrow that the change of period produced in the flame, B, by a magnetic field, destroys the absorption, and causes the black border round the flame, A, to disappear, and to re-appear sharply when the magnetic field is suppressed.

This experiment was described in the *Comptes Rendus* of November 29th, 1897; and with more detail in an article in *Eclairage Electrique* (March 5th, 26th, 1898), where are also given experiments on the reversal of the sodium lines, and on the application of reversed lines to the study of the Zeeman effect.

In the experiment performed before the Society, the observation was made parallel to the field. The very intense field employed makes the experiment easy, but is not really necessary. A field of 1,000 units is sufficient if the flames are suitable. The observation can be made at right angles to the field, and the different behaviour of the vibrations when parallel and perpendicular to the field can be observed with the aid of a nicol. Or the arrangement proposed by M. Kœnig (*Weidemann's Annalen*, December, 1897, suppl.) may be employed for observations normal to the lines of force.

* Translation of a paper read before the Société Française de Physique, May 20th, 1898.

ROYAL SOCIETY CONVERSAZIONE.

THE second conversazione of the Royal Society held on June 8th was not distinguished by anything very remarkable in the number or originality of the electrical exhibits. The new gas Krypton—the latest find of Prof. Ramsay in the residues of the atmosphere—was the great scientific sensation of the evening. Only one part of this gas occurs in 10,000 parts of air, and it was necessary to evaporate about one litre of liquid air in order to find it. The spectrum shows two brilliant lines, one of which is almost coincident with a line in the helium spectrum. The finding of so many new elements recently, in a field so well explored as the atmosphere, is calculated to shake the foundations of our chemical faith.

† Ewing gives $\mathfrak{H}$ = 24,500, $\mathfrak{B}$ = 43,350 as the highest induction he has obtained, the dimensions of his "isthmus" being 2·66 mm. diameter, 3·5 mm. long.

The Steljes Printing Telegraph Recorder was exhibited by Louis P. Casella. This instrument is operated by the Wheatstone A B C magneto-transmitter, and does not require batteries. The printing lever is raised and held up by the alternating current from the transmitter energising an electro-magnet, and when the circuit is broken it is released and allows the weights to do the printing. About 12 milliamperes are required for the instruments, several of which can be worked from one transmitter over a distance of at least 40 miles. The messages sent are printed simultaneously at the sending and receiving stations, and require no skilled operators. The device for placing all the instruments in circuit, in unison, is an interesting one. It prints with rubber type on a tape.

The automatic telephone switch exhibited by the Direct Telephone Exchange Syndicate appeared to be a remarkably efficient instrument for doing the work of the telephone girl. Exchanges for 1,000 or more subscribers have been worked successfully on this system. Secrecy of conversation and continuous service day and night are some of the obvious advantages of such systems, if they can be successfully carried out.

Mr. Roxby exhibited some remarkably good specimens of photographs in natural colours obtained by a process invented and patented by Dr. Selle. As in Ives's, Vogel's, and similar processes, three negatives, representing the three primary colours, are first obtained. From these negatives (in Selle's process), positives are printed on coloured collodion films and superposed. Collotype printing surfaces, with suitably coloured inks, may also be used when larger quantities are required. These three colour processes are likely, in the future, to play a very important part in the reproduction of works of art.

Mr. Campbell Swinton has considerably improved his cathode lamp since the last conversazione. He has now been able to get a light of an intensity of 100 C.P., 1 watt giving about 1 C.P. Mr. Swinton uses alternating currents of about 10,000 volts to excite a tube with two cathode discs which focus the cathode rays on a refractory material. The refractory material becomes brilliantly luminescent. This is a considerable advance upon Ebert's lamp, which never gave much more than 1 C.P., though it was asserted to be enormously more efficient than anything claimed by Mr. Swinton.

Messrs. Watson & Sons exhibited the new induction coil, designed by MM. Wydts and Rochefort, described in the ELECTRICAL REVIEW, 42, p. 165, and criticised recently by Mr. Apps in a paper read before the Röntgen Society (ELEC. REV., Vol. 42, p. 782). The instrument exhibited was said to yield an 8-inch spark. The secondary wire weighed less than 2 lbs., and occupied a narrow central position round the primary wire. The insulation was effected by means of a thickened oil of secret composition.

Lord Blythswood and Mr. E. W. Marchant showed some interesting experiments bearing on electrostatic phenomena in vacuum tubes. In a specially shaped tube the flow and return of the electrified particles of the residual gas was shown to be affected by external bodies suitably placed outside the tube. The diagrams illustrating the variation of potential difference at different distances in tubes with movable electrodes were especially interesting. A peak of maximum E.M.F. has been found to exist at a moderate distance between the electrodes, a rapid falling off taking place, both when the distance is diminished, and when it is increased.

Prof. Callendar's apparatus for electrically recording temperature at a distance was shown at work. Diagrams were shown of temperature curves which had been produced at a distance of a mile from the place of observation.

THE REPORT OF THE PARLIAMENTARY ELECTRICAL ENERGY COMMITTEE.

THE report from the Joint Select Committee of the House of Lords and the House of Commons on Electrical Energy (Generating Stations and Supply) has now been published.

The Committee was appointed in March to consider and report—

1. Whether, notwithstanding the provisions of Section 12 (1) of the Electric Lighting Act, 1882, powers should be given in any cases for acquiring land compulsorily for generating stations; and, if so, under what conditions as respects liability for nuisance, notices to surrounding owners, and otherwise.

2. Whether compulsory powers of acquiring land for generating stations, if proper to be given in any case, should be given where the proposed site is not within the area of supply.

3. Whether, in case of a generating station, however acquired, not being situate within the area of supply, power should be given for the breaking up of streets between the generating station and the boundary of the area of supply.

4. Whether powers should be given in any case for the supply of electrical energy over an area including districts of numerous local authorities, involving plant of exceptional dimensions and high voltage; and, if such powers may properly be given, whether any and what conditions should be imposed—

(a) With respect to system and plant, and to the construction and location of generating stations, in view of the powers of purchase conferred upon local authorities by Sections 2 and 3 of the Electric Lighting Act, 1888.

(b) With respect to the relations of the promoters to other undertakers and to local authorities within parts of the area.

5. Under what conditions (if any) ought powers to be conferred upon promoters seeking to supply electrical energy to other undertakers and not directly to consumers.

The House of Commons appointed Mr. Ashton, Lord Balcarres, Mr. Kimber, Sir Leonard Lyell, and the House of Lords appointed the Lord Privy Seal (Viscount Cross), Earl Spencer, Viscount Knutsford, Lord Monkswell.

The Committee reported:—That the Committee have met and considered the subjects referred to them, and beg leave to make the following report:—

The Committee have taken evidence from Sir Courtenay Boyle, K.C.B., the Right Honourable the Earl of Morley, the Honourable Chandos Leigh, Q.C., Mr. Preece, C.B., engineer-in-chief and electrician to the Post Office, and from Major Cardew, electrical adviser to the Board of Trade.

Counsel appeared before the Committee on behalf of the following:—

1. Central Electric Supply Company, Limited.
2. Chelsea Electricity Supply Company, Limited.
3. General Power Distributing Company.
4. Midland Electric Corporation for Power Distribution, Limited.
5. House-to-House Electric Light Supply Company, Limited.
6. Kensington and Knightsbridge Electric Lighting Company, Limited.
7. London Electric Supply Corporation, Limited.
8. County of London and Brush Provincial Electric Lighting Company, Limited.
9. Westminster Electric Supply Company, Limited.
10. Corporation of Doncaster.
11. Corporation of Glasgow.
12. Corporation of Huddersfield.
13. Corporation of Ilkeston.
14. Corporation of Lincoln.
15. Corporation of Manchester.
16. Corporation of Nottingham.
17. Corporation of Retford.
18. Corporation of Rotherham.
19. Corporation of Salford.
20. Corporation of Sheffield.
21. Corporation of Wolverhampton.
22. London County Council.

The Corporation of Edinburgh and the Metropolitan Electric Supply Company were represented before the Committee by their Parliamentary agents.

The several Bills now pending in Parliament in which effect is proposed to be given to new developments of the electrical industry, have been brought to the notice of the Committee, but they have not considered them in detail, nor taken any evidence upon them. They have treated them only incidentally, as showing the lines upon which the industry is likely to expand. They have laid down the general principles which they suggest should guide Parliament and the Board of Trade, but whether those principles should in whole or in part be applied, and whether any and what special conditions should be imposed, must, of course, be decided in each individual case, according to its merits.

The Committee have heard all the witnesses tendered by the several parties, and have agreed upon the following answers to the several questions referred to them:—

Question 1.—(a) The proved public advantages of electrical energy in the generation of light and power warrant, in their opinion, the granting to undertakers of compulsory powers for acquiring sites for generating stations and lands or easements for pipes and mains therefrom, and other works.

(b) Provision should be made for the granting of these powers in the provisional orders of the Board of Trade, subject to confirmation by Parliament. Such provision would facilitate a continuance of the existing practice, according to which more or less uniform conditions under which undertakers are to work are provisionally settled by the Board of Trade. Procedure by private bill should be reserved, as at present, for exceptional cases.

(c) Such powers may be given either to local authorities or to incorporated companies, whether the incorporation be by special Act or provisional order or under the Companies' Acts.

(d) With respect to liability for nuisance, they are of opinion that where the site for a generating station is acquired under compulsory powers, and is specified in the provisional order or special Act, the undertakers should not be subjected to any further liability than that which, according to Lord Blackburn (*Geddis* v. *Bann Reservoir*, 3

App. Cas. 455),* is imposed by the common law in the case of persons exercising statutory powers and duties. On the other hand, where the site for a generating station is acquired by agreement, they think the undertakers ought to be subject to the liability imposed by the common law.

(c) With respect to notices, they think that the existing practice as to notices to the local authorities and also to owners, lessees, and occupiers of lands proposed to be taken should be followed.

With respect to notices in gazettes and newspapers, they do not suggest any amendment of the existing procedure.

The amendment of the Electric Lighting Acts, necessary to empower the Board of Trade to grant compulsory powers, will, they assume, comprise provisions for notices and other matters of procedure, for which precedents are found in the Housing of the Working Classes Act, 1890, and in the Light Railways Act, 1896.

Question 2.—Subject to the above observations, the Committee are of opinion that compulsory powers for the acquisition of land for a generating station, and lands or easements for pipes and mains and other works to the area of supply, may also properly be given where the proposed site is not within the area of supply. The local authorities for the district or districts in which the site is, and the owners, lessees and occupiers, should have the same notices and the same *locus standi* as if that district were the area of supply. Provision also should be made for serving notices to local authorities and owners, &c., of districts or land through whose districts or land mains are to be run from the generating station to the area or areas of supply.

Question 3.—In the case of powers being given for the erection of a generating station outside the area of supply, they think that powers may properly be given for laying the mains in streets leading from the generating station to the boundaries of the area of supply. In such case the local authority liable to maintain these streets should have the same option of themselves breaking up and reinstating the streets at the undertakers' expense as is now given in the provisional orders to local authorities within the area of supply, and should be empowered accordingly.

The Committee are of opinion that while it may be advisable to maintain the veto of local authorities as to the erection of overhead wires, given by Section 14 of the Act of 1882, in respect of other electric wires, it is not advisable that in the case of overhead wires for traction purposes the local authority, other than the London County Council and County Boroughs, should have an absolute veto. While due weight should be given by the Board of Trade to the representations of local authorities, the Committee think that in the case of wires for purposes of traction it would be sufficient to give a *locus standi* to such local authorities.

Questions 4—5.—Where sufficient public advantage is shown, powers may be given for the supply of electrical energy over an area including districts of numerous local authorities, and involving plant of exceptional dimensions and high voltage. The Committee further think that undertakings of this character may properly be authorised on conditions differing in some respects from those imposed by and under the existing Acts.

Among the undertakers referred to in the preceding paragraph will be found undertakers supplying energy chiefly in bulk or wholesale to other undertakers, whether local authorities or companies, whose areas of supply are wholly or partly within the area of such bulk or wholesale supplying company, and who distribute the energy so obtained to consumers.

As to giving compulsory powers of purchase of undertakings to local authorities, the Committee, without questioning the policy of Parliament in having given such powers, observe:—

First.—That when the power of purchase was granted in 1882 and 1888, no such schemes of supplying energy in bulk were contemplated as are now before Parliament.

Secondly.—That when the power of purchase was thus granted, the question then before Parliament was chiefly one of light; whereas the evidence given before the Committee shows that although electric light is at present the predominant feature of the enterprises now before the public and Parliament, the application of electrical energy in the form of power to an infinite variety of other purposes is likely to be in the near future the predominant feature and function of these undertakings.

Thirdly.—It does not appear to them that an undertaking supplying energy in bulk at high voltage and in comparatively few mains is, as a rule, so desirable for the local authority to acquire as a low voltage undertaking with many distributing mains.

The Committee think the provisions of the Electric Lighting Act, 1888, enabling the local authority to purchase an undertaking after a term of years, inapplicable, as a general rule, to the case of an undertaker supplying energy in bulk at high voltage, but there may be special cases where it is desirable that the local authorities should have the right to purchase reserved to them. To meet such cases they suggest that the Board of Trade should have power to insert the purchase clause in the provisional order, if the local authorities concerned can, in the opinion of the Board, show good cause for such a course.

It is to be observed that the exemption from liability to compulsory purchase would not prevent local authorities, either alone or in combination with other local authorities, from applying for powers to purchase, but each case would have to be judged on its merits, and such conditions imposed as might be thought fit.

In cases of the exemption from liability to purchase, it would be specially expedient in the interest of the consumers that some kind of sliding scale, as in the case of gas undertakings, should be imposed.

In connection with this question of purchase under Section 2 of the Act of 1888, evidence has been given to the effect that with a view to secure in London one and the same time for the execution of the powers, the Board of Trade have in some cases imposed upon undertakers a less term than 42 years within which they are liable to be purchased.

The Committee suggest that if the full period of 42 years is not granted, and if a substantially shorter period is imposed by the Board of Trade, the terms of purchase should in each case be reconsidered.

The Committee consider that the provisions of the Electric Lighting Act, 1888, which require the consent of the local authority as a condition precedent to the granting of a provisional order, should be amended. In their opinion, the local authority should be entitled to be heard before the Board of Trade, but should not have, so to speak, a provisional veto, only to be dispensed with in special cases by the Board of Trade.

With respect to conditions, the Committee think it reasonable that where a local authority, or company having power to supply light within a certain area of supply, seeks to obtain compulsorily land for a generating station outside that area, it should not be allowed, except where Parliament or the Board of Trade decide otherwise, to supply from that generating station any area outside the area of supply of such authority or company.

With regard to the powers of purchase conferred by Section 2 of the Act of 1888, they are of opinion that local authorities should be empowered to purchase undertakings partly outside their area of supply on terms agreed upon by the Board of Trade.

PROVISIONAL ORDERS.

The ordinary clause which forbids any connection with the earth, except with the approval of the Board of Trade, and the concurrence of the Postmaster-General, should be inserted in every case.

As to protection of telegraphs and telephones, the clauses now inserted in provisional orders seem to be sufficient in all ordinary cases, and regulations to protect the public can be made by the Board of Trade under Section 6 of the Act of 1882.

The clauses which protect gas and water-pipes have worked satisfactorily, and should be continued; but the Committee would direct attention to the observations of Mr. Preece as regards the difficulty arising from the working of tramways by trolley wires; his suggestion as to a strong "control clause" should be carefully considered.

They are disposed to concur generally with Lord Morley and Sir C. Boyle in thinking that, as compulsory powers are given solely for the benefit of the public, it would be desirable to make some provision against these companies being subject to foreclosure on mortgage, and against their rolling stock and plant being liable to distress.

The Committee have directed the minutes of evidence, together with an appendix, to be laid before your Lordships.

Though not directly connected with the matter of the above report, the following discussion which took place on Tuesday night in the House of Commons is of considerable interest. Our report is taken from the *Times* of Wednesday.

On the order for the second reading of the Electric Lighting Provisional Orders (No. 12) Bill, which is to enable the local authorities of Bermondsey and Marylebone to lay down mains for the supply of electric energy, although it can be done by private enterprise under statutory powers which have been conferred,

Mr. CRIPPS (Gloucester, Stroud) moved the rejection of the Bill, remarking that the Bill raised some of the most important questions which could possibly be raised in connection with our industrial policy, and there was a principle involved which, if sanctioned by the House, applied not only to electric lighting companies, but to all industrial companies whether for the construction of tramways or the supply of gas and water. He spoke in no sense on behalf of the companies involved. He had no connection with them, and no interest in them whatever. The question was whether a private company authorised by Parliament to carry on an industrial undertaking, and which had admittedly carried out all its obligations to the public, should by means of rate-aided competition be be liable to what was, in substance, expropriation without compensation. This was an insidious and dangerous infringement of the recognised principle of security—that every man should be compensated before his property—particularly property guaranteed under an Act of Parliament—could be attacked or depreciated. There was no precedent for the proposition before the House. Where a private company did its duty with statutory powers, and against which no allegation of mismanagement was made, it was only right and fair that it should be bought out before anything in the nature of rate-aided competition was allowed. The principle applied not only to electricity, but to gas and water undertakings. It has been justified, and properly, from two points of view, that it was the only fair way of treating those who had invested under the guarantee and faith of Parliament, and that, unless the local authority sought to purchase, rate-aided competition was wasteful and wanton extravagance. No private enterprise could, in the long run, hold its own with rate-aided competition, and where once Parliament had sanctioned private enterprise it did not allow it to be unfairly crushed. There was no case here of a company not doing its duty and not fulfilling its obligations. They had the assurance in this case of the local authority that the company was amply and properly fulfilling all its duties within its district. They therefore came back to

* Lord Blackburn's opinion is in these words: "It is now thoroughly well established that no action will lie for doing that which the Legislature has authorised, if it be done without negligence, although it does occasion damage to anyone; but an action does lie for doing that which the Legislature has authorised if it be done negligently. And I think that if by a reasonable exercise of the powers either given by statute to the promoters, or which they have at common law, the damage could be prevented, it is, within this rule, negligence not to make such reasonable use of their powers."

the pure question of principle of whether it was fair, where a company had invested its capital on the security of Parliament that the concession was for 42 years, that the ultimate purchasing authority should be allowed to come in, and, by means of rate-aided competition, to depreciate the company's property or to crush out private enterprise altogether. He moved that the Bill be read a second time this day six months.

Mr. Kimber (Wandsworth) seconded the motion for the rejection of the Bill. Although in the Act of 1888 it was provided that the fact of a private company having received a provisional order should not prevent the Board of Trade from giving another order to a local authority, it was implied that the Department should exercise the power delegated to it upon principles of equity. The Board had the duty, with the power, to see that the recipients of the provisional order performed the duties required, but the Board of Trade misconceived its duty if it deliberately exercised its arbitrary confiscatory power, saying to a local authority "take possession of the undertaking of this successful company, it will enable you to reduce your rates." The Board of Trade was a *quasi*-judicial body and should exercise its powers on principles of justice.

Mr. Stuart (Shoreditch, Hoxton) said the speech of the hon. and learned member who moved the amendment was an argument against the Act of 1888; it was now quite out of date. This was no new raid of an unusual kind. In the Act of 1888 it was distinctly provided that the grant of authority to any undertakers to supply electricity within an area "shall not in any way hinder or restrict the granting of a provisional order to the local authority." There was no more to be said about the matter except that these words were introduced into the Act of Parliament as the result of a prolonged negotiation and after a due consideration of all the circumstances of the case.

Mr. Lafone (Southwark, Bermondsey) supported the provisional order, contending that where a company had neglected to do its duty, the local authority should be enabled to step in and do the work.

Sir A. Forwood (Lancashire, Ormskirk) observed that when the Act was passed with the clause reserving power to the Board of Trade to concur in the granting of licenses, that was regarded by the municipalities as a protection to them from the monopolies which had been created by gas companies in previous years. Feeling they had that protection, they did not oppose the obtaining of provisional orders by private parties. Had it been supposed that by not opposing the provisional orders they were going to hang round the necks of the municipalities a monopoly such as that which had been hung round by the gas companies for years, the corporation of which he was a member would have strenuously opposed the passing of any provisional order which would have had that effect. The various private lighting companies had accepted these orders under the conditions of the Act of Parliament which had been quoted. The shareholders knew perfectly well the risks and conditions under which they entered into the businesses and invested their money, and it would be a mistake at this stage to take away from the Board of Trade or municipalities the powers reserved to them under the Act. The clause in the Act of 1888 was a reasonable protection to the municipalities against monopolies, and an adequate protection against undue pressure on the part of municipalities. He thought these electric lighting systems were likely to be taken up very largely by municipalities. This country was sadly behindhand in the matter of electricity. It was a century (*sic*) behind the United States in this respect. In America they had established enormous central power stations, from which not only did they provide for the lighting of a district, but they generated the power for electric tramways and for small industries. What could be more calculated to improve the condition of the people than to enable a small manufacturer to take into his workshop sufficient electrical power to enable him to produce articles, in competition it might be, with larger undertakings? Electric lighting would soon become like gas and water, a public necessity, and such it ought to be in the hands of the municipality.

Mr. Bartley (Islington, N.) said he was doubtful of the wisdom of local authorities embarking on those undertakings; but there was no doubt that the spirit of the age in London was for local authorities to embark on them. There was no doubt also that words were expressly inserted in the Act of 1888 to prevent companies from securing a monopoly of electric lighting in their various districts, and therefore the companies entered on these enterprises with their eyes open. If London municipalities were to be debarred from entering upon these undertakings, it would be very bad for the Government side of the House.

Mr. Knox (Londonderry) thought the House should have some guidance from the Board of Trade in the matter. There were two cases dealt with in the provisional orders—Bermondsey, in which the company had not performed its duty, and Marylebone, in which the company had provided a good service. The object of the Act of 1888 was to give security to any company which gave a good service, and to protect the public against inefficiency and overcharge. But the Board of Trade had given to the local authority in Marylebone competitive powers with the existing company in an area which was being well served by the company. That appeared to him to be going beyond the Act of 1888. If private capital were deterred by such action of the Board of Trade from entering upon these undertakings it would not in the end be for the good of the community.

Mr. Ritchie (Croydon) said he desired to tell the House the position of the Board of Trade in regard to this matter. Applications for provisional orders were not received by the Board of Trade from the local authorities of Bermondsey and Marylebone alone. In one case the local authority and a private company, and in the other case the local authority and two private companies applied for provisional orders for a second supply of electric lighting in their respective districts. The Board of Trade had to consider, first, whether or not any additional provisional order should be granted; and if the provisional order were to be granted, whether it was to be granted to a private company or to the local authority. He had no hesitation in deciding that it would not meet with the approval of Parliament if the Board of Trade were to reject the application from the Vestry and to give the additional provisional order to another company. The hon. and learned member for Stroud had contended that as long as the existing company was properly discharging its duty no second order should be granted in the locality. The meaning of that was that a monopoly was to be given in each area to the company which first obtained the order. That was not only contrary to the public interest, but absolutely contrary to the direction of Parliament. The Act of 1888 clearly showed the intention of Parliament to be that a second order might be granted in any locality, either to the local authority or to another company. Subsequently to the passing of that Act an inquiry was held by Major Marindin as to the conditions under which provisional electric lighting orders might be granted in the metropolis; and he laid it down distinctly that two companies might be granted an order in each area. Therefore it could hardly be said that a company applying for an order after the Act of 1888, and after this inquiry of 1889, did not do so with its eyes open to the possibility of competition. Hon. members had shown that the competition of a local authority might be keener than that of another company, but the Act of 1888 having expressly provided that a local authority might apply for and be granted an order, it was impossible for the Board of Trade to have adopted any other course in this case than that which they had taken. The Board of Trade had not gone into the merits of the case; that was left to the Committee of the House. If the Board of Trade had refused either of these orders Parliament would have been precluded altogether from considering the applications. His view of Section 1 of the Act of 1888 was that it imposed on the Board of Trade the duty of receiving applications, and, unless there was some strong reason other than those which had been advanced, to grant the order in order that it might come before Parliament. If the House of Commons rejected the Bill on its second reading it would not be in accordance with the traditions of the House or with public policy.

Mr. Bryce (Aberdeen) said that the right hon. gentleman had shown that the Board of Trade had no option but to send these proposals to the House. Further, the House was bound to send them to a Committee, for otherwise the Act of 1888 would in effect be repealed. It seemed to be taken for granted that the present lighting arrangements in Marylebone were quite satisfactory. As a matter of fact he, as a resident, knew that that was far from the case. He hoped that the House would support the Board of Trade.

Mr. Brodrick (Surrey, Guildford) wished to corroborate what had been said by the right hon. gentleman of the electric light supplied by the Marylebone Company. It had been assumed throughout the discussion that the supply was satisfactory. He could assure the House that those who had the light in their rooms had made many complaints. When it was proposed to grant a monopoly for 32 years this should be considered by the House.

The House then divided—

For the amendment	114
Against	198
Majority against	—84

The second reading of the Bill was then formally agreed to.

Mr. Cripps moved that the Bill be referred to a hybrid committee.

Sir W. Harcourt (Monmouthshire, W.) asked why it should be dealt with differently from other Bills. They knew the sort of influences to which the House was exposed in regard to Bills affecting private companies, and the sort of solicitation made on Bills of this description. The hon. and learned member had given no reason why the Bill should be dealt with exceptionally. But probably he thought that in a hybrid committee he would have a better opportunity than he now had of defeating the measure.

Mr. Cripps said that, after the statement of the right hon. gentleman, he would withdraw his motion.

The motion was, by leave, withdrawn.

LONDON COUNTY COUNCIL.

Telephones and Generating Stations.

Mr. McKinnon Wood (chairman of the London County Council) presided on Tuesday afternoon at the County Hall, Spring Gardens, over a conference of members of the Council, and the representatives of Metropolitan local authorities. The conference was called to consider the question of telephones and also the report of the Joint Committee on Generating Stations for Electricity in Bulk.

The Chairman in opening the proceedings expressed the great gratification he felt at the representative character of the gathering, and said he had never known a more representative body of local authorities assembled in that hall before. As they knew, a conference of provincial authorities had already been held, for the Council considered the matter was of national importance. At that gathering he was struck with the unanimity which prevailed, and there seemed to be a feeling, with no dissention whatever, that the telephone service at present was grievously restricted, and that reduced cost and improved efficiency would cause very great development. They also protested very strongly indeed against the claims made to break up the streets and override the authority of the local authorities. With regard to London they had a special grievance, for they had the dearest system of all, and they felt that there was a very wide field for extension in the Metropolis. Now only those engaged in extensive commercial transactions used it, and it would be a great advantage if it could be used in smaller businesses; therefore, they felt it most desirable that those who represented all the districts in London, should, if possible, unite in placing their views before the committee which was thoroughly investigating the subject. With regard to the other question, that of generating stations for the supply of electricity in bulk, they had a direct interest in that, and he felt that in the near future that interest would be greatly increased. Consequently it was considered expedient to discuss that question also at the conference.

Mr. Beachcroft pointed out that it was important that the evidence given before the Joint Committee should be before them to enable them to come to a conclusion.

The Chairman: I believe the report of the committee has been circulated.

Mr. Ogilvie (Lambeth) in proposing the first resolution, said that the National Telephone Company, having taken the wrong line at first, persisted in sticking to it. It seemed that the Post Office had gone body and soul over to the company, but he thought the telephone was not a thing out of which private companies should make profits. The service was both costly and inefficient. The company had paid large sums in buying up opposition, and the users had to pay for it. He moved:—"That in the opinion of this conference the present telephone service of the London area, as supplied by the National Telephone Company, is both inefficient and and inadequate; that the charges, as compared to those made by the same company in the provinces, are much too high, and that these disadvantages to London are largely due to the abandonment by the Post Office of that principle of competition which was expressly adopted prior to 1892 for the protection of telephone users."

This was carried without discussion.

Mr. John Smith (St. George's-in-the-East) moved, and Mr. Mortimer (Rotherhithe) seconded, the following motion:—"That this conference views with alarm the action of the Post Office in using, for the benefit of the National Telephone Company, its special powers as to the breaking up of streets, as instanced in the recent case of the Commissioners of Sewers and the Post Office; and urges the Select Committee on Telephones, which is now sitting at the House of Commons to preserve intact that control over the streets which has hitherto been vested in the municipal authorities.

Mr. Dewey (Islington) while against any interference with the streets, contended that the local authorities could not give the company permission to break open the streets, inasmuch as the Telephone Company had no statutory powers whatever for the purpose of breaking up streets or laying their mains. At present they were placed in the invidious position of being told that they placed obstacles in the way of the company giving a proper service, but the vestries had no power to give the permission. He knew that local authorities had given consent, which he ventured to say they had no right to give.

Mr. Begg (Limehouse) said they had allowed the company to lay their mains under their streets for five years, but the public had received no benefit and the company would not get an extension. Their clerk said they had the right to give permission, and he was as good a lawyer as Mr. Dewey.

Mr. Benn (L C.C.) trusted that one result of the conference would be to band the vestries together to fix a universal charge as rent for their streets. It was a question whether the London County Council could extract a rent, but the vestries, if they combined together, might get a considerable sum.

Mr. Beachcroft (L.C.C.) said the motion was of wide application, because the question of the Council's position in regard to the streets of local authorities if the Postmaster-General granted them a license would have to be considered.

After further discussion the motion was carried.

Mr. Kimber moved a resolution to the effect that considering the great public importance of the telephone, it should be taken over by the Post Office and worked as part of the postal service of the nation. He contended that the only way to get an efficient service was to have it worked under one management.

Mr. Ridley (Wandsworth) seconded the motion. It was supported by delegates from Greenwich, Lee, and Clerkenwell.

A discussion took place between Mr. Benn and Mr. Kimber as to altering the terms of the resolution so as to exclude the words "take over the system," but Mr. Kimber said he did not believe in confiscation.

Eventually, Mr. Benn proposed the following amendment:—"That in the opinion of this conference, the telephone system is of such general public importance, and calculated to become of such general benefit, that it should no longer remain exclusively in the hands of a trading corporation, but should be worked by the Government as part of the postal service of this country."

This was carried.

A motion of Mr. Lyon (Camberwell) respecting the means to be taken to combine for a telephone service was discussed at some length, and having been amended, was carried as follows:—"That in the event of the Government not undertaking the telephone service, it is desirable that the local and central authorities of the London telephone area should at once combine to secure an efficient and cheap municipal telephone service."

It was agreed that the chairman should place the resolution before the Select Committee now sitting.

Mr. Benn said that with regard to the generating stations, it was proposed to erect large generating stations to supply electricity in bulk, and the companies promoting such schemes wished to set aside the provisions of the Electric Light Act of 1888, as regarded area and supervision of the purchase clauses. The general principles embodied in these Bills were being considered by the House of Commons, and unless there was some definite proposal brought forward by the Council and local authorities they would probably be passed. One of the results might be that a local authority on acquiring the electric lighting service within its area might find its supply cut off. He thought the Council, as the central authority, should have the power to purchase the bulk companies.

Mr. E. J. Wakeling (Shoreditch) moved: "That this conference regards it as essential to the interests of London as a whole that the present purchase clause of the Electric Lighting Acts, which applies to defined areas, should also be made to apply to such companies as propose to supply electrical energy in bulk to the whole of London without regard to area."

The following motion was also carried on the motion of Mr. E. Howes (St. Luke's): "That while preserving intact the rights of the local authorities with regard to electric lighting and energy, in the opinion of this conference it is desirable that the London County Council should be in a position to undertake, if it so determine, and if so requested by the local authorities, the supply of electrical energy in bulk for the convenience of any districts desiring to be so supplied, provided they do not become competitors with the local authorities."

CORRESPONDENCE.

Purification of Sewage Effluent by Electrozone.

After reading the article in your issue of April 29th, entitled "The Purification of Sewage Effluent by Electrozone," it occurs to me that the results of an extended and systematic investigation which I carried out some time since in the same line may be of interest.

The purpose of the experimental work was to determine how much "available chlorine" is produced per ampere-hour under various conditions of current density, solution density, &c., in solutions of sodium chloride, and magnesium chloride, and also in mixtures of the trio.

I enclose a table which fairly summarises the results obtained, and is self-explanatory. It is somewhat startling to have the so-called "experts" you mention find the exceedingly huge production of 1·45 gms. Cl. per litre when, according to Faraday's law, the maximum amount possible could be but 1·32 gms.

My experiments were carried out by electrolysing four litres of solution, containing the amounts of salts indicated in the table. This quantity should be sufficient to give a good indication of what we may expect of the process on a commercial scale, besides determining the conditions under which the "available chlorine" is produced most economically.

In several instances the temperature was kept constant at about 11° C., otherwise it was allowed to rise, due to the C^2 R loss in the electrolyte.

The much better results found under this condition of low temperature pointed out very clearly the necessity of keeping the electrolyte at a low temperature.

M. C. Beebe.

Madison, Wis.

[There is no occasion for publishing Mr. Beebe's table. He does not tell us what kind of electrodes he used, and his laboratory experiences do not seem to be of any particular interest.—Eds. Elec. Rev.]

"Honour to whom Honour is Due."

Within the past week, Mr. James Wimshurst, "the inventor of the famous electrical machine," has been elected a Fellow of the Royal Society. Your article that sought to detract from his claims to that honour, has consequently failed in its main purpose. In your last issue you revert to my former criticism, and you cite various German and French authorities to show how great are the claims of Hr. W. Holtz. I have already admitted the greatness of those claims; indeed, anybody who reads Holtz's admirable papers in *Pog. Ann.* and elsewhere, must always acknowledge him the father of the "influence" machine. But he was only the father. He did not gather into one mechanism the sum of his ideas. This was reserved for Wimshurst. The Wimshurst machine is self-exciting; its polarity is subject to no capricious reversals; it does its work well in all weathers; its discharges can be regulated as to quantity, potential, and rate of interruption; and it is, for some purposes, the best possible exciter for Röentgen-ray tubes. Holtz never made a machine that combined those merits.

It is a curious and significant fact that the most modern

Holtz machines are provided with an auxiliary exciter of the Wimshurst type. This is a very proper arrangement, and indicates the exact relationship that should exist between the honoured inventors themselves.

The letter of Hr. Uppenborn consists of two parts; in the first he cites his own book, in the second he gives us a measure of his judgment. It is always a pity to deny a Teuton the luxury of a grievance. Has Hr. Uppenborn forgotten the wise saying of Karl XII.: "Wenn mancher Mann wüste, was mancher Mann wär, thät mancher Mann manchem Mann manchmal mehr Ehr."

Rollo Appleyard.

June 14th, 1898.

Ring Slotted Armatures.

I should be very much obliged if any person could inform me that when designing a ring slotted armature if the section is calculated as if the slots were solid, or how is it calculated, or what allowance is made for slots?

Also supposing the slots were a quarter of an inch wide, would the air space between armature and fields be one-eighth of an inch on each side of armature, or what proportion of width of slot would the air space on each side be?

Subscriber.

Melbourne.

Section of the drum slotted armature is found by taking the diameter across from bottom of slots to bottom of slots. The air space or clearance should be equal to half the breadth of the teeth; in calculating the reluctance of the air space in a slotted armature, the breadth of the teeth multiplied by their number embraced by the poles will give the area of the air space.

Slots should be same width as breadth of teeth; the air space is regulated by breadth of the teeth, not by width of slot.

In a ring armature the section is taken from bottom of slot to inside of ring.

The tendency of recent designs is to make the slots narrow, numerous, and deep; tooth and slot about equal, and the magnetic density in the air space is run up to 10,000 units or double that of a smooth core.

R. Kennedy.

Prof. Carus-Wilson's Paper.

Will you kindly correct a slip in my letter published last Friday to the effect that, in the two curves which I selected for comparing the results obtained with constant and with variable acceleration, the same final speed held for both.

As a matter of fact the figures which I gave at the Institution erred in the same direction as did those of Mr. Short; but the question at issue is not materially affected thereby, so it is sufficient to just mention it.

There was an obvious slip, also, in the employment of the word "acceleration" instead of the word "speed" (at the foot of the page in your issue of Friday last).

I should like to add that my remarks at the Institution, and in my letter to you last week, were based on the assumption that Prof. Carus-Wilson's paper was intended to deal more particularly with high-speed *railway* motors as we understand the term in this country; *i.e.*, with motors hauling trains of carriages between fixed, starting and stopping points, and at a high rate of speed; such as the Central London, the Waterloo and City, the Liverpool Overhead, and the City and South London Railways.

My remarks as to adhesion were based on the values found to hold in the case of the two latter.

A. M. Taylor.

BUSINESS NOTICES, &c.

Books Received.—"The Calorific Power of Fuels." By Herman Poole, F.C.S. London: Chapman & Hall, Limited. $3.

"Acetylene Gas and Calcium Carbide." By G. F. Thompson, Lombard Chambers, Bixteth Street, Liverpool. 3s. 6d.

"Duncan's Manual of Tramways, Omnibuses, and Electric Railways," 1898. 3s. 6d. London: T. J. Whiting & Sons, Limited, 7A, South Place, E.C.

"Electricity in Town and Country Houses." By Percy E. Scrutton. Archibald Constable & Co., 2, Whitehall Gardens. 2s. 6d.

Electric Cooking.—Messrs. Crompton & Co., Limited, Arc Works, Chelmsford, have issued a new edition of their catalogue of electrical heating and cooking apparatus. The list, which consists of about 40 pages, describes the various domestic and other apparatus manufactured under the Crompton-Fox patents. It is claimed that, in the method of attaching the utensil or apparatus, the wires are firmly secured in place on an insulating ground work, and completely protected from the action of the atmosphere, and also from mechanical damage, by a coating of a strong vitreous enamel of very high insulating properties, and capable of thoroughly withstanding the heat of the wire itself. The wires which generate the heat can be fixed in very close contact with the article to be heated, thus giving a high efficiency, and the methods by which this is done are the result of over eight years' experience. The list gives prices and particulars of a variety of hot plates, saucepans, fry pans, flat irons, radiators, &c. The prices of certain articles are considerably reduced. Messrs. Crompton also send us a copy of a pamphlet by Mrs. Seaton, giving practical hints on the use of electrical cooking apparatus, and instructions for using electric heating appliances.

Electric Lighting of Tin Plate Works.—Morfa Tin Plate Works, Llanelly, are following in the wake of other works of the same kind in this centre of the Welsh industry by securing an installation of electric light. The contract has been given to Messrs. J. C. Howell, Limited, Llanelly. The work will be commenced shortly.

Electrical Plant for Australia.—The machinery for the lighting of the City of Goulbourn, N.S.W., is being built by Messrs. Johnson & Phillips, of Old Charlton, the order having been handed to them by their sole representative in Australia (Mr. W. W. Crawford, consulting engineer, Imperial Chambers, Sydney, and Brookman's Buildings, Adelaide), who is at present on a visit to London. This firm have also in hand the order for plant for lighting Port Adelaide, South Australia.

The Jandus Arc Lamp.—Messrs. Drake & Gorham inform us that the gold medal was awarded to the "Jandus" arc lamp at the recent Hull Exhibition. The firm also exhibited a selection of their specialities in electric light fittings, which was awarded a silver medal. The same firm also show some good specimens of art metal work at the Exhibition now being held at the Royal Aquarium. Amongst other fittings can be seen French candelabra and sconces of the best designs, and a special feature of the exhibit is an attractive collection of old Dutch fittings and Japanese bronzes adapted for the electric light.

Nernst Incandescent Lamps.—Messrs. Ganz & Co., of Buda-Pesth, have purchased the Austrian, Hungarian, and Italian rights in the Nernst process for the manufacture of incandescent lamps. We believe we are correct in saying that the rights for this country and the Colonies respectively have been purchased by two well-known companies.

New Premises.—Mr. James Morris has opened new premises in Railway Road, Leigh, Lancashire, as an electrician, optician, and photographic dealer.

Messrs. Palmer & Watson, electric light and power engineers, 100, Charing Cross Road, have again to extend their business premises, and they will shortly open a showroom for electrical fittings and appliances on ground floor at the above address.

The Ventnor Electric Light and Power Company have opened premises in High Street, Ventnor, for the supply of electric light fittings, &c.

Messrs. Dobsons & Curtis Bros., Limited, electrical engineers, of Dublin, have opened an office at 74, South Mall, Cork. Mr. L. E. Buckell is in charge of the branch.

Salmony v. Kitching.—In the Hull County Court last week Messrs. H. M. Salmony & Co. sued Mr. C. H. Kitching, electrician, Beverley Road, Hull, for £18 16s. 1d. for goods sold and delivered. Mr. Stamp said that on September 7th the defendant was endeavouring to obtain the agency for Hull and district for the plaintiffs' firm, and saw Mr. Rosenberg, a member of the firm, who was in Hull, and then ordered verbally a quantity of electrical goods. The order was subsequently taken down in writing at the defendant's dictation. Dr. Jackson (for the defendant) explained that 13s. 10d. admitted had been paid into court, and £7 14s. 6d. was paid into the High Court, whence the case had been transmitted. Mr. Stamp, continuing, said that the order was given on September 7th, and the real question in dispute was whether the defendant was entitled to return certain lamps on the ground that they were ordered of the Electrical Company's make, and not so supplied, but someone's else At the time, however, nothing was said as to any lamps whatever. The plaintiffs did not manufacture lamps, and the defendant was endeavouring to obtain the agency for the plaintiffs' firm. The firm whose lamps it was afterwards alleged were sent, were the direct competitors of the plaintiffs' firm, and neither of the firms actually made lamps. They were supplied from Berlin. On the 14th of the same month the defendant wrote complaining that the lamps were very unsatisfactory, and informing the plaintiffs that he was going to send them back as he declined to receive them. On September 25th plaintiffs sent 716 lamps at 7s., and 72 lamps at 1s. 1d. each in two boxes and a few other goods in a barrel. On October 26th plaintiffs received back an empty barrel, and gave defendant a credit note of 5s., and on October 27th they received two boxes of electrical goods, for which they also gave credit. On November 27th defendant for the first time complained that he had not received proper credit. The plaintiffs now claimed that they had not received 621 lamps which it was alleged were returned, and for them they now claimed £18 2s. 3d. Dr. Jackson contended that there had been no contract made, and that the goods sent were of an inferior quality and were sent back, and at present were in the possession of the plaintiffs' agent. His Honour gave a verdict for the amount claimed, with costs.

Electrical Wares Exported.

Week Ending June 14th, 1897.	£	s.	Week Ending June 14th, 1898.	£	s.
Alexandria	20	0	Adelaide	137	0
Amsterdam	260	0	Amsterdam	130	0
" Teleg. cable	39	0	Auckland	293	0
Antwerp	22	0	Balia	614	0
Archangel	19	0	Bombay...	52	0
Auckland	159	0	Boulogne	122	0
Barcelona. Teleg. wire	53	0	Buenos Ayres	189	0
Bombay	1,286	0	Calcutta...	119	0
Boulogne	12	0	Cape Town	2,784	0
Brussels...	2,229	0	Copenhagen	11	0
Buenos Ayres	50	0	Durban	26	0
Calcutta	742	0	East London	123	0
Canterbury	84	0	Fremantle	2,794	0
Cape Town	217	0	Hong Kong	85	0
Colombo	74	0	Monte Video	81	0
Constantinople... ...	80	0	Nagasaki	690	0
Copenhagen	8	0	Nelson	12	0
Delagoa Bay	255	0	Ostend	85	0
Durban	242	0	Penang. Teleg. mat. ...	400	0
Fremantle	3,733	0	Port Chalmers	442	0
Gibraltar	1,330	0	" Elizabeth	350	0
Hamburg	180	0	Rio Janeiro	1,154	0
Havana	156	0	Rotterdam	248	0
Madras. Teleg. mat. ...	65	0	Saigon	16	0
Marseilles	125	0	Santos	337	0
Melbourne. Teleg. mat.	53	0	Singapore	54	0
Monte Video	25	0	Stockholm	161	0
New York	100	0	Sydney	725	0
Penang. Teleg. mat. ...	95	0	Tantave...	33	0
Port Said	26	0	Valparaiso	48	0
Quebec	480	0	Wellington	40	0
Rangoon	15	0			
Rio Janeiro	43	0			
" Teleg. mat.	4,607	0			
Shanghai. Telephone...	82	0			
Singapore	60	0			
Stockholm	120	0			
Suez	21	0			
Sydney	621	0			
Wellington	30	0			
Total ...	£17,828	0	Total ...	£12,455	0

Bankruptcy Proceedings.—At a sitting of the London Bankruptcy Court held last Friday, Wm. Retallack was allowed to pass his public examination upon accounts showing debts £568 6s. 10d., and no available assets. In the course of his evidence the bankrupt said he commenced business as a manufacturer of electrical appliances in 1882, at Canonbury Square, N., in partnership with another as "Player & Retallack." In all he had had five partners, but during the latter part of the trading he was the sole proprietor of the business, which was abandoned because the trade had fallen away and could not be continued at a profit. His insolvency was due primarily to loss on the trading. The examination was concluded.

At the Sheffield Bankruptcy Court a few days ago, before the Registrar (Mr. Joseph Binney), John Henry Dewhurst and John Longden, lately carrying on the business of mechanical and electrical engineers and mill furnishers, Attercliffe Road, under the style of John Dewhurst & Son, came up for their public examination. The statement of affairs showed liabilities amounting to £2,143 13s. 9d., and assets estimated to realise £100. Debtors were represented by Mr. J. E. Wing. The examinations were closed.

A meeting of the creditors of James Fletcher and John Arthur Hirst, carrying on business under the title of Messrs. Fletcher, Hirst and Co., electrical and mechanical engineers at Burnley, Chester, and Derby, was held at the offices of Mr. C. J. Dibb, official receiver, in Quay Street, Manchester, on Tuesday last. The liabilities amounted to £2,184, and the assets to £424, a deficiency of £1,760. Debtors were adjudicated bankrupt, and Mr. George Proctor, of 3, Grimshaw Street, Burnley, chartered accountant, was appointed trustee of the estate. A committee of inspection was also appointed.

In the Manchester Bankruptcy Court last Monday, R. C. Douglas formerly carrying on business as an engineering contractor at Bradford, and some time in partnership with others, under the style of "The Manchester Electric Company," at Haworth's Buildings, Cross Street, Manchester, was examined by the Official Receiver. His statement of affairs showed a surplus of assets over liabilities of £1,036, and he attributed his failure to inability to obtain payment of amounts which he claimed from certain persons. The examination was adjourned.

Auction Sales.—On June 20th and 21st, Messrs. Robins, Snell & Gore will sell by auction, at 219A, Oxford Street, W., the entire stock of an electrical contractor, including accumulators, switches, arc lamps, motors, cycle lamps, &c. See our "Official Notices" this week for further details.

Messrs. Percy Huddleston & Co., will sell by auction at 11, Long Millgate, Manchester, on June 30th, a quantity of electrical apparatus, &c., for particulars of which see our "Official Notices" this week. The list includes dynamos, motors, 10,000 switches and fittings, cables, and wires, &c.

Change of Address.—The offices of the Brockie-Pell Arc Lamp, Limited, have now been removed from 97, Queen Victoria Street, E.C., to 21, 23 and 25, Tabernacle Street, E.C.

Lists.—Messrs. Crompton & Co. are circulating a price list of enclosed long-burning arc lamps.

The Davy Electrical Construction Company, Limited, of Highbury, send us a number of lists illustrating and describing their types A, B, and C enclosed arc lamp.

Messrs. Beanland, Perkin & Co., of Leeds, have issued a list of electric air propellers, table ventilators, and small motors.

The Langdon-Davies Electric Motor Company, Limited, have issued a new list of their alternate current motors. A catalogue will be brought out in a few weeks.

Messrs. Foxcroft & Duncan, of 24, Queen's Road, Dalston, N.E., send us a set of lists of their various manufactures, including gravity and dead-beat voltmeters and ammeters, permanent magnet ditto, Cardew voltmeters, "Phœnix" and "S.S." arc lamps, hatchet switches, resistances and choking coils, &c. The firm make all the measuring instruments as formerly manufactured by Messrs. Paterson and Cooper, of Dalston, including the Ayrton and Perry commutator and non-commutator instruments. The gravity instrument mentioned above has been only lately introduced.

Smoke Nuisance.—The London Electric Supply Corporation, who were recently fined for a smoke nuisance, have given notice of appeal to the Greenwich Board of Works. Two more cases of nuisances having been reported, the Board have decided to proceed against the parties concerned.

ELECTRIC LIGHTING NOTES.

Barmouth.—On 7th inst. the District Council held a special meeting to consider the question of lighting the town by electricity. A proposal was put forward by Mr. Dd. Davies, of Beach Road, who offered to destroy the refuse for 5s. a day, and put down an electricity works, the wires to be laid underground, the work to be completed in 18 months, and a guarantee to be given to supply electric light for five years on terms to be agreed upon. The Council agreed to support Mr. Davies's scheme, and he is to submit plans.

Barnsley.—Mr. Miller, electrical engineer, has been instructed by the Council to prepare plans, estimates, &c., for an electric lighting scheme. Application is to be made to the Local Government Board for a £23,322 loan. It was stated last week at the Council meeting that there was such a large demand for electrical materials that it might be 18 months before the scheme would be completed.

Barrow.—The Electric Lighting Committee has appointed a sub-committee to superintend the erection of buildings and the carrying out of works in connection with the electric lighting undertaking. The sub-committee will negotiate for sites for the erection of sub-stations. The electrical engineer has been authorised to engage the necessary staff for breaking up the streets to lay mains. Before the mains are laid, the Highways and Lighting Committee are to be asked whether they contemplate street lighting by arc lamps. It is expected that current will be available by the end of October.

Belfast.—The engineer last week reported the progress of the works at the new electricity station, and the successful testing of the first and second boilers. It was decided to advertise for a fully qualified man to act as engineer-in-charge.

Bethnal Green.—In regard to our last week's paragraph under this heading, Messrs. Calvert & Co., electrical engineers, 4, St. Mary's Street, Manchester, write calling attention to a slight inaccuracy in the report. They say:—"The Board of Guardians accepted a tender of ours apparently without reading it, and then requested us to sign a contract containing a clause 'in accordance with the specification and plans prepared by the engineers but *not* in accordance with the said tender.' We offered, we did not *demand*, as the original tender was the one accepted—an addition at which we would be willing to sign the draft contract with the inclusion of a minor protectionary clause. This offer, as you know, was not accepted. We have been asked to send in a fresh tender, the work being re-advertised."

Birmingham.—At the City Council meeting on Tuesday, the Lord Mayor submitted the recommendation of the General Purposes Committee as to the purchase by the Council of the undertaking of the Birmingham Electric Supply Company, Limited, at the price of £420,000, and authorising the committee to take the necessary steps for the promotion of a Bill in Parliament to authorise the purchase. The recommendation of the committee was that they should pay £10 10s. per share for the £5 shares of the company, and take over the undertaking as a going concern, with all its assets and liabilities, as from January 1st, 1898. There was no opposition to the scheme, and the recommendation of the committee was agreed to. The voting was 53 for, 0 against, and 5 neutral.

Blackpool.—At a meeting of the Town Council on Tuesday last week, Councillor Brodie, as chairman of the Electric Lighting Committee, presented a statement as to the working of the department during the past financial year. This showed that the working of the tramways had realised a gross profit of £5,290, and after paying £2,984 for interest on capital and sinking fund, there was a net profit of £2,306 on the working, as against £230 in the preceding 12 months. The gross profits in the electric lighting department were £5,675, and with £3,856 placed to sinking fund and interest on capital, there was left a net profit of £18,190. Councillor Brodie said some complaint had been made on the ground that the Committee were making a profit, and demands put forward for a reduction in price. He referred the Council to what occurred two years ago, when the whole of the cables failed involving an unexpected expenditure of £13,700. Had there not been a suspense account the ratepayers would have been taxed very heavily to repay that amount; and the Council were determined that until this suspense account was put right again the users of electricity should not have the benefit of any reduction. He added that it was proposed to spend a sum of £40,000 in extensions. The statement was adopted. At the same meeting the salary of Mr. R. C. Quin, the electrical engineer, was advanced from £300 to £400 per annum.

In response to a requisition signed by a large number of ratepayers, the Mayor of Blackpool has convened a public meeting for the purpose of considering the proposal on the part of the Town Council to borrow a further sum of £40,000 for extensions in connection with the electric lighting scheme. The petitioners to the requisition assert that the ratepayers generally desire fuller information as to the expenditure by this department of the Corporation since the inauguration of the works. The undertaking was commenced five years ago with a capital of £26,000, but in subsequent years other sums, amounting to £54,000 were expended, so that if the present application for £40,000 is granted the capital will be raised to £120,000. Upon this large expenditure, and also in regard to the overhead system, many of the ratepayers apparently hold strong opinions.

Bray.—The Township Commissioners have decided to reduce the price of electric current from 6d. to 3½d. per unit after one-and-a-half hours' lighting of maximum demand.

Bridgwater.—The Somerset Drainage Commissioners will oppose the electric lighting Bill for Bridgwater when it is heard.

Burslem.—Last year when the Council passed its resolution applying for a provisional electric lighting order, it was too late for anything to be done. A second resolution has now been passed, and the application will go forward.

Burton-on-Trent.—We understand that, in addition to a large sum voted for gas extensions, £11,000 is to be spent upon electric lighting extensions.

Buxton.—Prof. Kennedy's plans, &c., of an electricity undertaking are before the Council, which has held a special meeting to consider them.

Camberley.—Mr. Lucas, of Bournemouth, is anxious to carry out the electric lighting of this district at a cost of £25,000 or £26,000, and last week he met the District Council and explained in outline his proposals. During the last three years Mr. Lucas is said to have expended £40,000 in the locality, and is to build a number of additional houses shortly. The scheme would extend from the schools to the Jolly Farmer, and would extend over the whole of the Frimley district, but he would not proceed with it if the Council would oppose his application for the order. The Council will meet Mr. Lucas again in committee.

Canterbury.—The Council has adopted the recommendation of the Lighting Committee that the sum mentioned by the contractors for connecting up to consumers' houses for 30s. per house be accepted, and that the charges for current be as follows:—Private lighting, 6d. per unit; power and heat, &c., 3d. per unit.

Chelsea.—The Chelsea Electricity Supply Company, Limited, announce that they have reduced their price for power and heating, supplied at 200 volts, to 3d. per unit.

Cheltenham.—At last week's Council meeting the Lighting Committee reported that the electrical engineer had submitted estimates of the costs of providing arc lamps for lighting the Gloucester Road from the High Street to the Lansdown Castle, and the Tewkesbury Road from the Gloucester Road to the High Street Railway Station. Three schemes were submitted, and he recommended the third, involving an expenditure of £3,855, viz., Gloucester Road, Tewkesbury Road, and Lansdown Road (from Lansdown Castle to Westal Green), 15 arcs on arches in Lansdown Road, 37 on side pillars in Gloucester Road and Tewkesbury Road, and one on a centre pillar at the Lansdown Castle. The estimate assumed that the arc lighting cables along Lansdown Road are laid at the same time as the private supply cables for this road. If these cables were not laid as described the extra cost would be about £80. The acceptance of this scheme would necessitate application for an additional loan of £875 beyond that last applied for and not yet granted. The Lighting Committee approved the report and advised the Council to authorise the electrical engineer to arrange to carry out scheme 3, and also recommended that the private lighting mains in Lansdown Road be laid at the same time as the main for street lighting, that the Local Government Board be asked to sanction an increase of the loan for which application to borrow is now pending by the sum of £875, and that the electrical engineer be authorised to order switch gear required for the arc lighting circuits in Manchester Street. After a brief discussion the Council approved of the various recommendations.

Clacton-on-Sea.—The Sea Wall Commissioners considered the question of lighting the front last week, and there was a feeling in favour of electric lighting.

Coventry.—Mr. G. W. Willcocks held a Local Government Board inquiry on Tuesday, with respect to the application of the Corporation to borrow £30,000 for the extension of their electric lighting system. The Town Clerk (Mr. L. Beard) said the electric light works were opened for public supply on January 1st, 1896, upon a comparatively small scale. An extension was soon necessary and the plant had been increased to 350 kilowatts, and the mains to 3¼ miles. The capital outlay was £33,000. The Electric Light Committee had adopted the recommendations of their consulting engineer (Mr. R. Hammond), for a large extension of mains, additions to plant, provision for street lighting, and a railway siding. The estimated cost was £33,000. After detailed evidence by Mr. Hammond, the inspector visited the works and the sub-stations.

Darlaston.—The Midland Electric Corporation for Power Distribution, Limited, has entered into a satisfactory agreement with the Council.

Douglas.—Prof. Fleming's report on the scheme of the Town Council for the lighting of Douglas has been received, and will shortly be issued. His estimate of the cost of the smaller scheme submitted, namely, the lighting of the Promenades, Victoria Street to Finch Road, and Duke, Strand, and Castle Streets, is £30,000. Calculations made on this estimate show that the cost of electricity compared with the present gas system would be £1,000 a year in excess at first. Prof. Fleming has also reported on an extended system.

Dover.—A lady has claimed compensation from the Dover Electricity Supply Company for injuries sustained through falling over an electric light box in High Street. The company has admitted its responsibility.

Ealing.—At the meeting of the Ealing District Council on the 2nd inst., the Electric Lighting Committee reported, says the *Middlesex County Times*, that the question of the conduct of the switchboard men had occupied its attention, and it recommended that Mr. Bush be discharged. Mr. Recano's resignation was received. The committee, with the exception of one member, declined an interview. Mr. Armriding said that that morning he had received an electrical paper, and in an article in it there were some very grave accusations against their chief engineer. As a member of the committee he had never once received any information of any complaint from these men, except that Mr. Jordan handed him a letter from Mr. Knight, and a letter from Mr. Bush. Had he known of these accusations he would certainly have supported Mr. Brampton's proposal that Mr. Recano should be heard. After some discussion, Mr. Taylor moved that a special committee should meet at the earliest possible moment. Mr. Brampton seconded, and said he should like it to be composed of the whole Council, as it was no good referring it back to the Electric Lighting Committee. The chairman: This particular subject has not come before them. Mr. Thayers moved as an amendment that the Electric Lighting Committee be the committee to take the subject into consideration. Mr. Armriding seconded. Mr. Cowley said he was rather inclined to vote with Mr. Taylor, though out of no disrespect to the Electric Lighting Committee. He thought it more satisfactory, considering the circumstances, and to avoid it being said afterwards that they wanted to carry out their own ruling. Mr. Norris said that he was afraid if the matter did not go to the Electric Lighting Committee, it might perhaps look like a little snub to them. The committee had perhaps been a little partisan, but he had every confidence in its justice and he felt sure it would give the other side a fair hearing. Mr. Jordan said that the evidence they had had before the Electric Lighting Committee was very serious, and it would lead to more serious consequences in the future. They had done their duty in taking the action they had done. The whole Council had sufficient confidence in Mr. Knight to make him the head man at the place, and it was the duty of an employer to place every confidence in his manager until he found him out. The amendment that the matter should go before the Electric Lighting Committee was then put and carried by six votes to three.

It is stated that the Electric Lighting Committee last week made an exhaustive inquiry regarding the allegations. On Tuesday last week the committee examined all the employés at the works, and on 10th inst. sat again for the purpose of formulating its report to the Council, which was to be presented this week.

Eastbourne.—The Town Council last week adopted minutes of the joint sub-committee, in which they reported that "they considered the reference from the Council as to authorising them, if they thought proper, to engage Mr. Wright, of Brighton, electrical engineer, in addition to or in substitution for Mr. Hawtayne. It was resolved that Mr. Hawtayne be engaged to report on the proposal that the Corporation should provide the necessary plant, &c., for generating electric light for the existing public lamps and public buildings, either separately or in conjunction with the refuse destructor, for a fee of 30 guineas, without binding the Corporation to engage him in the event of their deciding to undertake any of those works. Further, that the question of engaging Mr. Wright be postponed for the present, pending the receipt by the committee of Mr. Hawtayne's report."

Edmonton.—In connection with the proposed installation of electric light in the workhouse, Mr. Sydney J. Ross has written offering to act as consulting electrical engineer for the scheme submitted by him, which amounted to £2,500. The letter was referred to the Works Committee of the Guardians.

Erith.—The Erith District Council have engaged the services of an expert on the matter of electric lighting.

Flitwick.—Mr. Alfred Pearse, the well-known illustrator to London magazines, has entered into partnership with Mr. Snetzler, engineer. They have purchased a factory in London. One of Mr. Pearse's smaller schemes is to light up the little village of Flitwick, where Mr. Pearse has a country residence, with electric light by means of the river Flit. At the place where it is proposed to erect the motor, the river is 15 feet wide, and is capable of supplying 20 H.P.

Folkestone.—Last week Colonel Coke, R.E., held a Local Government Board inquiry in respect of an application made by the Town Council to borrow the sum of £1,200 for the purposes of electric light—namely, the purchase of standards. The town clerk explained the purposes for which the money was required. There were, he said, to be 40 standards along the Leas front. The Council had accepted a tender at the price of £15 14s. per standard for those on the Leas, and £14 for the streets, and in addition there would be an allowance for fixing and painting—£2 each.

Frimley.—At the last District Council meeting, Mr. Lucas attended and addressed the Council *re* electric lighting. He asked the Council whether they would support him when he applied for the provisional order, or whether they intended to carry out a scheme of electric lighting themselves. The outlay on the whole scheme would be something like £25,000 or £26,000. After consideration it was decided that Mr. Lucas, with his engineer, should meet the whole Council in committee and go through the scheme.

Garston.—At the last District Council meeting a letter was read from the Local Government Board, enclosing a copy of a letter sent to them by Messrs. Peacock, Gregory & Bousfield, solicitors, Liverpool, asking them not to sanction the application of the Garston District Council for power to borrow £24,000 for the purpose of erecting a refuse destructor and electric lighting station at Grassendale; also petition signed by 542 owners objecting to the refuse destructor and electric light generating station being fixed there. The central authority asked for the opinion of the Council on these matters. After some discussion the Special Purposes Committee was instructed to prepare a reply.

Germany.—Messrs. Siemens & Halske, Berlin, have just secured a contract for the establishment of a central electric lighting station at Ahlfeld-am-Leine at a cost of £65,000.

Glasgow.—The Watching and Lighting Committee advises that in the event of the Corporation deciding to erect trolley poles for the High Street tramways, from Glasgow Cross to Parliamentary Road, such poles should be used for lighting purposes. 37 lights would be required, the annual cost of the electric current, at the present rate, being £666. Gas lighting costs £191 at present.

The Dean of Guild Court last week granted the Glasgow Corporation permission to erect a new generating and electric storage station in Corn Street and Sawmillfield Street.

Godalming.—The authorities at Whitehall have refused to sanction the raising of a loan for the purpose of electric lighting at Godalming, in consequence of the strong opposition laid before the inspector who inquired into the matter.

Hackney.—We learn that the Vestry has referred Mr. F. H. Medhurst's action to a Special Committee, consisting of the Chairman of the Vestry, and the Chairmen of the several Standing Committees, the said Special Committee to have power, in the name of the Vestry, to engage counsel, incur expenditure, and to take all steps that may be deemed expedient to defend the interests of the Vestry in respect of such action. The Vestry last week decided by a good majority not to hand the provisional order over to a company.

Hanley.—The North Staffordshire Traders' Association is agitating for a reduction in the charges for current.

Hampstead.—The Vestry has decided to extend the public lighting by arc lamps from a point near the Hampstead Fire Station along Heath Street to a point close to the summit of the Heath.

The Vestry is to be asked to consider the advisability of lighting West End Lane, Mill Lane, Fortune Green Road, and Fortune Green by electricity.

Huddersfield.—At Wednesday's meeting of the County Borough Council, the electrical engineer reported the number of consumers of electric light for the month to be 685, an increase for the month of 24. The lamps connected—46,014—showed an increase of 1,257, and the units metered in May, 28,460, or an increase on the corresponding period of the previous year of 9,779, equal to 52 per cent. The tender of Mr. James Proctor, of Burnley, for the sum of £69 per boiler, delivered and fixed, for mechanical stokers for the four new boilers at the electric supply station, was accepted. The tender of Messrs. Read, Holliday & Sons has been accepted for the electric fittings for the new police station at Huddersfield.

Ilkeston.—The Town Clerk has reported to the District Council *re* the Dover electric trams, and in consequence the Council will hold a special meeting on July 12th to pass a statutory resolution applying for a provisional order under the Tramways Act. At the same meeting a resolution will be brought forward applying for a provisional electric lighting order. The scheme of the General Power Distributing Company is to be opposed.

Ipswich.—After again going into the question of electric lighting for the workhouse, the Workhouse Committee advised that a gas engine be supplied by the gas company for £400, and that Messrs. Crompton & Co.'s tender for the other plant, &c., for the installation be accepted at £1,650. The Board of Guardians, however, rejected the proposal on an amendment, and the matter has been referred back to the committee to get estimates for gas lighting.

Islington.—The Progressives on the Vestry last week ousted Mr. Lambert from the position of Chairman of the Electric Lighting Committee, and appointed Mr. Gordon in his place. We have already briefly referred to this matter.

King's Norton.—The Board of Trade have issued copies of the new provisional order which they have just issued to the Council.

Leigh.—The District Council having obtained an Electric Lighting Order, are proposing to borrow £10,500 to spend on electric works. The estimate of the gas manager, Mr. J. Foster, is that £10,000 will be required for the buildings and plants. The proposed buildings include an engine and accumulator house, concrete foundations for two engines and dynamos, which will cost £1,250; £250 is allowed for the woodwork, and £180 for an eight-ton overhead travelling crane. Under the head of engines, dynamos, &c, £1,150 is allowed for one 80-kilowatt coupled engine and dynamo; £1,300 for the other engine (40-kilowatt dynamo), while the switchboard will cost £700; and the accumlators £1,550. The cost of the main feeders and distributors, including 2,180 yards of triple concentric lead covered distributing main in Queen Street, Bradshawgate, Church Street, King Street, Railway Road, and Market Street, would be £2,885 2s. 6d, £1,100 of this being absorbed under the head of "100 house connections, including service cable meter, cut-out, &c., and fixing at £11. Electric tramways have also been under discussion.

Leith.—By six votes to five, the Council has agreed to authorise the electrical engineer (Mr. Bryson) to advise parties as to the wiring of their premises, with a view to their taking in the Corporation electric light supply; but on condition that the fees received by him be put into a fee fund in the Council's hands, out of which the Council might, at any time they think fit, allow Mr. Bryson any extra remuneration.

Lewisham.—Last week the Blackheath and Greenwich District Electric Light Company wrote to this Vestry that they were concluding negotiations for the purchase of a site for their electricity station at Blackwall point, which would be conveniently situated for the erection of a dust destructor. The company offered to enter into negotiations with the board with a view to the erection of such works for destroying the refuse of the district. A committee will consider the point.

Leyton.—The District Council have resolved to apply for an additional £5,000 for electric lighting, in consequence of increased demand for current. It is proposed to at once erect a new battery station. The electrical engineer has obtained quotations for batteries and accessories from various manufacturers, and an order has been given out, as stated in our "Contracts Closed" this week. Arc lamps are to be placed, by way of experiment, in High Road, Leytonstone.

London.—The St. James's Vestry is requesting the Electric Ligting Company which supplies the district, to reduce the charges for current. The company is understood to have replied, stating that it had done its best for the district, and suggesting that the matter be referred to arbitration.

At last week's Court of Common Council, Mr. Brooke-Hitching's resolution referring the question of the purchase of the undertaking of the City of London Electric Light Company to the Streets Committee for consideration was adjourned. When the Council passed the company's account for £209 odd for one quarter's current for the City Lands Committee, Mr. Norton said that the company's action in reducing the charge from 7d. to 6d. per unit was due to the Court's action in protesting against the high charges.

Luton.—A committee of the Town Council has been considering the electric lighting question, and on 7th inst. its report was submitted to the Council. The committee visited various electricity works in the country and gathered particulars, and had also considered a communication from the Municipal Electric Supply Company. The company laid before the committee the terms upon which they would take over the municipal provisional order, and after detailing various conditions, concluded by saying that the "company is not connected with makers of engines, boilers, dynamos, mains, &c., and is thus quite free from any trade bias in favour of particular machinery." The company is also stated to have expressed a desire to establish a tramway system to Dunstable and Houghton Regis, and the town and suburbs generally. The committee advised the Council to ask Mr. Albion T. Snell whether he would be prepared to meet the committee to confer upon the question, and to carry out the installation proposed for the town. After a long discussion, the proposal was adopted by 14 votes to 1, and a further resolution was passed to the effect that the committee has no further communication with any company.

Macroom.—The Commissioners can get no reply from the contractor (Mr. Thierman, Manchester) for electric lighting of the town. The Town Clerk is to write again requesting a reply, and in the meantime to advertise for a new contractor.

Manchester.—At last week's City Council meeting Alderman Higginbottom (chairman of the Electricity Committee) reminded the Council that the joint report on the subject of electrical supply had just been issued, and that it had gone against municipal authorities. The principle laid down therein did away with what they always considered they had in Corporations, namely, the monopoly and the right over their streets. It would enable any private incorporated electric company to place a generating station outside any city or town, and give notice to the authority inside that the mains were to be laid. That authority would have to do the work and would be paid for doing it. Now this was a position they in Manchester very strongly objected to. The principle affected some four or five Bills at present before Parliament, in one of which Manchester was interested. Lord Morley and Sir Courtenay Boyle had laid down the principle that a tramway company could go to Parliament for a provisional order to equip its lines and work them with electricity; and, having obtained that, it could go to the Board of Trade and ask for a provisional order to supply consumers with the electric light along the whole route, thus entering into competition with the authority. The joint report lay upon the table in Parliament, and it would have to lie there for a certain time. No discussion whatever would take place upon it, which seemed to him to be a very curious thing. It naturally followed, however, that if the principles he had referred to were to be placed in all provisional orders and all other Bills relating to electrical energy in any form, there must be legislation. That being so, the measure would have to be fought step by step in the interests of the Corporation. Upon their supposed monopoly they had borrowed money and laid down plant, and now that monopoly was threatened. It was a state of things which they could not look forward to with any degree of composure, and he hoped the Council would entrust the committee with the necessary authority to protect the interests of the Corporation.

Monmouth.—At last week's Council meeting the report of the Drainage and Electric Light Committee was discussed at great length. The £20,000 borrowed for the carrying out of the combined scheme of drainage and electric light appeared to have been already practically expended while the work was not nearly completed. Mr. Breakwell, chairman of the committee in charge of the scheme, explained that their engineer, Mr. Lailey, had not yet rendered his report. They were therefore unable to give the figures. They were also at a deadlock for money, as the Local Government Board would not sanction the additional loan of £10,000 until they got Mr. Lailey's report explanatory of the extraordinary difference between his original estimate and the actual cost of the work. It was resolved to write to Mr. Lailey again on the subject.

Newcastle.—The Committee which is considering the question of purchase of the electric lighting undertakings met on Monday, but nothing particular was decided, as it is proposed to await the action of the Tramways Committee before drawing up a recommendation.

A main box cover was blown off by an explosion on 7th inst. No one was hurt.

Newport.—A report to the Electricity Committee shows that the number of lights now connected and on order is equivalent to 18,538 of 8 C.P. It has been decided to adopt the electric light for the new Union Workhouse and offices, the estimated number of lights required being 550. The borough electrical engineer submitted his report upon the condition of the plant, which is all in satisfactory working order. A comparison of the capacity of the plant, with the number of lights connected, shows it to be overloaded to a slight extent at the lighest load even at the present time. With reference to the question of obtaining an emergency plant to cope with the demand during the coming winter, pending the delivery of the new plant, the consulting engineer, who attended, reported that he had made a number of inquiries and obtained several offers, which he had considered in conjunction with the chairman. The one they considered most suitable was that of the Sheffield Electric Light and Power Company, Limited, a marine type Brush engine, driving a 100 kw. Mordey alternator by ropes. The engine was in excellent order, but the alternator required re-winding, and the Brush Company proposed to make practically a new machine of it for the sum of £371 17s. 6d., and to deliver in 16 weeks. The company would remove the plant from Sheffield and erect it at Newport for £182. It is recommended that the plant be placed at the far end of the extended engine house, just beyond the foundation for the second 300 kw. set. The total cost is estimated as follows:—

	£	s.	d.
Plant, as it stands at Sheffield	400	0	0
New field magnets and armature coils	371	17	6
Dismantling, carriage, and re-erection	182	0	0
Foundations	60	0	0
Steam and exhaust pipes	20	0	0
Switch gear	0	0	0
Fees and contingencies	116	2	6
	£1,150	0	0

It was assumed that connection would be made to the new steam range at its extreme end, and the switch gear for No. 7 alternator will be available. The matter having been considered, the Council resolved that the plant be purchased and erected. Application is to be at once made as to a loan in respect of this plant and the extension of the low tension distribution system in Commercial Road decided upon at the last meeting. A letter from the Board of Trade approving the additional system for supply of electrical energy and describing their requirements for the construction of transformers, was reported to have been received. The mains are to be extended along Risca Road.

Nottingham.—The Corporation is negotiating for the purchase of property lying between the present works and Hanley Street, for the purpose of extending the electric lighting station, upon whose supplies there is a greatly increased demand.

Poplar.—The Board of Works have asked the Guardians to suspend their own electric lighting of the workhouse pending the supply of the parochial current.

Provisional Orders.—There are at the moment quite a number of Bills before Parliament to confirm provisional orders made by the Board of Trade under the Electric Lighting Acts, and, remarks a daily paper, amongst those of interest to London are orders in regard to Holborn and St. Giles, Bermondsey, and St. Marylebone. As regards Holborn and St. Giles, the undertakers under this order are the County of London and Brush Electric Lighting Company, Limited, and the area of supply is portions of the districts of the Board of Works for the Holborn and St. Giles Districts; while under the other the undertakers are the Charing Cross and Strand Electricity Supply Corporation, Limited, and the area of supply is portions of the districts of the Board of Works for the Holborn and St. Giles Districts. The Bermondsey and Marylebone undertakers are the respective Vestries.

The Middlesbrough and Darlington Electric Lighting Bills were on 10th inst. sent for second reading in the House of Lords.

Rotherhithe.—The Vestry agrees to take a supply of current from the London Electric Supply Corporation at the usual terms, for lighting the Town Hall as soon as the mains are laid there.

Sale.—At the last meeting of the District Council, it was stated that the Manchester Corporation could make arrangements for supplying the electric light to Sale either by way of Stretford or Chorlton-cum-Hardy, and that the price would not exceed 3d. per unit. One speaker was not satisfied with the report on the electric lighting of the township as drafted by Mr. Shaw, and he moved that Prof. Kennedy should be asked to prepare a report and submit a scheme with and without street lighting. The motion had no seconder.

Salford.—The Electric Light Committee has instructed the engineer to proceed with the laying of the cable along Bolton Road. The engineer reported that it was advisable that the committee and the Electric Light Committee of the Manchester Corporation should meet together for the purpose of arranging standard pressure for the working of the tram service, so that the cars might run smoothly on the Salford and Manchester lines. A communication was directed to be made to the Manchester Electric Light Committee, asking them to receive a deputation from this committee upon the subject. A tender from Messrs. W. T. Glover & Co. for the supply of one mile of low tension single cable, lead covered, for the sum of £115, was accepted.

Sheerness.—The first installation of electric light in Sheerness has just been completed, the proprietor of the Bell and Lion Hotel having adopted this method of lighting throughout his premises. He is also supplying a neighbour with the light.

Sheffield.—The Sheffield Chamber of Commerce has passed a resolution in regard to the scheme of the General Power Distributing Company to the effect that it favours the establishment of a competitive supply of electrical energy for Sheffield.

Shrewsbury.—At last Monday's meeting of the Shrewsbury Town Council, the question of purchasing the Shropshire Electric Light Works was carried another stage. The matter has been under consideration for some time. The proposal was vigorously attacked at the last annual meeting of the Shrewsbury Gas Company, both on financial grounds and those of the effectiveness of the illuminant, but the Council were not persuaded from the attempt to buy the undertaking, and negotiations resulted in its being decided on Monday to instruct the Town Clerk to make application to the Local Government Board for sanction to a loan of £35,000 "to complete the purchase of the Shropshire Electric Light and Power Company, and also a sum of £800 for adjoining buildings." It was stated in the discussion that on the Council's getting the works, they will at once proceed to light the town with electricity.

Southport.—The electrical engineer (Mr. C. D. Taite) has just issued his second annual report, showing that during the year the net profit of £643 has been made, as against a loss of £471 in the previous year.

Stanford-le-Hope.—A parish meeting has been discussing the lighting question. Gas and oil systems were considered, and then Mr. Simpson said the firm he represented were prepared to form a local company for the supply of electric light, with a capital of £2,000, of which they were prepared to find one-half if the other were subscribed locally. The price per unit for street lighting would be 4½d., and about 7d. per unit for private use. That capital would be sufficient for 500 lamps of 16 C.P. They would require about 50 for street lighting, which would work out at about £2 12s. per lamp.

Stockton.—Mr. H. P. Boulnois, C.E., held a Local Government Board inquiry last week into the application of the Corporation to borrow money for electric lighting. Borrowing powers to the extent of £30,000 are asked for, and it is proposed to spend £22,000 of this sum at present.

St. Pancras.—At the Vestry meeting on Wednesday last week, the Electricity and Public Lighting Committee reported that they had elected Dr. Walter Smith as chairman for the ensuing year. There were 47 candidates for the position of inspector of works, rendered vacant by the resignation of Mr. J. C. A. Ward, and Mr. F. Alan Wilkinson, superintendent of mains at Bournemouth, has been appointed.

Tunbridge Wells.—On Friday the Tunbridge Wells Improvement Association passed a resolution in favour of the consumer being given a share of the profit made on the Corporation electric light undertaking, by reducing the charge, instead of devoting all the profit to the reduction of the rates.

Twickenham and Teddington.—A proposal is on foot to form a company with the object of supplying electricity to Twickenham and Teddington. A communication made by the company was under consideration by the Twickenham District Council last week, and it was decided to consult the members of the Teddington Council.

Wells.—The Board of Trade has informed the Council that it has no power to extend the time of the provisional order for electric lighting.

Westgate-on-Sea.—The Board of Trade have informed the Isle of Thanet Rural District Council that, after consideration of the report made to them by the inspector appointed to inquire into the matter of the Westgate-on-Sea electric lighting provisional order, they do not propose to proceed with the application.

West Hartlepool.—The Council is to obtain estimates for a dust destructor, which may be used in connection with electric lighting.

Weston-super-Mare.—The Weston and District Electric Light and Power Syndicate has intimated its intention to apply to the Board of Trade to annul the Council's provisional order, and to grant the company a similar order.

Woking.—The Woking Electric Supply Company has agreed to the deductions made from their account for failures. The company is endeavouring to meet the Council's wishes by close attention to the efficiency and upkeep of the street lights.—The District Council last week had a discussion with regard to the dense volumes of smoke which have lately been issuing from the Electric Light Company's works. Mr. Cox thought that indulgence should be granted to the company in order to allow them time to alter their furnaces in such a way as would prevent this nuisance in the future. The company is to be written to on the matter.

Wolverhampton.—At the monthly Council meeting on Monday, the Lighting Committee submitted the electric lighting accounts for the year ended March 31st. The accounts show that a profit of £589 14s. 4d. has been made, after payment of interest and sinking fund. This has been applied to the deficiency on the working of the previous year, reducing the sum to £588 0s. 6d. A few of the figures from the accounts may be interesting. The capital account shows that the amount of loans sanctioned is £47,799 (at 2½ and 3 per cent., and for 25 and 30 years), and that £32,660 was borrowed up to March 31st. A sum of £345 has been repaid. The total capital expenditure up to March 31st was £41,781. The revenue account for the year shows income amounting to £6,257 (including £4,687 by sale at 6d. per unit, and £302 at 3d., £1,275 by sale of current for public lamps, &c.). The expenditure reaches to £3,423, including £2,211 for generator, £247 for repairs to public lamps, £703 management expenses, &c. The credit balance was £2,833. This is set against the capital charges for the year, leaving a net profit of £589 14s. 4d., as above stated. This latter sum is in turn set against the debit balance of £1,177 at March 31st, 1897, reducing it to £588 0s. 6d. The statement of output shows that 370,084 Board of Trade units of current were generated during the year. Of these 291,233 were sold, and 3,931 were used at the works, leaving 74,925 units as waste or leakage. The maximum demand which the works are under covenant to meet is equal to 14,151 32-watt lamps. The committee make the following recommendations:—(1) That from July 1st the price of energy for motor power and heating purposes be fixed at 2d. per unit on a maximum demand for an average of two hours per day, and 1d. per unit for all energy consumed in excess thereof. (2) That application be made to the Local Government Board for a loan to cover capital expenditure in purchasing and hiring out motors to motor power consumers, both on the simple hire and the hire-purchase system, and in the wiring and fitting up by consumers of the premises for electric lighting purposes. (3) That your Committee be empowered to make such terms as they shall deem advisable for the hire of motors and for the repayment of the capital expenditure incurred on behalf of consumers in wiring and fitting up their premises. The above recommendations were agreed to at the meeting of the Council. Alderman Mander said that in 1897 they sold 224,709 units, which was an increase of 14 per cent. on the previous year. But this year they had sold 291,233 units, or an increase of 22 per cent. The number of lamps was in 1896, 8,941; in 1897, 11,307, an increase of 21 per cent; and in 1898, 14,151, an increase of 20 per cent. Their gross profit this year was £2,833 14s. 9d., or 6½ per cent., the net profit being 1 per cent. The Council is to spend £200 upon fitting up the Free Library for electric lighting.

Wolverhampton.—The report of the Lighting Committee was issued to the members of the Council last week. The Committee report that the operations of the year have again been successful. A profit of £589 14s. 4d. has been made after payment of interest and sinking fund. This has been applied to the deficiency on the working of the previous years, reducing the same to £588 0s. 6d.

Worcester.—Last week the Council concurred in an agreement transferring to the National Electric Free Wiring Company, Limited, the rights and obligations of the Electric Free Wiring Syndicate under their agreement with the Council. There was a brief discussion *re* the Brush Company's bill for £365 for additional work and goods supplied, but the bill was passed for payment.

Worthing.—At a meeting of the Council in committee held on May 12th, Alderman Linfield, as chairman of the Electric Lighting Committee, submitted the report of Messrs. Burstall and Monkhouse, electrical engineers, upon the three schemes received by the Committee for the proposed electric lighting of the borough from Messrs. Siemens & Co., Edmundson's Electricity Corporation, Limited, and the Municipal Electric Supply Company. It was resolved "That it is expedient to undertake the construction of electric lighting works on the same or similar terms to those contained in the proposal of Messrs. Siemens and Co., keeping the same in their own hands, and requiring the contractors to work the undertaking at a stipulated rental for five or seven years.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Birmingham.—Sir James Smith's name having been mentioned in connection with a letter which was stated to have reached the Birmingham Tramways Company, in which permission had been given to proceed with the overhead wire system, Sir James Smith made a personal explanation at Tuesday's meeting of the City Council, from which it appeared that he had given no authority for any such letter to be sent. It seems that Sir James had a conversation on the matter with a certain gentleman, who wrote to Mr. Ross of the Tramways Company, and quoted a remark made by him. Sir James's explanation was considered perfectly satisfactory.

Brierley Hill.—The District Council had various matters regarding the electric tramway scheme before it last week. It approved of the creosote wood blocks proposed by the British Electric Traction Company for paving, it acceded to the company's application for permission to lay underground electric cables, gave the surveyor instructions that not more than 100 yards of the road should be broken up at one time, resolved not to oppose the application of the Dudley and Stourbridge Electric Traction Company for a renewal of the steam power license for a year (this is merely a formality that must be gone through, as already explained), and has resolved to support the company's application to the Board of Trade for confirmation of the order granted to them by the Light Railway Commissioners for making a light railway for the Cradley Heath district. This application, it should be mentioned, is opposed by the Dudley Corporation. The Stourbridge District Council has also decided to support the company's proposals, and will send representatives to the forthcoming inquiry with that object. The Brierley Hill Council will do likewise.

Bristol.—The Bristol Tramways (Electrical Power, &c.) Bill and the Bristol Tramways (Extensions) Bill were on Tuesday ordered for third reading in the House of Commons.

Cape Town.—The *Westminster Gazette* remarks that the electric car can be made to pay, and pay well; and this seems evident from some figures relating to the Cape Electric Tramways, Limited. For the past six months the revenue has amounted to £66,934, and the expenditure to £29,902, leaving a profit of £37,032, or at the rate of £74,064 a year, which is a handsome return on the capital. The 6 per cent. interest on the £315,000 first debentures, and the 5 per cent. interest on the £115,000 second debentures would absorb £24,650, so that even after paying a 10 per cent. dividend on the £400,000 ordinary shares a balance of nearly £10,000 would be left for reserve fund and other purposes. Of this company, Sir Charles Euan-Smith, K.C.B., is chairman, and amongst the directors are Vice-Admiral A. H. Markham, Mr. John Hays Hammond, Dr. Rutherfoord Harris, and Mr. Alfred Parrish.

Clontarf and Hill of Howth.—A special meeting of the proprietors of the Dublin United Tramways Company was held last week at the office, Upper O'Connell Street, Dublin, for the purpose of considering and approving, or otherwise, of the Bill applied for by the Clontarf and Hill of Howth Tramroad Company in the present session of Parliament. A resolution was adopted approving of the measure, subject to such conditions, alterations, and variations, as Parliament may think fit to make in it. The Bill passed second reading on Tuesday.

Dover.—At last week's meeting of the Finance Committee in connection with the bill from the Dover Electricity Company for £500 for the supply of current to the trams during the last quarter, Alderman Peake said he saw that the Corporation had taken all the power they guaranteed, within £56 worth. The Town Clerk replied that that was so, and when the two new cars arrive—probably this month—the whole of the current will be taken.—Councillor Edwin said he saw the amount charged in the company's bill was £56 19s.

for unused current. Would they get credit for this sum if they used over the guaranteed amount during the year?—The Town Clerk: Yes, an average is struck.

Dublin.—Major Cardew made a Board of Trade inspection on 7th inst. of the new electric line between Haddington Road and Nelson's Pillar. He was accompanied by Mr. Anderson, J.P., secretary and manager of the company; Mr. Astrow, engineer in charge of the new electric service; and Mr. Towle, electrical engineer. A journey was made from Haddington Road to the Pillar, and the line and rolling stock were found to be in good order. Some of the underground work still remains to be completed, so that the new service will not be open for traffic for a few days yet.

The Corporation will not allow electric tramways to be run through Phœnix Park.

Glasgow.—The question of the electrolysis of the gas and water mains, as the result of the working of the Springburn tramway route by electric energy, having been recently raised, the subject was remitted to a joint sub-committee of the Gas and Water Committees for consideration. The sub-committee referred the question to Mr. Chamen, the electrical engineer to the Corporation, who has just presented an elaborate report, in which, says the *Glasgow Herald*, he discusses the subject in all its bearings. Having considered this report and received further verbal explanations, the joint sub-committee have resolved to report (1) that if the Tramway Department observe and carry out the rules and regulations of the Board of Trade with respect to the construction and maintenance of the electric tramways, there does not appear to be any danger of the gas and water mains along the route being injuriously affected by electrolysis from the action of the return current along the tramway rails or otherwise; and (2) that the electrical engineer should report to the engineers of the Gas and Water Departments respectively any further facts or circumstances which may from time to time hereafter come to his knowledge in regard to any of the matters dealt with in his report.

Great Northern and City Railway.—The secretary of the new company informs a financial paper that the size of the electrical locomotive required to haul the Great Northern Railway Company's suburban trains, consisting of 11 coaches, and seating 500 passengers, from Finsbury Park to Moorgate Street station, will be very moderate, compared with some of those in successful use in the United States, where trains of five times the weight are satisfactorily hauled by electric locomotives.

Hastings and Bexhill.—Last week an inquiry was held at Hastings by the Light Railways Commissioners regarding the scheme of the Hastings, Bexhill, and District Light Railways Company. The inquiry came to an abrupt termination, the chairman stating that the Commissioners considered that as there was a feeling of great opposition to tramways, although the majority of the Council was in favour of the project, they did not think it desirable to try and force upon the town a scheme which was not generally acceptable.

Huddersfield.—The Council has resolved that the new tramway rails at present being manufactured for the Corporation, be ordered to be drilled so as to be applicable for electric traction.

Hull.—Laying the first rail of the electric tramways was made the occasion of a public ceremony on the 9th inst., the Mayor and Corporation being present. There were speeches by local dignitaries, and in the evening Alderman Larard, chairman of the Works Committee, entertained his colleagues on the committee with their wives and a number of friends, to dinner at the Town Hall.

King's Norton.—The Clerk to the District Council has been instructed to write to the Town Clerk of Birmingham, pointing out that that body is opposed to overhead electric tramways, and expressing the hope that the Corporation would not sanction experiments upon any of the tramways within the city which had their terminus in the district of the Council.

Kirkcaldy.—On Monday night the Town Council had before them Prof. Kennedy's report as to the proposed introduction of the electric lighting and trams. The report shows the proposed route of the tramway to be 6½ miles, with circular routes from West Bridge by the Public Park, Victoria Road, to Pathhead, and thence to Gallatown; also along Links Street, High Street, and Sands Road. A branch line will be made to provide for station traffic by placing a line up Whyte's Causeway and Wemyssfield to join the upper routes. The Provost intimated that a private company which had the matter in hand was desirous of allowing the Council to take up the scheme, failing which they would take up the matter and float the scheme. The cost, he considered, would be nothing less than £100,000. In view of the limited time at the disposal of the promoters to enable them to apply for a Bill, it was agreed to hold a special meeting to consider the whole matter, and give a final decision in July.

The London United Tramways Bill.—This Bill came before a Select Committee of the House of Commons on Thursday last week. Mr. Little, Q.C., who appeard for the promoters, explained the objects of the measure. It contemplates, says the *Times* report, the construction of a series of new tramways, one from Acton to Hanwell, over two miles in length along the Uxbridge Road, another from Hanwell to Brentford, one mile one furlong in length along the Boston Road, and another from Kew Bridge to Hounslow, two miles four furlongs in length. It is proposed to carry a line over Kew Bridge when the contemplated new structure is completed. The new lines will pass through the districts of Acton, Ealing, Hanwell, Brentford, and Heston and Isleworth. They are to be worked by electricity, on the overhead trolley system. The learned counsel pointed out that another object of the Bill was to enable the promoters to work their existing lines from the Uxbridge Road station to the boundary of Acton and from the same place to Kew Bridge, and from Hammersmith Broadway, by loop, to a place on the last-named line, by electricity. The districts through which the new lines would run were well populated, and the service of omnibuses was not efficient. He further pointed out that the chief opponents of the Bill were the Ealing local authorities and the London County Council. The Middlesex County Council also petitioned against the Bill. Inside London the London County Council and the Hammersmith Vestry seemed both to be in a condition of absolute darkness as to the existence of overhead wires elsewhere, and they opposed the Bill. The proposal originally made by the company to use mechanical power on their line to Richmond had been withdrawn for the present. The Hammersmith Vestry, after being consulted by the company, had sent a deputation to Havre to see the working of the overhead system there and had unanimously approved the adoption of the system, but it had since altered its mind and decided to oppose the Bill. The Ealing District Council had agreed by a majority of one only to oppose the Bill.

The first witness called on behalf of the promoters was Mr. Clifton Robinson, managing director and engineer of the London United Tramways Company. In examination by Mr. Balfour Browne, Q.C., he said that 8½ millions of passengers were carried over the existing lines last year. He had had considerable experience of other tramways, and that experience taught him that the introduction of electric traction doubled the volume of traffic. He estimated that if such traction were introduced and the proposed extensions were made to Hounslow and Hanwell the company would carry 25,000,000 of passengers every year. His experience further showed that, with the advent of electricity, the best results would be obtained by the reduction of fares by at least one-half. The fares charged on workmen's cars would be half the ordinary fares. As far as he knew there had never been an accident owing to the use of overhead tramway wires.

In cross-examination by Mr. Pope, Q.C. (on behalf of the London County Council), witness said that the County Council had at present the right to approve or negative the use of electric traction within the county of London. The company had sent three deputations to the County Council, one of them being supported by the Hammersmith Vestry. Having been unable to overcome the County Council's ill-advised obstruction to a popular mode of traction, the company had resolved to appeal to Parliament. It was the case that the company proposed to substitute the Board of Trade as the controlling authority in connection with these matters for the London County Council. The County Council had the right to purchase the company's undertaking in 11 years' time.

Sir J. Brunner asked whether any tramway in London was worked by electric traction at present.

Mr. Pope replied that there were none.

Sir J. Brunner asked whether the County Council had opposed all applications for power to use electric traction.

Mr. Pope said they had not. They were not opposed to electric traction, but, generally speaking, they were opposed to overhead wires.

Replying to Colonel Welby, witness stated that the average life of a horse employed on a tramway did not exceed five years, no matter how well it was selected or how well it was taken care of.

In answer to further questions witness strenuously denied that an electric tramcar made as much noise as an ordinary motor-car, and said that an electric tramcar glided along like a boat on ice. He expressed the opinion that electric traction had now reached such a point that there could be no opposition to it that was not factious.

The committee resumed its investigation on Friday. Evidence in support of the Bill was given by gentlemen who had had experience of such tramways in Dublin, Dover, and Wednesbury, and the committee adjourned.

The committee had the Bill before it again on Tuesday. The question of the opposition was discussed between counsel and the committee.

Wednesday's proceedings before the committee consisted of evidence from residents in favour of the scheme, and technical evidence by Mr. Alex. Siemens and Dr. John Hopkinson in favour of the overhead trolley. Dr. Hopkinson said that so far as there was any force in the objection of the London County Council to the Bill, he thought the objection might be met by proposing to the tramway company that they should agree with the County Council that, in the event of the latter body constructing a conduit electric tramway in continuation of the company's tramway, they would themselves introduce the conduit system as far as the county boundary.—Mr. L. Coward (for the company) said his clients would be prepared to enter into such an agreement.—Mr. J. Swinburne also gave evidence.

Manchester.—At a meeting of the Electricity Committee of the Manchester Corporation held on Tuesday, a deputation attended from the Salford Corporation for the purpose of conferring on the subject of the proposed electrical traction for tramcars. Manchester has decided that when electricity forms the motive power on the tramways the pressure shall be 400 volts, which will suffice for both lighting and traction purposes. It is desirable that the pressure shall be the same in Salford as in Manchester, and the Salford Corporation will now doubtless make arrangements for supplying a pressure similar to that which will be given in Manchester.

Middlesbrough.—Last week several trips were made over the entire length of the electric tramway from here to Stockton, partly for the education of drivers and conductors. The opening day is not yet fixed. The Government inspection will have to be held first.

Merthyr Tydfil.—The Roads and Bridges Committee of the Glamorgan County Council has decided to recommend the Council to take steps to oppose the scheme being promoted in the Merthyr Tydfil Light Railway Order for the construction of electric railways, and to intimate to the Local District Council that in the event of the scheme being carried out the Council would discontinue its contributions to the maintenance of the roads in the district. The principal of these lines would run for part of its length along a road contributed to by the County Council, a great deal of which was of insufficient width to admit of a railway or tramway with safety to the public.

Morecambe.—It is proposed to erect a novel tower for the east end of the town. The tower will be illuminated by electric lights and an electric car will run underneath the spiral roadway. At the apex of the tower will be a search light of great power showing its light for 20 miles. There will be a special electric lighting plant put down for supplying the requirements of the tower.

Norwich.—The Norwich Electric Tramways Bill was read a third time on Tuesday.

Rochester.—A committee of the Corporation has received a deputation consisting of Mr. Henry Jasper and Mr. Atherton (promoters), Messrs. Giepel and Walters (engineers), and Mr. A. R. Norman (solicitor), *re* a scheme for the construction of a light railway partly within the city. Plans, sections and other particulars are in the Town Clerk's possession.

Ryde.—The Ryde Pier Company are stated in a daily paper to be making preparations for the season by improving their electric railway, and placing it on a stronger and better foundation.

Southborough. — The Southborough tradesmen are opposed to the proposed electrical tramway from Tunbridge Wells to Southborough on the ground that it will induce customers to shop at Tunbridge Wells.

St. Helens.—At the last meeting of the Borough Council the Mayor moved the confirmation of the minutes of the Electric Lighting and Traction Committee, in which were set out the arrangements come to in regard to equipping the tram lines and supplying electrical current for the new electrical tramcars The St. Helens Tramway Company will continue to run the trams and provide rolling stock, and the Corporation have undertaken to supply electricity from the depôt in Boundary Road at the following rates:—2d. per unit on a guaranteed consumption of 200 000 units per annum; 1¾d. per unit for 400,000 units; 1½d. per unit for 600,000 units; and 1d. per unit if the tramways are extended in such a manner as to require 800,000 units per annum. The fixed rent per annum at present paid by the company will be increased to £2,700 when the Prescot and Denton's Green sections are ready for work, and to £3,000 per annum when the whole of the present lines are worked by electricity. This arrangement as to rent is to continue for seven years.—After several questions had been put by Councillor Burchall, the minutes were approved.—The Mayor remarked that they hoped to have the work of converting the tramways from steam to electricity done quicker than was at first anticipated.

TELEGRAPH AND TELEPHONE NOTES.

The "Brazilian" and "Western and Brazilian."—*Money* understands that the agreement between these two telegraph companies will be issued in about a week, and that by its terms the Western and Brazilian deferred shares will be found to be worth about £6 each.

Chatham Telephones.—The Corporation has given the National Telephone Company consent, on certain conditions, to change their service over to the twin wire system.

China Cables.—"Secohm," writing to the *Westminster Gazette*, says that it is important to know at what point the projected cable to Wei-hai-Wei is to be connected to the existing cable systems. "If at Shanghai, as is probable, do not let us forget that the cable office there is a Russo-English one; the Russian interest, according to your Danish interviewee, having taken the place of the previous Danish property."

The Telegraph Wire Export Trade.—The month of May has proved to be a very quiet one as regards the exports from this country of telegraph wire and parts connected therewith, the value for the month having only amounted to £41,944 as compared with £64,883 in the preceding month, £61,226 in May last year, and £112,215 in May, 1896. For the five months ending with May the exports have attained a value of £355,615, as against £382,386 in the corresponding period of last year, and £323,583 in the first five months of 1896.

Telegraphic Isolation of the Cape.—From the daily press we learn that the cable which runs between Mozambique and Delagoa Bay, on the East Coast of Africa, broke down on the evening of the 13th, since which time there has been no means of cable communication with the Cape and the Transvaal, as the cables along the West Coast of Africa have not been available since June 3rd, on which date the cable between Loanda and St. Thomé was interrupted. The following is a list of interruptions to the cables to the Cape during the last 15 months, from which it will be seen that, if anything, the West Coast is less trustworthy than the East Coast route. An examination of the dates will show that in August last the Cape was quite cut off, and that on various other occasions the West Coast route has been only just restored when the East Coast cables fail, and *vice versâ*:—

Cables.	Down.	Repaired.
East Coast Route.		
Durban-Lourenco Marques	May 29th, 1897	June 6th, 1897
Aden-Zanzibar	July 28th, 1897	Sept. 5th, 1897
Mozambique-Lourenco Marques	Sept. 4th, 1897	„ 22nd, 1897
„ „ ...	Oct. 14th, 1897	Oct. 20th, 1897
Aden-Zanzibar ...	Feb. 28th, 1898	March 4th, 1898
Durban-Lourenco Marques	Mar. 19th, 1898	„ 25th, 1898
„ „	May 14th, 1898	May 20th, 1898
Aden-Zanzibar	„ 24th, 1898	„ 25th, 1898
Mozambique-Lourenco Marques	June 13th, 1898	(still interrupted)
West Coast Route.		
Benguela-Mossamedes ...	April 14th, 1897	May 1st, 1897
Sierra Leone-Conakry ...	„ 23th, 1897	„ 24th, 1897
Accra-Kotonou	July 15th, 1897	July 24th, 1897
Cape Town-Mossamedes ...	„ 19th, 1897	„ 28th, 1897
„ „ ...	Aug 7th, 1897	Aug. 10th, 1897
Loanda-St. Thomé ...	Nov. 8th, 1897	Nov. 29th, 1897
„ „ ...	Dec. 4th, 1897	Dec. 12th, 1897
„ „ ...	„ 13th, 1897	Jan. 10.h, 1898
„ „ ...	Mar. 17th, 1898	—
Sierra Leone-Accra	April 9th, 1898	April 19th, 1898
Benguela-Mossamedes ...	„ 20th, 1898	May 5th, 1898
Cape Town-Mossamedes ..	„ 14th, 1898	„ 5th, 1898
Kotonou-St. Thomé ...	„ 27th, 1898	„ 25th, 1898
Loanda-St. Thomé ...	May 4th, 1898	„ 14th, 1898
„ „ ...	June 3rd, 1898	(still interrupted)

The Telephone Service.—In connection with the London County Council Telephone Conference, a report of which appears in another column, the *City Press* quotes the resolution passed: "That, in the event of the Post Office not undertaking a telephone service, it is desirable that the local and central authorities of London should at once combine to secure an efficient and cheap service," and adds editorially, "We agree that in one way or another the metropolis must have an efficient service on reasonable terms." This seems to be the general opinion of all who have anything to do with the service.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	**April 6th, 1898**	...
West Indies—		
St. Croix-Trinidad ...	**Nov. 30th, 1896**	...
Mole-St. Nicholas-Caimanera	June 10th, 1898	...
Caimanera-Santiago de Cuba	June 10th, 1898	...
Amazon Company's cable—		
Cable beyond Gurupa ...	June 8th, 1898	...
Cyprus-Latakia	Feb. 10th, 1898	...
Bolama-Bissao	April 12th, 1898	...
Maranham-Para	„ 17th, 1898	...
Hong Kong-Manila	May 3rd, 1898	...
Loanda-San Thomé ...	June 3rd, 1898	...
Mozambique-Lourenco Marques	June 14th, 1898	...
Landlines.		
Trans-Continental line beyond Masol	**March 12th, 1896**	...
Cartagena-Barranquilla ...	July 4th, 1896	...
Volo-Larissa	June 8th, 1898	...
Saigon-Bangkok	June 11th, 1898	June 14th, 1898.

CONTRACTS OPEN AND CLOSED.

OPEN.

Barnet.—June 24th. The Lighting Committee want tenders from firms willing to undertake such installation for lighting the district by electricity. Particulars at the Council offices, and see "Official Notices" June 10th.

Belfast.—June 22nd. The Corporation wants tenders for the supply of turned and bored C. I. pipes and C. I. bell mouths for electric cable conduits. Particulars from Mr. V. A H. McCowen, Corporation electrical engineer; also see our "Official Notices" this week.

Bethnal Green.—June 28th. The Board of Guardians invite tenders for supplying the necessary plant and installing the electric light at the new infirmary, Palestine Place. For particulars see our "Official Notices" June 10th.

Bournemouth.—June 20th. The Corporation is inviting tenders for the supply, &c., of cables, arc lamps, incandescent lamps, wiring, switchboards, fittings, &c.; also steam dynamo, &c. Particulars from the borough engineer, Mr. F. W. Lacey, also see our "Official Notices" May 27th.

Bulgaria.—June 27th. Some little time ago the municipal authorities of Sophia, Bulgaria, invited tenders for the concession for the electric lighting of the public streets of the city, and for the construction and working of an electric tramway. The authorities are again inviting tenders, until the 27th inst., for this concession, particulars of which may be obtained from above.

Cardiff.—June 28th. The Corporation wants tenders for two water-tube boilers for the electricity works. Particulars from the borough electrical engineer, Mr. Appelbee; also see our "Official Notices."

East London (Cape Colony).—June 28th. The Town Council is inviting tenders for erection of buildings and the supply of electric lighting machinery, electric tramcars, plant, rails, &c., and for their maintenance for six months from completion. Particulars from Messrs. Dyer & Dyer, 17, Aldermanbury, London, E.C., on payment of £5, repayable on the receipt of a *bonâ fide* tender.

Edinburgh.—June 30th. The Corporation wants tenders for the supply of copper strip for electric conductors. Particulars from the resident electrical engineer, and see our "Official Notices" this week.

France.—June 30th. Tenders are being invited by the municipal authorities of St. Laurent de la Salanque, a small town of about 4,500 inhabitants in the Pyrenées Orientales, for the concession for the electric lighting of the public streets. Full particulars may be obtained from, and tenders to be sent to, Le Maire, de St. Laurent de la Salanque, Pyrenées Orientales, France.

Heckmondwike.—June 30th. The directors of the Heckmondwike Industrial Co-operative Wholesale Society want tenders for an electric light installation (about 500 lights) including generating plant for their premises. Consulting electrical engineer, Mr. Walter Leake, 51, Victoria Buildings, Manchester. See our "Official Notices" this week.

Hull.—July 1st. The Corporation wants tenders for wiring and the supply of fittings for the East Hull Baths. Particulars from the city engineer (Mr. A. E. White). See our "Official Notices" this week.

Leeds.—June 16th. The Council requires tenders for two engines and dynamos of about 1,000 H.P. each; also for 50 electric tramcars. Particulars from Dr. John Hopkinson; also see our "Official Notices."

London.—June 21st. The London County Council is inviting tenders for engines, dynamos, accumulators, switchboards, feeders, distributors, and service mains and all accessories, to be fixed complete in buildings at the Crossness Outfall Works, near Erith, Kent. The L.C.C. also requires tenders for providing and fixing cables, wires, conductors, casing, pendants, brackets, and other fittings, columns, lanterns, lamps, switches, and switchboards, distributing boards, fuses, cut-outs, &c., necessary for the lighting by electricity of the Crossness pumping station and works, near Erith, Kent. Particulars of both contracts from the Engineer's Department, County Hall, Spring Gardens, S.W. See also our "Official Notices" May 27th.

Newington.—July 1st. The Vestry of St. Mary invites tenders for the construction, supply, and erection of boilers, pumps, steam and water mains, water tank, surface condenser, fuel economiser, &c., for the electricity works in Penrose Street, Walworth. Consulting engineers, Messrs. Kincaid, Waller & Manville. See our "Official Notices" this week.

Southampton.—June 20th. The Corporation invites tenders for the supply and erection of lamp columns, arc and incandescent lamps, automatic switches and fittings. Consulting engineers, Messrs. Kincaid, Waller & Manville. See our "Official Notices" June 3rd.

Tynemouth.—June 20th. The Corporation wants tenders for the supply of steam dynamos, balancer and boosters, &c. Consulting engineers, Messrs. Lacey, Clirehugh & Sillar. See our "Official Notices" June 3rd, for particulars.

Victoria.—June 24th. The Council of the city of Hawthorne (Colony of Victoria, Australia) is inviting tenders for the supply and erection of buildings, boilers, engines, dynamos, transformers, mains, meters, arc lamps, poles; also running the plant for three years. See our "Official Notices" March 11th.

Wimbledon.—June 27th. The District Council wants tenders for the installation of the electric light mains and fittings in the new depôt buildings in Queen's Road, Wimbledon. Particulars from the Council's engineer, Mr. C. H. Cooper. See our "Official Notices" this week.

York.—June 24th. The Corporation is inviting tenders for the erection of an electric light station. Particulars from the City engineer, Guildhall.

CLOSED.

Aberdeen.—A committee of the Harbour Board has accepted the tender of Messrs. Lucy & Co., Oxford, to erect lamps and standards for the electric lighting of the Quays.

Belgium.—Mr. G. Boty, of Brussels, submitted the lowest tender (12,387 fr.) for the installation of electric lighting in the Bibliothèque Royale, Place du Musée, Brussels. Three other firms tendered.

Hammersmith.—It is proposed to give Messrs. Ferranti the contract for the extension of the rectifiers and switching apparatus, at £640 and £154 respectively.

Leyton.—The contract for a secondary battery for the District Council has been given to the "Hart" Secondary Battery Company, Limited, The battery consists of 170 cells of a capacity of 1,100 ampere hours at a normal discharge rate of 200 amperes and a maximum discharge rate of 600 amperes for 1 hour. The following were the tenders received:—

Headland Battery Company, Limited	£1,402	0
"Hart" Secondary Battery Syndicate, Limited *(accepted)*	1,480	0
General Electric Company, Limited	1,526	0
E. P. S. Company	1,562	10
Tudor Accumulator Company, Limited	1,780	0
Chloride Electric Storage Company, Limited	1,980	0
Epstein Accumulator Company	2,081	0
D.P. Battery Company, Limited..	2,400	0

Sunderland.—The tender of Messrs. Abbott & Co., of Gateshead, for steam piping, has been accepted by the Council in connection with the electric lighting extensions.

FORTHCOMING EVENT.

1898.

Friday, June 24th at 5 p.m.—Physical Society. Agenda:—1. Exhibition of an Apparatus illustrating the action of two coupled Electric Motors, by Prof. Carus-Wilson; 2. Exhibition of Weedon's Expansion of Solids Apparatus, by Mr. J. Quick; 3. "On the Theory of the Hall Effect in a Binary Electrolyte." By F. G. Donnan, M.A., Ph. D.

NOTES.

Société Internationale des Electriciens.—The monthly meeting of the Société des Electriciens was held on June 1st at 8.30 p.m., with M. R. V. Picou in the chair. M. Ducretet performed a series of experiments on the Hertz system of wireless telegraphy with M. Branly's radio-conducting tube, and various other accessories invented by him. At the transmitting station we find, in the first place, a battery feeding a small electro-motor which works a mercury interrupter. This interrupter is introduced into the circuit which supplies the energy to the inductive circuit of a Ruhmkorff coil. The current which is derived from a special battery passes through the interrupter, a hand switch which is also worked by mercury, and which enables the circuit to be very quickly opened and closed, and the inductive circuit of a Ruhmkorff coil, which is capable of producing a spark ·4 of a metre in length. The two extremities of the induced circuit meet an oscillator which consists of two balls placed opposite to two separate rods, which meet two spheres placed in an insulating liquid. It is in this medium that the spark is emitted. One of the wires of the induced circuit is connected to earth, and the other to a large vertical insulated rod. The electric waves start from this rod and proceed to a receiving station where are installed a Branly radio-conducting tube with an automatic tapper and an automatic Morse register. All the electric waves sent into the atmosphere are registered automatically. M. X. Gosselin then showed in projection some of the best known potentiometers at present employed in various industries.

The Ameer and the Dynamo.—If any of our readers should desire to obtain any further particulars of the career of Sir Thos. Salter Pyne, to which we alluded on page 790 of last week's issue, we would refer them to the April issue of the *Indian and Eastern Engineer*, from whence our information was derived.

The Alexandra Palace Electric Tramway.—The Electricitäts-Gesellschaft Wandruszka & Cie, of Berlin, who are the general European agents for the Steel Motor and Johnson Company, in Johnstown and Lorrain, U.S.A., some months ago entered into an agreement by which they had to erect and work an electric railway in the grounds of the Alexandra Palace. As already mentioned in our columns the line has been in operation since May 15th, and is giving satisfaction. The length of the line is 1·2 miles, on which four motor cars, of a seating capacity of 50 passengers each, are running. The mean takings have proved up to the present to be £12 5s. per day, a good result. The track is double and of ordinary gauge throughout, and the line is equipped with overhead wires on centre poles. At the generating station, the generating plant is in duplicate for the purpose of reserve. The average gradient of the whole line is 1 in 13. The motor cars are fitted with double equipments of the Steel Motor, type 18. On the highest gradient, which is 1 in 11, the motors want a supply of current equal to 37 amperes, with an E.M.F. of 510 volts. Although the seating capacity of the cars is stated as 50, we are informed that they have been carrying 64 passengers.

Municipal Electrical Association.—At the business meeting of this Association, held at the Royal United Service Institution, Whitehall, S.W., on Saturday last, it was resolved to hold the next Convention in Bristol, and Mr. H. Faraday Proctor was elected President. Mr. J. H. Ryder, of Plymouth, and Mr. G. H. Cottam, of Hampstead, were elected Vice-Presidents; Mr. Wilmshurst, Halifax, and Mr. J. F. C. Snell, Sunderland, being elected members of the Council, to serve three years. Bailie Maclay, Glasgow, and Dr. Panton, Bolton, were also elected members of the Council, each to serve one year. Mr. G. H. Cottam was re-elected hon. treasurer, and Mr. W. A. Godfrey hon. auditor. The President stated that the Council had had such valuable help from Councillor Pearson, of Bristol, that they found with extreme regret the fact that, under the constitution, he was not eligible to serve upon the Council during the coming year, and with the idea of retaining his valuable help, and his great knowledge of legal matters, it was considered desirable by the Council to ask the Association to appoint Mr. Pearson as hon. solicitor, and he was elected unanimously. The appointment of hon. secretary was left with the Council.

Electrical Engineers wanted by the War Office.—We understand that the Under-Secretary of State for War, War Office, London, is to appoint an electrical engineer with thorough mechanical and electrical training and experience of electric lighting work, including the distribution of current. He will be required to assist in the preparation of particulars and supervision of the execution of electric lighting contracts at Aldershot. An electrical and mechanical draughtsman is also required for the preparation of plans and record drawings in connection with the above. He must be thoroughly competent, and must have had experience in the office of a consulting electrical engineer or contractor for large electric light installations. Applications, by letter only, stating age, experience, and salary required, and furnishing references, to Under-Secretary of State for War, War Office, London.

Röntgen Rays in War.—In the House of Commons on Friday last week, in reply to General Russell, Mr. Brodrick said :—The Röntgen ray apparatus, which is a very recent invention, is very difficult to adapt for field service, and was not carried with the field army in the recent operations. From the returns the medical authorities do not consider there was a single case in which life could have been saved by the use of the apparatus. Two sets are now in Egypt, and one more will be sent out shortly. Two have been adapted as far as possible for field service, and one is for use in the base hospital. Sir J. Fergusson asked whether 400 men were not wounded by bullets, and whether the apparatus would not have been most useful in locating the bullets. Mr. Brodrick.—The senior medical officer has gone carefully into the cases and has been unable to trace any single case in which the apparatus would have been specially useful or in which an operation would have been carried out more successfully by the use of the rays.

Wireless Telegraphy.—The following copy of a letter addressed to the President of the Académie des Sciences, Paris, June 12th, 1898, has been handed to us for publication :—

"Sir,—The first station for the *Hertz system of wireless telegraphy* is established at my works. The mast rises to a height of 26 metres from the ground (the height of the ground is about 55 metres). This mast overtops the neighbouring houses, and can be seen from a great distance. The conducting wire, which is insulated and attached to the top of this mast is 32 metres long. This collector of the electric waves goes into my laboratory, and is connected with one of the electrodes of the Branly *radio-conductor* of the receiving station, the other electrode is connected to earth.

"Yesterday, Saturday, from 2.30 to 3.40 p.m., during the storm my *automatic receiver* registered 311 *intermittent atmospheric discharges* as they made their presence felt on the *collecting mast*. These discharges were registered *before* the appearance of the lightning and the noise of the thunder.—Believe me, Sir, your devoted and obedient servant, E. DUCRETET.

This note cancels that dated the 7th, which is less complete, the collecting mast not having been erected at that date."

The Langdon-Davies Motor.—The Davies Motor Company inform us that the manufacture of the Langdon-Davies motor having grown too large to be carried on in their present works, they have transferred the English manufacturing rights to a new company under the name of the Langdon-Davies Electric Motor Company, Limited, which has taken and equipped considerably larger works at 101, Southwark Street, S.E., to whom all communications on the subject of motors should be addressed. The instrument business, with the exception of ammeters, voltmeters, and the other electric lighting instruments still continues at the above address as for the eight years past, and previously to that at Westminster. The company has reverted to the old name of Nalder Bros. & Co., Limited, and its business will be carried on, as it has continuously been for the past 10 years, under the two partners in the original firm of Nalder & Co., Messrs. Crawley and Soames, as its managing directors, and with the same staff. To prevent confusion, the business previously carried on at 16, Red Lion Street, is now divided into the three following totally distinct concerns, the latter two having taken over the branches specified :—Nalder Bros. & Co., Limited, as above. Nalder Bros. & Thompson, 34, Queen Street, Cheapside, E.C., ammeters, voltmeters, switchboards, &c. The Langdon-Davies Electric Motor Company, Limited, 101, Southwark Street, S.E., alternate current motors.

British Association, Bristol, 1898.—The local hon. secretaries, Messrs. Arthur Lee and Bertram M. H. Rogers, are sending out the report of the executive of the B.A. Local Committee held on June 6th, giving details of the arrangements which are being made for the September meeting at Bristol. Particulars as to presidents of the various sections and other information appeared in our April 8th issue.

Personal.—Mr. George C. Sillar, M.Inst.E.E., who for nearly 17 years has been connected with the Brush Electrical Engineering Company, Limited, in various capacities, has been appointed general manager of the Otis Elevator Company, Limited, Queen Victoria Street.

Mr. W. H. Allen, of the Queen's Engineering Works, Bedford, is now a justice of the peace for Bedfordshire.

Forthcoming Prospectus.—*The World* understands that the prospectus of the "Cotsworth" Arc Lamp and Electric Lighting Syndicate, Limited, will be issued at no remote date. "The lamp is said to be the simplest ever offered to the public, while the cost of production is estimated at a very low figure."

Will.—The late Mr. Thos. Holliday, Edgerton, Huddersfield, of the firm of Read, Holliday & Co., Limited, electrical engineers, &c., has left gross estate £108,618 16s. 1d.

Marriages.—Mr. Guy C. Fricker, of Messrs. Fricker, Miller & Co., was married on Wednesday last week, June 8th, to Miss Lena Bockett, third daughter of the late Mr. John Bockett, solicitor, Lincoln's Inn Fields. The "happy pair" have gone for a three weeks' tour in Switzerland.

Mr. Thomas Harding Churton was married on 8th inst. to Ethel Blanche, younger daughter of Marshall Nicholson, Esq., of Middleton Hall, Leeds, at St. Mary's Church, Middleton. Mr. Harding Churton, of Leeds, needs no introduction to the electrical fraternity.

"Stand-by Charges."—Mr. Robert C. Quin, the borough electrical and tramway engineer at Blackpool, read a paper before the Municipal Electrical Association on "Stand-by Charges," raising the question of the unfairness to electrical undertakers to be compelled to find capital for plant usually lying idle to supply consumers whose premises are equipped with their own generating plant. We refrain from commenting on this paper, as the Council of the Association decided at the last moment to withdraw it from discussion, and to make it the subject of a report from their body.

Blackpool and the Overhead Trolley.—We understand that, after careful consideration, the Board of Trade has decided to sanction the overhead trolley system of electric traction on the Corporation tramways on the condition that the special regulations made by the department are strictly complied with.

Paris Exhibition of 1900.—The Royal Commission, of which the Prince of Wales is chairman, are now prepared to circulate information respecting the Exhibition. The classification and rules for exhibitors, together with forms of application for space, can be obtained by applying to the Secretary of the Royal Commission, Paris Exhibition 1900, St. Stephen's House, Westminster, S.W.

Presentation.—On 7th inst., the superintendent engineer of the Northern Electrical Engineering and Plating Company, Limited (Mr. Thomas W. Ogilvy), was, at Newcastle, presented with a handsome cruet and a pair of bronze ornaments subscribed for by the employés of the firm on the occasion of his marriage.

Burglary.—Messrs. E. P. Allam & Co., electrical engineers, of 14, Hatton Garden, E.C., ask us to state that a few days ago their premises were broken into and an Evershed generator, No. 125, and a Nalder Bros. ohmmeter, No. 6,418, were stolen. They will be pleased to reward anyone giving information which will lead to the recovery of the instruments and the apprehension of the culprit.

"Truth" on Trams.—After condemning the existing tram service at Hull, Labby asks in *Truth:* "Why does not the municipality start electric trams?" and proceeds to eulogise the overhead trolley system. We are quite at one with him in this matter, but he is not *au fait* in regard to the progress of mechanical traction, or he would know that the Hull Council some time ago gave out contracts for electrical equipment of the trams on the trolley system, and the first rail was laid last week.

Verband Deutscher Electrotechniker.—The sixth annual meeting of the Verband Deutscher Electrotechniker was held at Frankfort-on-Main from the 2nd to the 5th inst. Among the papers read was one by Dr. Th. Bruger "On a Direct Indicating Phase Meter," and one by Dr. M. Levi on "Progress with Röntgen Rays."

The Royal Society.—The following papers were down for reading yesterday afternoon:—C. Coleridge Farr, "On some Expressions for the Radial and Axial Components of the Magnetic Force in the Interior of Solenoids of Circular Cross Section." A. A. C. Swinton, "On the Source of the Röntgen Rays in Focus Tubes." Prof. W. Ramsay, F.R.S., and M. W. Travers, "On the Constituents of Argon."

Appointment Vacant.—The Croydon County Polytechnic is wanting a teacher of electrical engineering. For particulars of qualifications, &c., see our "Official Notices" this week.

NEW COMPANIES REGISTERED.

Asbestos and Rubber Company, Limited (57,673).—Registered June 7th, with capital £10,000 in £1 shares, to acquire the business carried on by Stanley, Morrison & Co. at Hull and Sheffield, to adopt a certain agreement, and to carry on the business of India-rubber, gutta-percha, and asbestos manufacturers, ship and engineers' stores manufacturers, electricians, telegraph and electrical engineers and contractors, cable and telegraphic instrument manufacturers. The subscribers (with one share each) are:—T. B. Hooper, 15, Old Jewry Chambers, E.C., solicitor; E. B. Morrison, 33, Greencroft Gardens, N.W., gentleman; R. M. Albery, Bowery Farm House, Wraysbury, Bucks, farmer; B. S. Ince, 1, Church Court, Old Jewry, E.C., printer; H. Pearce, 129, Cheapside, E.C., stationer; F. D. Leslie, 74, Coleman Street, E.C., accountant; O. M. Bolton, 431, Liverpool Road, N., clerk. The number of directors is not to be less than two nor more than five. The first are:—A. Morrison (chairman), B. Gee, and J. Cuthbert. Qualification, £100; remuneration as fixed by the company. Registered by Lumley & Lumley, 15, Old Jewry Chambers, E.C.

Harry W. Cox, Limited (57,703).—Registered June 8th, with capital £2,000 in £1 shares, to acquire and carry out business as an electrician, electrical and mechanical engineer, contractor, model maker, and manufacturer of electrical and scientific appliances, carried on by H. W. C. Cox at 10, 11 and 28, Cursitor Street, Chancery Lane, W.C. The subscribers (with one share each) are:—C. F. Leighton, Manorfield, St. Albans, gentleman; A. Greek, 41, Oakley Road, Canonbury, N., clerk; B. Aylward, 35, Brook Green, W., gentleman; F. R. Nutt, 17, Cornwall Cottages, Essex Road, N., electrician; H. W. C. Cox, 51, Cricketfield Road, Hackney Downs; E. F. C. Savory, 2, Clement's Inn, W.C., gentleman; Mrs. M. Cox, 51, Cricketfield Road, Hackney Downs. The number of directors is not to be less than three or more than five; H. W. C. Cox, B. Aylward, and C. F. Leighton. Qualification, £100; remuneration as fixed by the company. Registered office, 10 and 11, Cursitor Street, Chancery Lane, W.C.

Biograph and Mutoscope Company for France, Limited (57,708).—Registered June 9th, with capital £100,000 in £1 shares, to acquire certain inventions for the reproduction of objects in motion, and the French patent rights for the same, to adopt an agreement with A. Grove, J. S. Montagu, and J. W. Orde, and to carry on the business of mutoscope, biograph, and mutograph manufacturers, battery makers, tablet and diaphragm manufacturers, electricians, electrical, mechanical, and chemical engineers, iron and brass founders, &c. The subscribers (with one share each) are:—E. B. Koopman, 18, Great Winchester Street, E.C., director; T. N. A. Grove, J.P., 11, Hans Road, S.W.; J. S. Montagu, M.P., 29, Cornhill, E.C.; J. W. Orde, 29, Cornhill, E.C., gentleman; E. Baker, 29, Cornhill, E.C., secretary; N. P. A. Brady, 81, Cannon Street, E.C., gentleman; A. R. Roberts, 13, Walbrook, E.C., solicitor. The number of directors is not to be less than two nor more than seven; the subscribers are to appoint the first; qualification, 100 shares; remuneration, £1,200 per annum and a share in the profits, divisible. Registered office, 29, Cornhill, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

British Electric Traction Company, Limited (49,855).—This company's annual return was filed on May 7th, when 30,000 ordinary and 10,000 preference shares were taken up out of a capital of £600,000 in £10 shares. £10 per share has been called on the ordinary, and £6 10s. per share (including £2 10s. per share premium) has been called on the preference. £354,817 has been paid, £10,183 is in arrears, and £57 has been received in advance.

India-Rubber, Gutta-Percha, and Telegraph Works Company, Limited (1,122 C).—This company's annual return was filed on May 27th, when 50,000 shares were taken up and paid for in full out of a capital of £812,000 in £10 shares.

Indo-European Telegraph Company, Limited (3,953).—This company's annual return was filed on May 10th, when 17,000 shares were taken up and paid for in full out of a capital of £450,000 in £25 shares.

London Platino-Brazilian Telegraph Company, Limited (12,093).—This company's annual return was filed on May 23rd, when 37,548 shares were taken up and paid for in full out of a capital of £400,000 in £10 shares.

Elmore's German and Austro-Hungarian Metal Company, Limited (32,457).—This company's annual return was filed on June 3rd. The capital is £162,981, divided into 50,000 preference shares of £2 each, and 62,981 ordinary shares of £1 each. All the ordinary and 22,275 preference have been taken up, and 25,000 ordinary are considered as paid. £1 per share has been called on the 37,981 ordinary, and £2 per share on the preference, and £82,531 has been paid. 1,730 shares have been forfeited, and 10,337 shares cancelled, and £22,131 12s. 10d. has been paid in respect thereof.

Oriental Telephone and Electric Company, Limited (40,691).—This company's annual return was filed on May 12th, when 171,504 shares were taken up out of a capital of £200,000 in £1 shares. 171,497 shares are considered as paid, and £7 has been received on the others.

Altrincham Electric Supply, Limited (40,795).—This company's annual return was filed on May 27th, when 25,000 shares were taken up and paid for in full out of a capital of £50,000 in £1 shares.

Rand Central Electric Works, Limited (43,712).—This company's annual return was filed on May 20th, when the capital of £300,000 in £1 shares was fully taken up. 25,000 shares are considered as paid, and £275,000 has been received on the others.

Electric Cycle Syndicate, Limited (36,227).—This company's annual return was filed on April 1st, when 2,827 shares were taken up out of a capital of £3,000 in £1 shares. 1,000 shares are considered as paid, and £1,742 10s. has been received on the others, leaving £84 10s. in arrears.

Electric Exploitation Company, Limited (40,256).—This company's annual return was filed on April 22nd, when 20,367 shares were taken up out of a capital of £25,000 in £1 shares. 20,000 are considered as paid, and £360 has been paid on the others, leaving £7 in arrears.

CITY NOTES.

Western Brazilian Telegraph Company.

The thirty-fifth ordinary general meeting of the above company was held on Thursday, June 9th, at Winchester House, Old Broad Street, Mr. W. S. Andrews presiding.

The Chairman, in moving the adoption of the report, said he was glad to say they were able to meet the shareholders under rather better auspices than had been the case for some little time back. There was an increase in the revenue and a decrease in the expenses. The revenue for the half-year had amounted to £72,332 9s. 10d., as compared with £71,315 12s. 2d., showing an increase of £1,116 17s. 8d., and that would have been rather more had it not been for special circumstances to which he would presently refer. With regard to the expenses, they were £37,774 1s. 11d., as compared with £38,160 19s. 4d., consequently there was a decrease of £386 17s. 5d. Dealing first with the expenses, there was a total increase of £1,211 under abstract A, but of that maintenance accounted for £750, and stores and new apparatus for another £524, and there was an increase of £400 under miscellaneous. The decreases in abstract A, were travelling, £300; and stationery and printing, £83; the net result being an increase of £1,211. Abstract B, which dealt with their shipping, was always a source of considerable anxiety with them, and he was very pleased to say that under that head there was a notable decrease, because in the period under review they dispensed with the services of the second ship that they had been obliged to employ previously—the *Buccaneer*—and the saving amounted to £3,477 15s. 5d., although their other ship, as a matter of fact, had to do all the same work, and did it very satisfactorily, of course, with an increased consumption of coal and other expenses. That saving of £3,477 he would have liked the shareholders to have had the immediate benefit of, but it had been partly absorbed by certain special expenses incurred in Buenos Ayres on account of the attack—which might have been rather a dangerous one for them—made under the guise of tariff changes. They had to defend themselves from that attack, and it was rather a costly defence. Then, in addition to that, they had maintenance and repair expenses, and new apparatus, which ran away with some £2,500 of that reduction, which they would otherwise have got the entire advantage of. In abstract C, out of the total increase of £167, £154 12s. was owing to arbitration expenses, so that was practically about the same. The result was that they were left with a decrease of expenses amounting to £386 17s., and he was glad to say that decrease did not end with the period under review, but it was going on and increasing, so that there was no doubt by-and-bye they would have a better tale to tell the shareholders with regard to the expenditure, even than they had that day. Dealing with the net revenue, there was the balance from last half-year, £3,867 15s. 2d.; there was the dividend on the shares in the Platino Company, £11,094—against none in the corresponding period—and the balance on their own working, after payment of expenses, amounted to £34,558 7s. 11d.—together, £49,520 3s. 1d. They had to deduct £8,060 8s. 4d. for interest on debentures and debenture stock; £2,159 12s. 4d. for sinking fund for the redemption of the new debentures, and, with £5,000 added to the reserve fund, they got a total of £15,220 0s. 8d., which left £34,300 2s. 5d. available. They proposed to declare a dividend of 6s. 9d. per share, and to carry forward £1,428 5s. 11d. to the current period. That distribution was equal to a dividend of 3¼ per cent. per annum, and consequently it was the best dividend that they had received since 1891, when it was at the rate of 4 per cent. That pointed to an improvement in their affairs which must be gratifying to all of them, but gratifying as was that comparison it did not end there. They not only paid more than double the dividend that they paid in the corresponding period which was 3s. per share, but the net revenue earned during the half year was more than double that earned in the six months ending June, 1896, and on this occasion they were able to pay more than double the dividend and add £5,000 to the reserve, instead of having to assist their smaller dividend as they did in 1896, by taking £7,500 out of the reserve. All they wanted now was a little revival in the trade of Brazil, and their position would be decidedly more satisfactory. The exchange had been 7⅜d. only as against 8⅝d., but, of course, under the new mode of collection, that was not so serious as it appeared. Still, under the new method, before fixing the rate of exchange for the coming three months, the Government took the average rates of exchange for the preceding period, and, of course, if the average for the preceding three months was higher than they got for the next three, when the rate had been fixed, they lost money. Strange to say, ever since that arrangement was made for the collection of the exchange, it had been going down, so that although the rate had been fixed at a certain point they had never actually got it, but something below it. At present the exchange was going up, and consequently their receipts were going up with it. The augmentation of the revenues of their company, and of those of the Platino, were continuing. Already they had reached a point in their revenue a good deal above the corresponding period, and therefore he hoped—he might almost say he was confident—that they would be able to tell the shareholders even a better story than the present when the current half-year's business came to be laid before them. No doubt they would have remarked that the new president-elect of the United States of Brazil had come over to this country to arrange important matters in connection with Brazil. There was no doubt that Brazil needed a period of rest and recuperation, and it was earnestly to be hoped that she might obtain it. When the great natural riches of the country were considered they had every reason to expect that, with a careful administration of the revenues, a very gratifying and prosperous result might yet be produced. He was sure they would all wish the president-elect every success in his patriotic efforts, and God speed in his important mission for the benefit of his magnificent country. There was one other question in the report which he could not say much upon. Undoubtedly the shareholders would have noticed that paragraph in which they stated that negotiations for closer working between their company and the Brazilian Submarine Telegraph Company had been in progress. Those negotiations were not completed yet. They were progressing satisfactorily and pretty actively, and they believed they would result successfully, and that the results would be welcome alike to the governments, the public, and the companies. Of course, nowadays it was necessary to do things which were agreeable all round, and not to shut one's eyes or direct them into a narrow focus. He would, therefore, ask them not to put any questions to him in reference to that subject, but if there were any other matters shareholders wished information upon he would be very happy to afford it them.

Lord Richard H. Browne seconded the motion for the adoption of the report and it was carried without discussion.

The retiring directors having been re-elected, Major Cotton, in moving the re-election of the auditors, said he thought they must congratulate the chairman and directors upon the improved state of affairs they had put before them, and upon the very hopeful prospects for the future. He hoped that the negotiations which were being carried on for closer working with the Brazilian Company might soon be brought to a satisfactory termination for the benefit of the shareholders especially.

The motion having been carried, the proceedings terminated with a vote of thanks to the chairman and directors.

British Thomson-Houston Company, Limited.

The third ordinary general meeting was held on Friday last at the offices of the company, Cannon Street.

Mr. E. A. Lazarus, the chairman of the company, presided, and in moving the adoption of the report, observed that their business had gone on very quickly during the year, and they had had to extend their offices and premises a good deal. With regard to the principal traction contracts now in hand, they had the city tramways of Dublin, Cork, which was also a lighting concern, the Central London Railway, Middlesbrough, Sheffield, Dudley-Stourbridge, and Oldham-Ashton. Those were the principal inclusive contracts, but they had a good deal of other business. They did not rely on patents for their success, but on the way in which they did their work. The industry, however, had been and was developing very quickly, and they had latterly found that a good many competitors were infringing their patents. They had spent about £100,000 on acquiring them, and they were therefore seriously considering whether it might not be worth something more to protect them.

Sir Thomas Thompson seconded the motion, which was adopted, and dividends of 10 per cent. for the year on the "A" and "B" shares were afterwards declared.

Elmore's German and Austro-Hungarian Metal Company, Limited.

The directors have been this week inviting applications for an issue of £60,000 6 per cent. debenture stock at par. The trustees are Lord Farrer, of Abinger, and Mr. J. R. Hollond. Applications were received for over £37,000 before the issue of the prospectus. The following table shows the increase in the value of the sales for the past three years and the balances of the profit and loss account of the "Metall" Company for the same period:—

1895 sales	... £17,052 12 3	...	Loss	... £1,575 9 5
1896 sales	... 24,747 17 9	...	Profit	... 347 18 3
1897 sales	... 37,929 18 6	...	Profit	... 3,202 11 0

while the sum of £5,748 11s. 5d. was deducted from revenue by way of depreciation during the same period. The value of the sales for the present year to the 1st inst. shows an increase of 90 per cent. as compared with that for the same period last year. In 1897 the "Metall" Company was given a contract to supply the total requirements of the German Navy for a period of three years. This contract was, by arrangement, cancelled in April last, and a new one has been entered into, whereby the company is to supply all tubes over 1⅜ inch in diameter for the next two years, but at greatly enhanced prices. Notwithstanding the increased production, the company was in 1897, and is now, unable to accept even a moiety of the orders offered by the large shipyards and private customers. The output for 1897 was 411 tons; the new plant, now nearly completed, when fully at work, is estimated to produce 1,100 tons per annum. The list closed yesterday afternoon.

Callender's Cable and Construction Company.

The report of the directors for the year ended December 31st last, states that the accounts show a balance at the credit of profit and loss of £24,746, from which must be deducted interest on debentures, £4,050, appropriation for depreciation of machinery, plant, &c., £3,000, leaving an available balance of £17,696. The directors now propose to pay a dividend at the rate of 10 per cent. per annum (clear of income-tax), being 10s. per share, whereof 4s. was paid on October 31st, 1897, as an interim dividend, leaving 6s. per share to be paid now, absorbing £10,000, and a bonus of 2s. 6d. per share, absorbing £2,500, leaving £5,196 to be carried forward. The total payment for interest and bonus on account of 1897 will therefore be at the rate of 12½ per cent. per annum. The expenditure on buildings, plant, and machinery has proved beneficial to the business, and has enabled it to produce better and cheaper cables than at any time in the past. The plant and premises have been maintained in a thorough state of efficiency, and the cost not only of all repairs and maintenance, but of alterations and improvements, has been debited against the year's profits. Some of the shares held by the company have been disposed of, and others have necessarily been acquired in connection with the business. The present market value of the shares held exceeds by several thousand pounds the value shown in the balance sheet, but it is not proposed to deal with this excess at present. The business transacted in 1897 was again much larger than that in previous years, and the directors are glad to report that it continues to increase, and that the output of the factory during the last five months has exceeded their utmost expectations. Although extensive additions to plant, machinery, and buildings were made in 1897, it became evident towards the close of that year that still further additions were required to cope with the fast growing business, and that these must be on a much larger scale than heretofore. The land at Erith which the company owns had been utilised nearly to its full capacity, and was clearly insufficient for these extensions, and, after lengthy negotiations, the directors have succeeded in purchasing about 25 acres of freehold land adjoining the present factory, which will assure ample space for extensions for many years to come. The present capital is quite insufficient to enable the company to carry on their rapidly increasing business to the best advantage and to meet the cost of the necessary extensions of the works. It is therefore proposed to increase the capital by the creation of 20,000 preference shares of £5 each, and the requisite notice of an extraordinary general meeting has been given for the purpose. It is not contemplated to issue more than 10,000 of these shares at the present time, and these will be offered first to the existing shareholders.

The second annual general meeting of shareholders of the above company was held on Wednesday last at the offices, 90, Cannon Street, Mr. Henry Drake presiding. The Chairman, in moving the adoption of the report, said he hoped the shareholders would consider the accounts satisfactory. The directors were very well satisfied with the progress of the company. They had had a very prosperous year, and the figures in the balance sheet carried out that view. There were one or two items in the accounts to which he would call attention, as he thought they prove interesting. In the first place they would observe that they had spent £11,355 on enlargement of works and additional plant, which was in addition to the £2,985 written off the profits, for repairs and maintenance. In 1896 they spent nearly the same amount—£11,238. The next item he would call their attention to was that of cable drums, which stood at £2,803 as against £2,170 last year. That afforded a very fair indication of the increase of the business, because they used those drums for winding their cables on, and the amount stood at about one-third more than last year. The next item was stock in hand, which was only £1,200 more than last year. Then came expenditure on contracts in course of execution and sundry debtors, and there they had an increase of £26,000—that was to say, those two items, together, came to about £100,000 as against £74,000, which was a very satisfactory thing. Cash at the bank and bills receivable stood at £9,136 as against £15,229, which, he thought, showed that they were using their means as closely as they could. Shares in other companies stood at £6,603, as against £8,800. That arose in this way: they had sold shares that they held in 1896, and they had placed the money that they had received from that to the credit of that account. They had taken up a few more shares, rendered necessary in the course of their business, but they had not increased the value of the shares that they held; they had left them simply at the value that they stood in the last balance-sheet. The result was, that there was an undisclosed profit on these shares, probably amounting to about £10,000, but they did not wish to deal with that money until they had realised it. Coming to the profit and loss account, the balance to the credit of that account was £17,696, as against £13,507, which was an increase of £4,000. They proposed to pay 6s. a share, being the balance of 10s. per share dividend, which was 10 per cent. on the capital. That would take £10,000. They also proposed to pay a bonus of 2s. 6d. per share, which would absorb another £2,500, which would make a total distribution of 12½ per cent., leaving £5,196 to carry forward to next year's account. He hoped the shareholders would consider those results satisfactory. The business of the company had very largely increased, and that led him to refer to the proposed increase of capital, to which reference was made in the report. It was absolutely necessary that their works should be extended. At present they had not sufficient room to carry on the business they had in hand, or the work which they would in all probability get in the future. They had considered the question of extension for a long time, and at last they had had an opportunity of purchasing 25 acres of land adjoining their factory. It had no river frontage, but as they already had as much river frontage as they required, that was immaterial, and it enabled them to buy the land very cheaply. It only cost them about £130 an acre, which, for their purposes, was a very small sum indeed. There was a small quantity of land on the other side of their works for which they were in negotiation, and for which they were prepared to give £500 an acre, but when the 25 acres adjoining their own place was offered them, they thought it far better to buy it than a smaller site, where they would not be able to place so much space between their buildings. That, of course, brought him to the point of increased capital. Their present capital was quite insufficient, and therefore they had sent out notices for an extraordinary meeting to increase the capital by £100,000, and there was a statement made in the report on that matter which he wished to qualify. It was stated that it was not contemplated to issue more than £50,000 of that capital at the present time, but since the report was issued the directors had again gone carefully into the matter, and had come to the conclusion that they must issue the whole, probably extending the period of payment over a longer time than they would otherwise have done.

Lieut.-Colonel G. A. Elliot seconded the motion, and the report was adopted.

Mr. T. O. Callender, the managing director, addressed a few words to the shareholders as to the progress of the business, and said he was glad to say that, good as was their business in 1897, it was nothing to what they were doing now. Their only difficulty was to turn out the work, and not only did they want further working capital, but also they needed more plant and machinery. It was very likely that within the next two or three years the business they were at present doing might be doubled, and it might interest the shareholders to know that 90 per cent. of the company's business was with leading corporations throughout the country.

Subsequently an extraordinary meeting was held, when resolutions were passed authorising the directors, subject to the confirmation of another extraordinary meeting, to create £100,000 additional capital in preference shares of £5 each.

Replying to a question, the Chairman said the new capital would, in the first instance, be offered to the existing shareholders to the amount of their present holding.

Altrincham Electric Supply Company, Limited.—The balance-sheet shows a balance profit for the past year of £725. The company has several important contracts in hand.

City of London Electric Lighting Company.—The transfer books and register of holders of £400,000 5 per cent. debenture stock will be closed from 21st to 30th inst.

Electric and General Investment Company.—The transfer books will be closed from 13th to 28th inst., inclusive.

TRAFFIC RECEIPTS.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending June 10th, 1898, were £2,899 0s. 1d.; corresponding period, 1897, £3,365 1s. 5d.; decrease, £466 1s. 4d.

The City and South London Railway Company.—The receipts for the week ending June 12th, 1898, were £931; week ending June 13th, 1897, £880; increase, £51; total receipts for half-year, 1898, £24,558; corresponding period, 1897, £24,215; increase, £343.

The Dover Corporation Electric Tramways.—The receipts for the week ending June 11th, 1898, were £157 4s. 8d.; total receipts to June 11th, 1898, £2,698 15s. 9d.

The Dublin Southern District (Electric) Tramways Company.—The receipts for week ending Friday, June 10th, 1898, were £648 5s. 3d.; corresponding week last year, £920 8s.; decrease, £272 2s. 9d.; passengers carried, 97,778; corresponding week last year, 128,715; aggregate to date, £10,963 10s. 1d.; aggregate to date last year, £11,548 5s. 7d.; decrease to date, £584 15s. 6d.; mileage open, 8 miles.

The Liverpool Overhead Railway Company.—The receipts for the week ending June 12th, 1898, amounted to £1,482; corresponding week last year, £1,857; decrease, £375. 1897 includes Whit Monday.

The Western and Brazilian Telegraph Company, Limited.—The receipts for the week ending June 10th, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,850.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, June 8th.	Closing Quotation, June 15th.	Business done during week ended June 15th, 1898. Highest.	Lowest.
137,400l	African Direct Telegraph, 4 % Debs.	100	4 %	...	...	100 —104	100 —104	...	...
25,000	Amazon Telegraph, shares	10	...	...	...	7 — 8	7 — 8	...	...
125,000	Do. do. 5 % Debs. Red.	100	...	...	...	93 — 96	93 — 96	...	...
923,960l	Anglo-American Telegraph	Stock	£2 9s	£2 13s	3 %	64 — 67	64 — 67	64½	64¼
3,038,020l	Do. do. 6 % Pref.	Stock	£4 18s	£5 6s	6 %	115 —116	116 —117	116¼	115¼
3,038,020l	Do. do. Deferred...	Stock	...	...	...	15¾— 16¼	16¼— 16¾	16½	15½
130,000	Brazilian Submarine Telegraph	10	7 %	7 %	7 %	15½— 16	15½— 16	16⅛	15$\frac{11}{16}$
75,000l	Do. do. 5 % Debs. 2nd series, 1906 ...	100	5 %	...	...	112 —116	112 —116	...	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	4 %	...	2¾— 3¼	2¾— 3¼	...	...
10,000,000$	Commercial Cable	$100	7 %	8 %	8 %	180 —190	180 —190	...	...
918,297l	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	105 —107	105 —107	106½	106¼
224,850	Consolidated Telephone Construction and Manufacturing	10/-	1½%	2 %	...	$\frac{1}{16}$— $\frac{3}{16}$	$\frac{1}{16}$— $\frac{3}{16}$	...	...
16,000	Cuba Telegraph	10	8 %	8 %	7 %	6½— 7½	6½— 7½	7⅜	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	14½— 15½	14½— 15½	14⅞	14⅝
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 11	10 — 11	10⅜	...
30,000l	Do. do. 4½ % Debs., Nos. 1 to 6,000 ...	50	4½%	4½%	4½%	103 —106%	103 —106%	...	...
60,710l	Direct United States Cable	20	2¼%	2½%	...	10½— 11	10½— 11	10⅞	10$\frac{9}{16}$
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	100—103	101 —104	...	...
400,000	Eastern Telegraph, Nos. 1 to 400,000	10	6½%	6½%	...	17 — 17½	17¼— 17¾	17$\frac{9}{16}$	17
70,000	Do. 6 % Cum. Pref.	10	6	6 %	...	18 — 19	18½— 19½	18⅝	18⅜
89,900	Do. 5 % Debs., repayable August, 1899...	100	5 %	5 %	...	101 —104	101 —104	...	...
1,302,615l	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	124 —128	123 —127	...	...
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	17½— 18	17½— 18	17$\frac{15}{16}$	17$\frac{9}{16}$
25,200l	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	5 %	5 %	100 —104	100 —104	...	...
100,500l	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	5 %	5 %	101 —104	101 —104	...	...
320,000l	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	126 —129	126 —129	...	...
35,100l	Eastern and South African Telegraph, 5 % Mort. Deb., 1900 red. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	...	100 —104	100 —104	...	...
46,500l	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	...	101 —104	101 —104	...	...
300,000l	Do. 4 % Mort. Debs., Nos. 1 to 3,000, red. 1909	100	4 %	4 %	...	101 —104	101 —104	...	...
200,000l	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	4 %	4 %	...	105 —108%	105 —108%	...	...
180,227	Globe Telegraph and Trust	10	4⅛%	4½%	4½%	11½— 12	11½— 12	11$\frac{13}{16}$	11$\frac{11}{16}$
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6 %	16¾— 17¼	16¾— 17¼	17⅛	16⅞
150,000	Great Northern Telegraph, of Copenhagen...	10	10 %	10 %	10 %	29 — 30	29 — 30	...	...
160,000l	Do. do. do. do. 5 % Debs. ...	100	5 %	5 %	5 %	100 —103	100 —103	...	...
97,000	Halifax and Bermuda Cable, 4½ % 1st. Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	98 —103	99 —104	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	50 — 53	50 — 53	51½	50½
100,000l	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	6 %	6 %	108 —111	108 —111	...	...
28,000	Montevideo Telephone, 6 % Pref., Nos. 1 to 28,000 ...	5	4 %	4 %	4 %	2¼— 2¾	2¼— 2¾	...	...
484,597	National Telephone, 1 to 484,597	5	5½%	5½%	6 %	5½— 5¾	5⅝— 5⅞	5¾	5½
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	14 — 16	15 — 17	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5⅜— 5⅝	5⅜— 5⅝	5⅜	...
1,329,471l	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	101—106	101—106	104	103
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	⅝— ¾	⅝— ¾	...	...
100,000l	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000...	100	4 %	4 %	4 %	105 —108	105 —108	...	...
11,839	Reuter's	8	5 %	5 %	5 %	8 — 9	8 — 9	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	136 —141	136 —141	138	...
58,000	United River Plate Telephone	5	4 %	5 %	...	4 — 4½	4 — 4½	4⅜	...
146,733l	Do. do. 5 % Debs.	Stock	5 %	...	...	104 —107	104 —107	106¼	106
15,609	West African Telegraph, 7,501 to 23,109	10	4 %	*nil*	*nil*	3½— 4½	3½— 4½	...	...
213,400l	Do. do. 5 % Debs.	100	5 %	5 %	5 %	99 —102	99 —102	101	...
64,269	Western and Brazilian Telegraph	15	3 %	2 %	3¼%	12 — 12½	11¾— 12¼xd	12	11$\frac{11}{16}$
33,129	Do. do. do. 5 % Pref. Ord.	7½	5 %	5 %	5 %	7½— 8	7¼— 7¾xd	7¾	...
33,129	Do. do. do. Def. Ord.	7½	1 %	*nil*	½%	4¼— 4¾	4½— 5xd	4⅞	4$\frac{11}{16}$
389,521	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	104 —107	104 —107	...	...
88,321	West India and Panama Telegraph	10	⅞%	1 %	¾%	½— ¾	½— ¾	$\frac{11}{16}$	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	6 %	6 %	7¼— 7¾	7½— 8	7$\frac{13}{16}$	7¾
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	6 %	6 %	5 — 7	5 — 7	...	...
80,000l	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	5 %	106 —109	106 —109	...	...
1,163,000$	Western Union of U.S. Telegraph, 7 % 1st Mort. Bonds	$1000	7 %	7 %	7 %	105 —109	105 —110	...	...
160,100l	Do. do. do. 6 % Ster. Bonds ...	100	6 %	6 %	6 %	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

Present Issue.	NAME.	Stock or Share.	1895.	1896.	1897.	Closing Quotation, June 8th.	Closing Quotation, June 15th.	Highest.	Lowest.
30,000	Charing Cross and Strand Electricity Supply	5	5 %	6 %	7 %	12 — 13	12 — 13	12¾	12⅝
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	...	...
26,000	*Chelsea Electricity Supply, Ord., Nos. 1 to 10,277... ...	5	5 %	5 %	6 %	8½— 9½	8 — 9	8¾	8½
60,000	Do. do. do. 4½ % Deb. Stock Red....	Stock	4½%	4½%	4½%	115 —117	115 —117	...	...
50,000	City of London Electric Lighting, Ord. 40,001—90,000 ...	10	5 %	7 %	10 %	24½— 25½	26 — 27	27⅜	25¼
10,000	Do. Prov. Certs. Nos. 90,001 to 100,000 £5 ...	10	...	...	...	16½— 17½	18 — 19	18⅝	...
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16½— 17½	16½— 17½	...	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	129 — 134	129 —134	...	...
30,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—30,000	10	*nil*	*nil*	*nil*	13 — 14	13 — 14	13$\frac{13}{16}$	13
10,000	Do. do. do. Nos. 30,001 to 40,000 £4 paid.	10	...	...	...	6½— 7½	6½— 7½	7	6¾
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	15 — 16	14½— 15½	15	...
17,400	Edmundsons Elec. Corp., Ord. Shares 1—17,400 £4 paid	5	...	...	...	3½— 4½	3½— 4½	...	...
10,000	House-to-House Electric Light Supply, Ord., 101 to 10,100	5	...	...	4 %	9 — 10	8½— 9½	9⅝	...
10,000	Do. do. 7 % Cum. Pref. ...	5	7 %	7 %	7 %	10½— 11½	10½— 11½	...	...
62,400	*Metropolitan Electric Supply, 101 to 62,500	10	4 %	5 %	6 %	15 — 16	15 — 16	16½	15¾
220,000l	Do. 4½ % First Mortgage Debenture Stock	...	4½%	4½%	4½%	117 —121	117 —121	119½	118½
6,452	Notting Hill Electric Lighting	10	2 %	4 %	6 %	18 — 19	17½— 18½	...	...
31,980	*St. James's and Pall Mall Electric Light, Ord.	5	7¼%	10½%	14½%	16 — 17	16 — 17	16¼	16
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9½— 10½	9 — 10	9½	...
50,000	Do. do. 4 % Deb. Stock Red. ...	Stock	...	...	4 %	107 —110	107 —110	...	...
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2 — 2½	2 — 2½	2$\frac{5}{16}$	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000 ...	5	7 %	9 %	12 %	15½— 16½	15 — 16	16⅛	15⅝

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation June 8th.	Closing Quotation June 15th.	Business done during week ended June 15th, 1898. Highest	Lowest.
30,000	British Electric Traction	10	...	...	...	15½— 16	15¾— 16¼	16⅛	15½
10,000	Do. do. 6 % Cum. Pref. 30,001—40,000 £4 pd. (issued at £2 10s. prem. all pd.)	10	...	...	...	7 — 8	7½— 8	7⅞	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	3	2½%	*nil*	*nil*	1⅞— 2⅛	1¾— 2	2	1¾
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	*nil*	4 %	2¼— 2½	2⅛— 2⅜	2 3/16	2⅛
125,000*l*	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	110 —114	110 —114	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red. ...	Stock	...	...	...	101 —104	101 —104	...	...
19,894	Central London Railway, Ord. Shares	10	...	...	...	10 — 10½	9¾— 10¼	10½	10⅝
129,179	Do. do. do. £6 paid	10	...	...	...	6 — 6½	5¾— 6¼	...	...
59,254	Do. do. Pref. half-shares £1 paid ...	...	...	...	...	1¼— 1¾	1¼— 1¾	1½	1 7/16
67,680	Do. do. Def. do. £5 paid ...	...	...	...	...	4¼— 4¾	4¼— 4¾	...	...
630,000*l*	City and South London Railway	Stock	1 9/16%	1 9/16%	1⅞%	68 — 71	68 — 71	70	...
22,500	Do. do. Ord. shares, Nos. 1 to 22,500 £2 pd.	10	...	...	...	... ...	1¾— 2¼	1¾	2¼
82,850	Crompton & Co., 5 % 1st Mort. Reg. Debs., 1 to 743 of £100, and 901 to 1,070 of £50 Red.	...	...	...	...	88 — 93	88 — 93	91¾	90
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	5 %	5½%	...	2¼— 2¾	2¼— 2¾	...	...
17,139	Do. do. do. "A" Shares, 01—017,139	5	5 %	5½%	...	4 — 5	4 — 5	...	...
194,023	Do. do. do. 4 % Deb. Stock Red. ...	100	...	...	...	103 —105	103 —105	...	...
110,000	Electric Construction, 1 to 110,000	2	5 %	6 %	...	2⅝— 2⅞	2½— 2⅞	...	...
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 ...	2	7 %	7 %	...	3⅛— 3⅜	3⅛— 3⅜	...	...
111,100	Do. do. 4% Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	106 —108	106 —108	...	...
91,196	Elmore's Patent Copper Depositing, 1 to 70,000	2	...	...	...	½— ¾	½— ¾	...	...
67,275	Elmore's Wire Manufacturing, 1 to 69,385, issued at 1 pm.	2	...	...	...	⅜— ⅝	⅜— ⅝	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	10½%	7 %	7 %	9 — 11	9 — 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ord.	10	8 %	10 %	12 %	21½— 22½	21½— 22½	22¾	21¼
3,000	Do. do. do. 7 % Pref.	10	7 %	7 %	7 %	18½— 19½	18½— 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½%	4½%	4½%	110 —115	110 —115	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	10 %	21 — 22	21 — 22	22	...
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	102 —106	102 —106	104½	...
37,500	†Liverpool Overhead Railway, Ord.	10	2⅞%	2⅞%	3¼%	10 7/16— 10 9/16	10 7/16— 10 9/16	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15¾— 16¼	15¾— 16¼	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	34 — 37	35 — 38	36	...
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	...	...	130 —133	124 —127	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 10½.
House-to-House, 4½% Debentures of £100, 106—109.
Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 15—16; 1st Preference Cumulative 6%, £5 (fully paid), 8—8½. Debentures, 107—110. Dividend, 1897, on Ordinary Shares 10%.

London Electric Supply Corporation, £5 Ordinary, 3¾—4¼.
*T. Parker, £10 (fully paid), 15¼.
Yorkshire House-to-House Electricity, £5 Ordinary Shares fully paid, 8¼—8¾. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount 3 per cent. (June 2nd, 1898).

THE MUNICIPAL ELECTRICAL ASSOCIATION, 1898.

ON THE NECESSITY FOR UNIFORMITY IN PLANT AND APPARATUS.*

By C. H. Wordingham, Assoc.M.Inst.C.E., M.I.Mech.E., M.I.E.E., City Electrical Engineer, Manchester.

The principles enunciated by Dr. John Hopkinson in his classical paper, on the cost of electric supply,† are now fully appreciated by the majority of supply engineers, municipal and others, but it is doubtful whether they recognise that their own field of labour is but one very small, indeed, insignificant, plot in the wide area to which these principles apply.

Manufacturers of all engineering products have to face the same problem, viz.:—the production of articles, the cost of which is made up of two items, one independent of the quantity sold, the other practically proportional to that quantity.

In the case of manufacturers, the standing charges comprise the establishment of the works, *i.e.*, the cost of land, buildings, engine power, machinery and tools, drawing office staff, patterns, &c.; the establishment of offices, and in many cases of showrooms, with staff of clerks, travellers, &c.; the holding of a stock to supply the demand without delay; while to these standing expenses must be added the salaries of a number of engineers, managers, &c., who must be ready to design the articles manufactured, and who must be kept up to date in the latest practice, often at great cost.

The running expenses are wages for labour, skilled and unskilled, fuel, oil, &c., for running the works, repairs to machine and other tools, raw material.

Probably no better example of high cost could be taken than the manufacture of submarine cables. In this case both items are greatly exaggerated. A large amount of very expensive machinery occupying great space, and extensive buildings, has to be provided and kept in good order, to be used perhaps once in the year, and when it is required it frequently happens that the work is of an urgent nature, and manufacturing has to be kept going day and night for a few weeks, necessitating overtime and high rates of wages, together with excessive wear and tear of plant, while the cost is still further augmented by the fact that the cable is probably of a special size and design.

Now let us examine into the means by which the cost of manufacture may be reduced. Assuming that all that is possible has been done to economise by the choice of a site where land is cheap, by suppression of superfluous cost in the erection of buildings, by skilful design to avoid unnecessary handling of goods, by the absence of display in offices, &c., what remains to enable the manufacturer to reduce his costs? One thing pre-eminently, restriction of the number of types and sizes of the articles produced. To produce, say, a dynamo machine or an engine, a number of calculations have to be made, then a series of drawings must be prepared, next the patterns, and finally the tools. All this means large expense, and, if only one article is made, the whole cost has to be charged to that article, and this standing cost may completely swamp by comparison the cost for material and labour. Whereas, if a thousand such articles were required, the fixed cost, being divided amongst them all, would be only one-thousandth part of what it was in the case of one. By limiting the number of patterns, it becomes possible to devote more time and attention to perfecting the design and the tools necessary for the manufacture, hence higher efficiency is gained in conjunction with reduced costs, for, though the provision of the tools requires a slight addition to the standing cost, it is quite inappreciable when divided among the number of articles sold, and there is a corresponding saving effected in labour.

The subject as a whole is a very wide one, but this paper must necessarily be confined to the particular case of electric supply stations, and the author hopes to be able to show that, even limited to this small area, the question is of great importance.

At present, every engineer in designing a station, seems to think it incumbent upon him to have something different in his station to that in every other. One fixes upon some peculiar declared pressure, involving special designs for every lamp, motor, radiator, or other consuming device that is to be attached to the circuit. Another wants alternating current of special periodicity, or transformers of an unusual capacity, or in a case of some unheard-of shape. Another

* Read June 9th.

† See Dr. John Hopkinson's paper on "The Cost of Electric Supply," read before the Junior Engineering Society, on November 4th, 1892.

wants extra large boilers, or dynamos of a capacity different to any stock size. Another requires cables of a size necessitating strands of some odd gauge of wire. No doubt this is not wholly intentional, but arises partly from want of thought, partly from ignorance, and partly, it is to be feared, from a feeling that manufacturers are a kind of inferior race, who cannot possibly know as much as the engineer, and who must do as he tells them. Now, it is essential to success, both mechanically and financially, that the engineer and manufacturer should mutually strive to secure it; the manufacturer must endeavour to carry out the engineer's objects, and the engineer must subordinate the details of his scheme to the convenience of the manufacturer. No man can know everything thoroughly, and it must be admitted that a manufacturer, who devotes his whole time and energy to the production of a particular class of machinery or apparatus, must know more about that particular class than the engineer with whom it is but one item out of the many comprising his whole scheme. Only those men, whose standing in the profession is assured, dare to admit and recognise this, the second-rate men fear that their doing so will be construed into a confession of ignorance or incompetency.

As an evidence of the want of uniformity now existing, I have made inquiries as to the practice as regards certain points, and through the courtesy of the engineers running the stations, have obtained the following information. The particulars relate to 109 stations, in 46 of which continuous current is employed, in 55 alternating, and in eight both alternating and continuous.

First as regards declared pressure, the following table gives the number of stations and the various pressures declared:—

TABLE A.—DECLARED PRESSURES.

Declared pressures.	Continuous current.	Alternating current.
50 Volts.	...	1
50—100 „	...	2
84—103 „	...	1
90—100 „	1	...
100 „	3	29
100—200 „	10	10
100—105 „	1	1
102 „	..	2
102—205 „	...	2
105 „	2	1
105—210 „	3	1
107—214 „	1	...
110 „	3	2
110—220 „	8	1
113 „	1	...
115—230 „	1	...
150 „	3	...
200 „	2	4
210 „	1	...
210—420 „	1	...
220 „	4	1
220—440 „	3	...
230 „	3	...
Total	51	58

In addition to the above, a few stations give special pressures for special reasons. One station varies its pressure according as the transformer is made by one or other of two manufacturers. Another, which normally supplies at 100 volts, supplies at 102 by special arrangement with a "Lunatic Asylum." (!) A third supplies at 113 volts, but naively recommends 110-volt lamps. Apparently this station is not run on the same lines as those in which the declared pressure is "102½ volts."

Incidentally, it may be remarked that the permission given by the Board of Trade to vary the declared pressure in different districts is practically never taken advantage of, while as against this, one station, in defiance of all Board of Trade regulations, boldly declares a pressure of 420 volts.

The next point of importance in which the practice differs is the question of periodicity in alternating stations. The periodicities are set forth in the following table:—

TABLE B.—PERIODICITIES.

3 at 40	periods	per second.
7 „ 50	„	„
1 „ 58	„	„
6 „ 60	„	„
1 „ 67·5	„	„
1 „ 74	„	„
3 „ 75	„	„
1 „ 77—80	„	„
1 „ 77	„	„
2 „ 80	„	„
6 „ 83	„	„
1 „ 83·5	„	„
1 „ 83—100	„	„
1 „ 87	„	„
1 „ 67·5	„	„
2 „ 90	„	„
2 „ 93	„	„
17 „ 100	„	„
1 „ 125	„	„
58		

The size and pressure of the generators is the next point of interest. It did not appear worth while to tabulate the pressures generated in low pressure stations as the declared pressure is a sufficient indication of the pressures used. As regards the high pressure generators, however, the following table shows the pressures generated:—

TABLE C.—HIGH PRESSURES GENERATED.

Pressure.	Continuous.	Alternating.
Volts.	No. of stations.	No. of stations.
1,000	3	3
1,000—1,050	1	...
1,400	1	...
1,800	...	1
1,800—2,000	1	...
2,000	1	35
2,000—2,100	...	5
2,000—2,200	...	3
2,000—2,500	...	1
2,050	...	1
2,100	...	4
2,110	...	1
2,200	...	1
2,400	...	1
2,500	...	2
3,000	...	1
Total ...	7	59

The size of generator is very important, and here again there is a most extraordinary discrepancy in the sizes employed. These are tabulated in Table D. Without entering into the number of machines, which do not very greatly affect the question, the following sizes are in use:—

TABLE D.—SIZE OF GENERATING UNIT.

Continuous.		Alternating.		
10 kw.	80 kw.	20 kw.	62 kw.	150 kw.
12 „	88 „	22 „	66 „	154 „
15 „	90 „	23 „	70 „	160 „
20 „	100 „	25 „	72 „	165 „
25 „	112 „	26 „	75 „	175 „
27 „	120 „	30 „	80 „	180 „
28 „	125 „	32 „	81 „	187 „
30 „	140 „	33 „	82 „	200 „
33 „	150 „	35 „	84 „	210 „
37 „	180 „	36 „	85 „	222 „
40 „	200 „	37 „	88 „	225 „
50 „	210 „	40 „	90 „	250 „
52 „	212 „	44 „	100 „	260 „
60 „	250 „	45 „	110 „	300 „
64 „	300 „	50 „	120 „	350 „
65 „	350 „	55 „	125 „	360 „
66 „	400 „	57 „	130 „	380 „
70 „	600 „	58 „	135 „	390 „
75 „	1,500 „	60 „	140 „	—

Inquiries as to whether standard sizes of mains, meters, &c., were employed, showed that in many instances such is not the case, the sizes being chosen haphazard according to requirements.

The above figures will serve to show the utterly chaotic state of central station practice as regards standardisation in this country at the present time, and very little consideration is necessary to show that the difficulties to be coped with by manufacturers in consequence must be enormous, and that, for the reasons stated at the beginning of this paper, the price of plant and apparatus to users must be very largely augmented, without there being any corresponding additional profit to manufacturers. The additional cost is in fact pure waste, and benefits nobody.

No doubt it is inevitable, in the early stages of any industry, that there should be great diversity of practice, indeed, it is desirable that things should not become stereotyped until the best has been discovered, but we have surely now arrived at a time when we can make up our minds on such subjects as those enumerated above, and it is of vital importance that the matter should be settled soon, for each new station that is to be built perpetuates its own set of quantities.

The most important point of all is the declared pressure, for this affects every consuming device as well as generators, or transformers if used. While it should be so fixed as to admit of as economical distribution as possible, it should not involve a loss to the consumer in wasteful resistance, or in enhanced price for lamps specially fragile or difficult to manufacture.

The author ventures to think that, taken all round, 100 volts and multiples thereof is the most convenient pressure, and the one most likely to meet with general acceptance. In the first place, it is that most largely used at the present time, and it meets the conditions named above, since two ordinary arc lamps, or one enclosed, can be made to burn steadily at 100 volts, the waste in resistance being reduced to a minimum, while for the first multiple, viz:—200 volts, there is little difficulty in obtaining single incandescent lamps. Moreover, it gives a convenient pressure across the outer conductors, a pressure suitable for tramway working, while allowing a good margin for loss on low pressure feeders, without necessitating a higher pressure at the generating station or transforming station, than 500 volts, which is the limit of low pressure fixed by the Board of Trade. Incidentally, 100 volts is very convenient for mental calculations, and for meters when ampere-hour instruments are employed.

In passing, it may be remarked that a good deal of doubt appears to exist as to the exact meaning of the Board of Trade definition of low pressure, viz., whether 500 volts is the limit at the station, or at the network end of the feeder, and an authoritative interpretation of this would be very acceptable.

Other directions in which standardisation is necessary may be mentioned here, viz, the adoption of standard candle-powers for incandescent lamps. It would appear that no more than four sizes below 100 candle-power are really necessary. A little consideration will show that, quite apart from the question of manufacture, the limiting of the number of sizes would enormously reduce the amount of stock that has to be held, and hence a large amount of capital uselessly locked up would be set free.

The number of sizes of arc lamps might very well be reduced. Three would suffice for all ordinary purposes. If this were done, not only would the cost of production be greatly lessened, but the ease of replacement of damaged and worn out parts, and the cheapening of carbons, together with convenience in obtaining them, would be a great gain.

As regards motors, it is probably not worth while to make anything smaller than 2 horse-power, whatever it is intended to drive, except perhaps in the case of ventilating fans. The bulk of the demand will probably be for motors under 25 horse-power, and three sizes between this and 2 horse-power should suffice.

So long as a supply of alternating current continues to be given to consumers, the question of periodicity will affect the stations concerned nearly as greatly as does the question of declared pressure, and it is therefore as important that some definite understanding should be come to. The variation at present, as will be seen from the table, is as great as or even greater than in the case of pressure.

The question of periodicity will always be an important one, as there can be little doubt that two or three-phase current will be generated in many stations in the future, though probably it will not be supplied to consumers.

Next in order of importance perhaps is the size of generating unit in the station. It was recently necessary for the author to go into this matter somewhat carefully, and he was astonished to find at what an early period in the development of a central station it becomes possible and safe to employ large units. There are practically four factors governing the choice of the unit of the plant. They are

(1) The initial capacity of the station.
(2) The probable ultimate capacity.
(3) The steps by which it is permissible to increase the capital expenditure.
(4) The percentage safe overload of the plant.

It may be mentioned here, that, in the author's opinion, it is preferable to have reserve plant in the shape of machines with considerable margin of possible overload beyond maximum economical load than in the form of spare machines, for the latter are only of use in cases of actual breakdown, while, in the former case, the reserve is always ready to be called into play at a moment's notice, and there is no delay due to having to start up another machine in case of sudden demand, whether from a running machine having to be switched out or from an abrupt change in weather. Further than this, the same amount of reserve can be attained more economically.

The conditions to be fulfilled then, are, that if any one machine break down, the remaining machine shall not be overloaded more than a definite amount, say, 33 per cent., 25 per cent., or 20 per cent. If the last-named figure be adopted, this means that the first installation of plant must consist of six machines of equal capacity; their size will depend on the initial capacity of the station. When extensions have to be made, the increment of plant will depend upon the increment of capital permissible. The condition that any one unit may break down without overloading the plant 20 per cent. allows of either one, two, or more machines being added. The amount of increase of capital will be a minimum if only one machine be put down, but this course is open to the serious objection that it means a number of machines all differing in size after the first six, hence absence of interchangeability of plant, and an unsightly station. It would appear most convenient to increase the plant by pairs of machines, since this gives a symmetrical arrangement, allows of reduction of spare parts, and renders the machines convenient multiples of one another. Time does not admit of a particular case being worked out, but if this be done, it will be seen that a large size is soon reached, and after a certain point the rule cannot be carried out, as it leads to engines of impracticable size. It then becomes necessary to add each time one or more machines of the same size. It would be a matter of great interest to learn from engine and dynamo builders what is the upper limit of size of generator.

It will thus be seen that we begin with six machines with parts interchangeable, and finish with a certain number of machines depending on the size of the station, also having the parts interchangeable, and between we have a number of machines of varying sizes. In very large stations put down on a sufficiently generous scale, all the units may be of the same size, but the author maintains that the initial number should not be less than that number which allows of one breaking down without overloading the remainder more than the specified amount, and it cannot be considered safe to put down one or two large machines to begin with, and to trust to good workmanship and design to avoid mishap.

On the above principles it should not be a difficult matter to work out a series of machines which will provide for stations of all ranks, and yet be limited in number.

Next may be considered the question of mains, both as regards the conductor and the insulation. It is greatly to be desired that only a few sizes of conductor should be decided upon. The author has endeavoured to show elsewhere* that of necessity the size of main required in a given street is largely a matter of guesswork, hence it should not be a difficult matter to agree upon standard sizes that may be such that they can be made up from ordinary S.W.G. wires. If this were done, a manufacturer could afford to stock a great deal of wire, and one source of delay in delivery would be avoided.

Again, it surely should be possible to settle upon standard tests for dielectrics of different kinds for given pressures, and if this were accomplished, manufacturers could stock cable actually ready for delivery. The advantage of this will be fully appreciated by central station engineers, for, instead of each one having to store for his own requirements, he would be able to order from stock, and save the expense of cable stores and their attendants, besides being able to meet unlooked for extensions at short notice, while the aggregate stock, and therefore the capital locked up, would be much less than if there were a number of separate stores.

We next come to accessories such as service cables, transformers (in the case of alternating supply), main fuses, meters, maximum recorders, meter boards, &c. Here again the cry must be standardise. Find out the best all round pattern of each, and keep to it. Have as few sizes as possible. Arrange your parts so that they shall come in if extensions take place so that the work may not have to be redone. In his own practice, the author has endeavoured to carry out these principles, and he has to a great extent succeeded, but it would be tedious to enter into the details.

It is of little use for one, or even many, individuals to standardise unless there be co-operation. It will probably be said, all admit that uniformity of plant is desirable, and you are but labouring to prove that which is evident. How do you propose that this desirable end should be achieved? The author replies that there is but one way, and that is by settling upon certain standards that will be acceptable to the majority of those concerned, and this can only be done by thrashing out the subject by a committee thoroughly representative of all classes interested.

This Association is representative of a section of one section only, viz, the Municipal section of users of plant, and it is not therefore competent to deal with the matter by itself. The Institution of Electrical Engineers, the mother of all British Electrical Societies and Associations, is the proper organisation to which the matter should be referred, and it will doubtless be a matter of satisfaction to the members of the Association to learn that our Council has already approached the Institution with a view to this, and a committee has been appointed by them to thoroughly go into the question.

The recommendations of the committee cannot fail to carry great weight, and, if the matter be properly taken up uniformity will soon be secured, for it will be found that the firms not making standard plant could not compete with those that did, and users with fads would find them too expensive to indulge.

It may be thought that such a system should be international, but it is to be feared that the difficulties of securing the desired end would be such as to make it impracticable, and it would result in the matter being indefinitely postponed.

In conclusion, the author trusts that the various points he has alluded to will be thoroughly discussed, and that some practical suggestions for the guidance of the committee referred to may be forthcoming.

APPROPRIATION OF PROFITS AND REPAYMENT OF LOANS.

By Bailie Wm. Maclay, Convener of Electricity Committee, Glasgow Corporation.

In every department of municipal work—however technical it may be—there always arises the question of finance. As the proverb has it, "Money makes the mare to go," and even an electricity committee must study ways and means. It would be a comparatively easy matter for a wealthy corporation to erect extensive buildings and put down an installation of the finest machinery and plant—it may be regardless of expense—but it is a different and a more difficult thing to generate current at a price that will commend its use to the majority of the community, either as an illuminant or a motor power, or both. An old friend of mine was at one time manager of the Home Farm, associated with one of the largest iron industries in this country. Many a time I wondered why he left the employment of that firm. I had it all explained to me one day by one of his contemporaries. Mr. Johnstone, he said, kept his farm in splendid order. Everything was done in the very best style, but he could not make it pay so he had to go. Fortunately for me, the subject of my paper does not compel me to deal with deficits—only with profits. As a rule profits can easily be disposed of. It is a fact, in the experience of most men that profits are more easily distributed than secured. But when a corporation does come to hold something like a monopoly, it ought to make profits, or perhaps I should rather say, ought to have a surplus every year. Those surpluses having been secured, the question naturally arises what is to be done with them. In the city of Glasgow we have no difficulty with that. We believe in letting "every herring hang by its own head." In other words, the Corporation allows each of our commercial departments to dispose of any surplus that may result from a successful year's business. We recognise the fact that not one of these depart-

* See his paper on "The Distribution of Electrical Energy," read before the Northern Society of Electrical Engineers, on November 8th, 1897.

ments exists to make profits—as is the case with a private commercial concern—but that rather it has been called into existence for the benefit of the community as a whole. This matter seems to be viewed rather differently in England, and had that not been the case, perhaps I should not have written this paper. Let us take Manchester as a typical example. At the end of their financial year they showed a surplus of £40,000 in the gas department, which was transferred to city fund account, presumably for the relief of taxation. Now it may be said that "it is as broad as it is long," and what is taken out of the one pocket is simply put into the other, the community being no poorer by the transfer. I am inclined to dispute that. Take, by way of illustration, our gas department, whose business is one of the largest of its kind in the three kingdoms. Annually we carbonise something like 600,000 tons of coal, and we supply gas to all consumers in the city of Glasgow, the important burghs of Govan, Partick, &c., and nearly every district within a radius of seven or eight miles from the centre of the city. Now let us suppose that every ratepayer uses our gas, but they all do not use this illuminant alike, and in an exact proportion to their rental, which is the basis of municipal assessment. Some of our people use gas only as an illuminant. Others, again, turn it to account in stoves for heating purposes as well as for lighting, whilst a third class use it not only for light and heat but also as a motor power. Having no differential charge in Glasgow, the large consumer would therefore pay away far more, probably, than he received back in the form of reduced taxation, whilst a small consumer might get a rebate of taxation out of keeping with his gas consumption, and that at the expense of the larger consumer. This is neither fair nor equitable, and would not be tolerated in our city. We contend that what has been taken from a gas consumer in excess of the cost of production and distribution should be given back to him at once and directly through the department in the form of a reduced charge in the immediate future. This meets all the wants of the case, and inflicts a hardship on no one.

But this is not my principal nor my strongest argument in favour of the Glasgow system of appropriation of profits. We hold that it is a sound policy to place as few restrictions on business as possible, especially in these days of keen competition. We maintain that if any of our commercial departments, originated solely for the good of the people as a whole, is compelled to keep the price of anything above the cost of production and distribution, then a restriction, an artificial and arbitrary restriction is placed upon the business of that committee. Is it fair or just to that particular committee? Is it fair or encouraging to the engineer or superintendent who is largely responsible for the prosperity of the undertaking? I say that it is not, and that every committee should in this respect be unfettered. It is true that it is very creditable to the gas department of Manchester that they should be able to supply gas at a moderate price, and at the same time hand over £40,000 annually to the city fund. We, in Glasgow, think that it is at least as creditable to supply gas to the community at, perhaps, as low a price as obtains in the three kingdoms, although we should not give a farthing to the city fund for the relief of taxation. Further, our Electricity Committee have faith in the proposition that by reducing the price of current they will increase the demand, and an increased demand will enable them to reduce the price still further, until it reaches the irreducible minimum. The two things are closely associated, and in fact, co-related. You cannot well have the one without the other. That leads us to the conclusion that every department—and especially the electrical department—ought to have a free hand in this respect, in order to demonstrate to the public that it is doing its best to provide, and provide successfully, for the wants of the people, and the best evidence of this is to be found in a low charge for current rather than in a continuous large surplus to be appropriated by other departments at the end of each year. Last year, on a turnover of £30,000, our Electricity Committee had a profit of £18,000. When disposing of this surplus, we first of all set aside £2,770 as an extra depreciation on the John Street and Miller Street stations, where the plant and machinery were old and somewhat obsolete, having been acquired from a private firm, when we received our provisional order. Next, we debited £1,500 against renewals on meters, and £1,000 for probable renewals of ordinary plant and machinery in the Waterloo Street station. We further appropriated about £5,500 of our large surplus for ordinary depreciation on our buildings, plant, and machinery, mains and cables, making in all £10,705 10s. for depreciation and renewals in our stations. The balance of our surplus of £18,000, amounting to £7,293, we disposed of as follows:—A sum of £4,300 was absorbed by interest on capital, £1,466 was placed to the credit of the sinking fund. This left a net balance of £1,527, which was carried forward to the credit of next year's account. This, gentlemen, is how we dispose of a surplus in Glasgow. Every penny of it was appropriated for the good of this department, and this department only, and we maintain that the citizens benefited quite as much as if the bulk of it had been devoted to the relief of our municipal taxation.

I now come to speak of the other branch of my subject—"the repayment of loans." It would take up too much of your valuable time were I to examine and compare the indebtedness of Glasgow with the obligations of other municipalities, or enlarge on their various systems of repayment. It may suffice that I treat of the indebtedness of our own municipality and of our sinking funds, allowing each of you to make his own comparisons and draw his own conclusions. In order to make my figures exact and complete, I shall deal with the year ending May 31st, 1897, being the latest financial year of the Corporation of Glasgow. At that date the liabilities of our Corporation, including gas and water annuities, and the debt of the common good department, amounted to £8,748,652, and our assets to £11,596,384, thus showing a clear balance in favour of the municipality to the extent of £2,847,732.

But having stated the amount of our indebtedness, the question naturally arises: How are these liabilities to be discharged? Let me say, before I proceed further, that all our money for departmental purposes is borrowed through the loans fund, at the head of which is an excellent financier. This is a useful institution, which unites and keeps in touch all the departments of the Corporation. Should any committee have more money than they can profitably use, they lend it to the loans fund, whereupon the loans department either pays off debt or lends the amount to some other department of the Corporation. In this way, we never have to go outside to seek for investments. Temporary loans on revenue account must be repaid within a reasonable time, and out of the revenue of the year in which they were borrowed. If any one of our departments promotes new undertakings requiring further capital expenditure, then its borrowing powers must be increased by Act of Parliament, and the money secured from the investing public by an issue of stock or otherwise. In the case of a temporary loan, the lending committee is credited with the current rate of interest, whilst the borrowing committee is debited with the average rate payable on the loans.

Our debts we liquidate in the customary way, by means of the sale of property, and the sinking fund and the rates vary according to the nature and character of each respective undertaking. At May 31st, 1897, our police department was still owing £1,549,254, but the sinking funds being all calculated on the maximum amount originally borrowed, this sum will be quickly reduced, and finally disappear altogether.

Under the heading of police department we include the following: Public health and permanent paviour work, the sinking fund for which is at the rate of 5 per cent. The rate for sewage purification works is fixed at 1⅝ per cent. For general police purposes, sewer construction, and street improvements purposes it is 2½ per cent, whilst for rebuilding of bridges and payment of county road debts the rate stands at 2 per cent. In 48 or 49 years after to-day this large debt will be extinguished altogether. Many of us in Glasgow will not live to see this "consummation devoutly to be wished," but whilst the individual citizen dies, the corporation lives on and flourishes in perennial youth.

In our water supply department, the balance of loan debt unpaid stood at £2,784,148 in 1897. At the departmental minimum rate of sinking fund 1½ per cent., this balance will be absolutely wiped out in 66 years hence. It is true that we are contracting new and large obligations, but we must leave something to be paid by posterity, as they will inherit from us, perhaps, the finest water supply in the kingdom.

I shall now say a word about the gas and electricity departments. Our electricity committee was a sub-committee of the gas committee until the November before last. It was then created a separate and independent committee unless in the matter of finance. We shall therefore have to treat the indebtedness and the sinking funds of the two as one joint obligation. In 1897, the joint indebtedness might be taken to represent £1,127,495.

These I have enumerated are the heaviest liabilities of the Corporation, and I think I need not go further into detail. The markets department, with its sinking fund and—in its case—surplus profits, should extinguish its present debt in 28 years, which is something like 3 per cent. per annum overhead. The parks and galleries departments and the municipal buildings have a minimum rate of 1 per cent. with accumulations for their sinking funds. The parks debt will be repaid in 49 years and the municipal buildings in 56 years. The city improvement's department has a loan debt of £1,246,256. The debt is reduced by sales of property and surplus income. The sinking fund does not come into operation till the last property is sold, and our tramways pay off their obligation of £516,556 by a sinking fund at the rate of 2 per cent., which if accumulated at 3 per cent. will pay off the debt in 30 years.

I have thus given you the particulars of the manner in which we repay our loans. The system seems to have commended itself to our fellow-citizens, and our finance has been approved by capitalists all over the kingdom. Were evidence of this wanting, it must be found in the very low rate of interest we pay on our loans. On our last issue of stock it is only 2½ per cent., and on our temporary loans the average rate is as low as £1 11s. 9d., whilst our promissory notes have been readily taken up by London financiers at even 1½ per cent. and 1 per cent.

Gentlemen, our motto of old was "Let Glasgow flourish by the preaching of the Word." To-day Glasgow flourishes also by the low rate of interest on capital expenditure.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

THE DESIGN OF ELECTRIC RAILWAY MOTORS FOR RAPID ACCELERATION. By Prof. CHARLES A. CARUS-WILSON, Member. Read May 26th, 1898.

(*Concluded from page 827.*)

IF single-reduction gearing is used, the largest ratio of *v to d* is limited by the number of teeth in the pinion for a driving wheel of given diameter. For example, let us take a driving wheel 33 inches in diameter. If the clearance between the casing of the gear wheel and the level of the rail is limited to 4⅝ths of an inch, we cannot get more than 67 teeth in the gear wheel. If the least number of teeth in the pinion is 14, the velocity ratio is limited to 4·78, and the ratio of *v* to *d* is limited to 0·145. These dimensions and numbers are taken from the standard street railway equipment made by the General Electric Company.

In our example, if the driving wheels were 33 inches in diameter, the velocity ratio required to get the best results would be 7·15. This would be impossible with single-reduction spur gearing. We should therefore have to use a smaller value of v than the best.

If the series-parallel controller is used, the maximum current from the line at the moment of starting is reduced by one-half. Since the current per motor is the same as with the parallel controller, the acceleration will be unaltered. The motors can be held in series until the speed is 5·7 f.p.s.; the result then is to reduce very nearly by one-half the expenditure of energy due to heat. In estimating the energy required to cover any distance, we may generally assume that the effect of series-parallel control is to halve the heat lost.

As an illustration of the application of these principles to the heavier class of railway work we may take the Metropolitan Elevated Railroad of Chicago. Particulars of this railway have been given by Mr. M. H. Gerry, and may be found in a paper published in the *Proceedings of the American Institute of Electrical Engineers* for 1897.

The rolling stock consists of motor cars and passenger cars. The former measure 47 feet in length, and weigh 62,000 lbs. when fully loaded. They are mounted on locomotive trucks, with driving wheels 33 inches in diameter, the velocity ratio being 3·18. One truck of each motor car is equipped with two motors.

The passenger cars are 47 feet in length, having trucks fitted with 30-inch wheels, and weigh 46,000 lbs. when fully loaded. Trains of two, three, and four cars are made up according to the demands of the traffic at different hours. We shall consider a train of one motor car and three passenger cars, weighing in all 90 tons. We shall take the case of two stations separated by a distance of 2,500 feet of level track, and consider first the effect of the period during which the brakes are being put on.

If the distance covered during the period of retardation bears to the time occupied the same ratio as the whole distance to the whole time, *i.e.*, if the mean speed during retardation is equal to the schedule speed—the value of $\frac{M v}{d}$ will be independent of the time during which the brakes are on. For this quantity depends only on the ratio of t to D, and by our supposition this is unaltered by the length of the retardation period. The final speed will therefore be unaltered, and hence the energy expended in accelerating will be independent of the rapidity of stopping.

Again, the accelerating current varies as $\frac{D^2}{t^3}$, hence it will decrease as t increases; *i.e.*, the accelerating current will decrease with the time occupied in braking. But the work done in heating will be nearly the same, since c_a constitutes by far the greater proportion of the whole starting current.

The energy spent in overcoming friction, however, will increase with the distance during which the motors are working, but the amount of increase will generally be a small proportion of the whole energy thus spent. If, then, the mean speed of retardation is equal to the schedule speed, we may determine the time occupied and the distance covered during the retardation period simply with reference to the ability of the brakes to stop the train. In the case before us we shall allow 20 seconds and 500 feet for retardation, leaving 2,000 feet to be covered in 80 seconds.

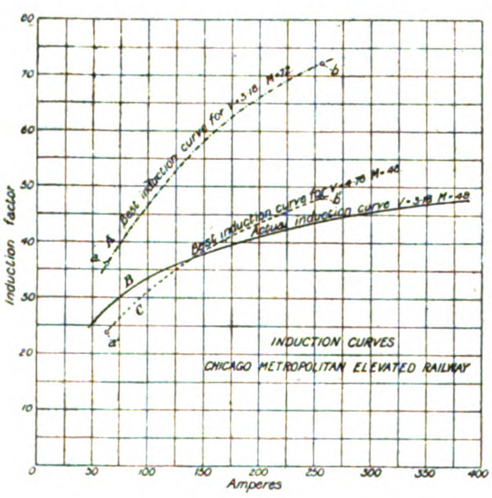

FIG. 9.

The tension of the line is 500 volts. If the drop at full speed is imited to 5 volts, we find from equation 15 that $\frac{M v}{d}$ must be 3·46. If we adopt the existing values of v and d, we get M = 35·9.

From the results of tests made on this line, the retarding forces at 15 miles an hour, including gear friction, amount to 13·6 lbs. per ton of load, or 614 lbs. horizontally per motor. Hence the current at full speed will be 63 amperes, and each motor must have a resistance of 0·0795 ohm. The train resistance, excluding gear losses, amounted to 450 lbs. per motor.

We have thus found one point on the induction curve, namely, M = 35·9 for 63 amperes. In fig. 9 horizontal ordinates represent current, and vertical ordinates values of M. Take a point, a, giving = 35·9 for 63 amperes.

The accelerating current is found from equation 16 to be 226 amperes. If the induction factor at the start is twice that at full speed, the current then required for friction is only 31·5 amperes, so that the total current at starting must be 257 amperes, and the corresponding induction factor 72. This gives us a second point on the induction curve, and is plotted at b in the figure. We shall suppose that A is the best curve that can be obtained passing through the given points.

The diagrams of current and acceleration with motors having A as their induction curve are given in figs. 10 and 11, and are drawn in full lines. The time taken to cover 2,000 feet is 78 seconds, the saving of two seconds being due to the series winding. Full speed is 37·3 f.p.s., but is not reached, the highest speed being 33·5 f.p.s., or 23·6 miles an hour. The initial acceleration is 1·27 f.p.s. per second.

The induction curve for the motors actually used is given at B in fig. 9, and the curves of acceleration and current for these motors are shown in figs. 10 and 11 by dotted lines. The brakes were applied at the end of 77 seconds, when 1,930 feet had been covered; and the

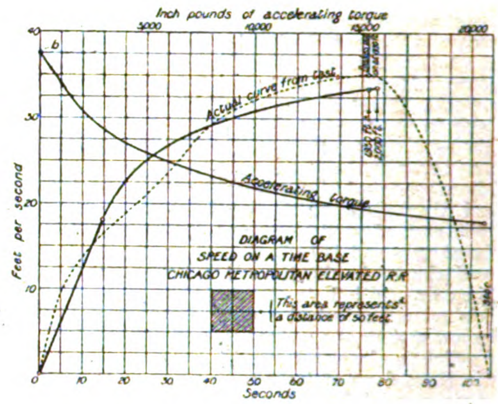

FIG. 10.

remaining distance of 570 feet, making up the total of 2,500 feet, was covered in 27 seconds, making the whole time 104 seconds.

The irregularities in the current-curve are the result of the uneven handling of the controller. The motors take 380 amperes each at the moment of starting, and are allowed to speed up in series for 10 seconds, after the starting rheostat is all out. When thrown into parallel the current per motor is 330 amperes, or 660 from the line. More careful manipulation of the controller would have effected a better start.

We have already seen that the force of a motor may be conveniently expressed as the product of the current and the corresponding induction factor. Since the ordinates in a diagram giving the induction curve represent current and induction factor, a curve of equal force is a hyperbola. In fig. 9 the point b represents an induction factor of 72 for a current of 257 amperes; in other words, the force factor required to start up with an acceleration of 1·27 f.p.s. per second is 18·5 kilodynes. If we draw a hyperbola through the point b, it will cut the induction curve B at a point giving the current that the motors in actual use must take in order to get an acceleration of 1·27 f.p.s. per second. The current thus found is 390 amperes. An inspection of the acceleration curves in fig. 10 shows that the acceleration obtained in the test is rather greater than that obtained by calculation, while the current is 380 amperes. The experimental curve, however, is somewhat irregular, and the agreement is as close as might be expected.

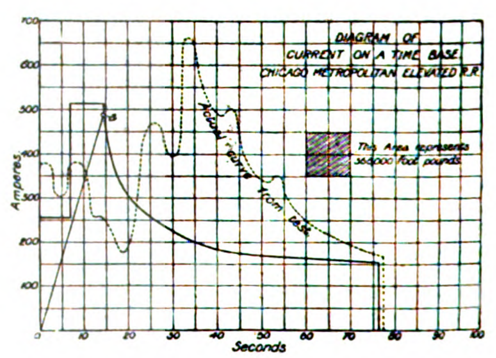

FIG. 11.

The effect of the form of the induction curve B on the current-curve is clearly shown in fig. 11. The maximum current from the line is 28 per cent., and the maximum current per motor 48 per cent., greater than it need be, while the expenditure of energy in the form of heat is 4·6 times what it would be if curve A had been used.

The force factor required to drive the train at full speed is given by the product of 63 and 35·9, namely, 2·26 kilodynes. If we draw a hyperbola through the point a in fig. 9, it will cut curve B at a point giving the current taken by the actual motors when running at full speed, and it will also give us their maximum speed. This will be nearly inversely proportional to the minimum induction factor, and we see that it will be nearly 45 f.p.s., or 30·6 miles an hour.

It does not follow that the highest speeds actually attained in the two cases will be in the ratio of the minimum induction factors, because the maximum speed is not reached, but we see that the expenditure of energy in acceleration will be greater with the lower induction curve. The values for the kinetic energy in the two cases are 380×10^4, and 350×10^4 foot-pounds. The following table gives the expenditure of energy, expressed in foot-pounds, for a distance of 1,930 feet:—

	Total energy. From test.	Total energy. Calculated.
For acceleration	380×10^4	350×10^4
For train resistance*	174×10^4	174×10^4
For gear loss, at 85 per cent. mechanical efficiency ...	98×10^4	92×10^4
For C^2 R loss	311×10^4†	67×10^4
	963×10^4	683×10^4

* 900 × 1,930.

† Obtained by deducting the previous amounts from the total expenditure, as ound by integrating the current-curve.

The greatest induction factor in the motors actually used is 48. If we take this as the limiting value of M, we see that we must increase the velocity ratio in the proportion of 48 to 72 to get the best results. In fig. 9, curve C has been obtained by taking each vertical ordinate this proportion of the corresponding ordinate of curve A. If, then, we make the motors with this induction curve, they will work with the same economy as those with curve A, provided that the velocity ratio is increased in the proportion of 48 to 72—*i.e.*, from 3·18 to 4·78.

We are thus able to make a clearer comparison between the two motors. The new curve crosses the actual induction curve, but gives higher values of M for large currents and lower values for small currents. The changes that would have to be made to give the best results are: First, the velocity ratio should be increased from 3·18 to 4·78; second, the air-gap should be increased in width so that the induction curve may pass through the point a'; third, the section of the iron in the magnetic circuit should be increased so that the curve may pass through the point b'.

The economy of working under these conditions may be expressed best in terms of the work done per ton-mile, the distance, of course, including that during which the brakes are on. The energy expended may be conveniently stated in watt-hours.

Thus, in the example we have been considering, the economy attainable with induction curve C is 60·5 watt-hours per ton-mile. We here assume that the velocity ratio is limited to 4·78. With a maximum induction factor of 48 the highest possible economy is obtained with a velocity ratio of 9·75; the heat loss is then reduced to 17×10^4 foot-pounds, and the economy becomes 56 watt-hours per ton-mile. An equally good result could be attained with a maximum M of 72 and a velocity ratio of 6·50. The economy actually obtained with curve B is 85·1 watt-hours per ton-mile.

We may here inquire what would be the economy if the specification had insisted on a gearless equipment. To get the highest economy—*i.e.*, 56 watt-hours per ton-mile—the product $M v$ must be 468 for driving wheels 33 inches in diameter. If $v = 1$, the induction factor must be 468—a value much beyond the practical limit. To comply with the conditions as to time and distance, the minimum induction factor would have to be 114; if we take the maximum induction factor twice this value, we get the maximum M equal to 228, and a heat loss of 72×10^4 foot-pounds.

Since we have now dispensed with gearing, we can reduce the item in the table of energy expenditure due to gear loss. Assuming 95 per cent. mechanical efficiency, this becomes 31×10^4 foot-pounds; hence the economy is 55·5 watt-hours per ton-mile, the current for maximum and minimum induction factors remaining the same.

It is, however, unusual to find the maximum induction factor twice the minimum induction factor in motors of this size; a ratio of 1·5 to 1 is more usual. If we take 171 as the maximum value of M, the heat loss is increased from 72×10^4 to 162×10^4 foot-pounds, and the economy of working is 63·4 watt-hours per ton-mile. Thus with geared motors the expenditure of energy is about 5 per cent. less than with gearless motors of four times the weight.

The expenditure of energy per ton-mile may be reduced if the track, instead of being level throughout the whole distance, is provided with down grades at the station exits.

The best results would be attained if the train could actually start on the down grade. This, however, is impracticable; but the train should be brought to a standstill as near the top of the grade as possible in order to get the full advantage of the grade.

Let us suppose that the centre of gravity of the train moves through 150 feet before coming to the top of the grade, and that the force of gravity acts on the whole train throughout the length of the grade, which we shall take to be 300 feet with a fall of 9 feet.

The energy due to the train falling through a vertical distance of 9 feet is 181×10^4 foot-pounds; but this does not represent the gain due to the grade, for the final speed has been increased from 33·5 to 35·5 feet per second, giving an increased expenditure for kinetic energy of 43×10^4 foot-pounds: the difference represents the benefit due to the grade, and is 138×10^4 foot-pounds. With this arrangement there is a gain of about 6 seconds in the time of covering 1,930 feet. We might, then, have taken a larger value of t in our original calculations, relying on the gain in time due to the grade to reduce the time to that specified.

If, then, we take 82 instead of 76 seconds for a distance of 1,930 feet, the kinetic energy would be reduced to 162×10^4 foot-pounds, the C^2 R loss to 47×10^4 foot-pounds, and the gear loss to 60×10^4 foot-pounds; giving a total of 466×10^4 foot-pounds, and an economy of 39·4 watt-hours per ton-mile. The grade thus effects a saving of about 33 per cent. of energy with the geared motor, but only 28 per cent. with the gearless motor.

The results are summarised in the following table. The energy expended is expressed in terms of a unit of 10,000 foot-pounds. The distance is 1,930 feet throughout, and the weight of the train is 90 tons. In each case we suppose that the minimum value of M is the best possible—*i.e.*, that the expenditure of energy in accelerating is a minimum.

Track:	Level.	Level.	Level.	Level.	8 ? Grade.	8 ? Grade.
Maximum M	48	72	468	171	48	171
Velocity ratio	4·78	6·48	1	1	4·78	1
Kinetic energy	350	350	350	350	162	162
Train resistance ...	174	174	174	174	174	174
Torque loss	92	92	31	31	60	18
C^2 R loss	67	17	17	162	47	162
Total energy	683	633	572	717	443	516
Watt-hours per ton-mile	60·5	56·0	50·6	63·4	39·4	45·6

PHYSICAL SOCIETY.

Ordinary Meeting, June 10th, 1898.

Mr. Shelford Bidwell, President, in the Chair.

Dr. S. P. Thompson described and exhibited a model illustrating Max Meyer's theory of Audition.

Max Meyer abandons the audition theory of Helmholtz, and contends that analysis takes place in the ear otherwise than by resonance of the Corti organ. Imagine a jointed system, like a hand, to be oscillated from one end, *i.e.*, from the finger-tips. A small motion affects only the top joints, but a large motion affects the whole structure. Such a structure is the membrane of the inner ear. It widens towards one end, and is effectively damped by the contained liquid. Wave motions of different amplitudes run along it to different distances before they are extinguished; these distances are recorded by nerves, and are thereby communicated to the Corti organ. In the model, the compound wave to be analysed is cut out on the edge of a disc of zinc, so that, as the disc revolves, the motions are communicated to a framework. If the frame is thus moved through more than a certain distance, a displacement occurs which sets a second frame in motion, and so on to a third and fourth. The depth to which the motion penetrates is indicated by a series of glow lamps connected electrically to the frames.

Prof. Ayrton said it had for some time past occurred to him, when considering the way in which an expert telegraph clerk reads siphon-recorder signals on a long cable, that it might be possible to analyse waves without the supposition of a resonating apparatus. The clerk interprets not so much the motions to one side or other of the zero line, as the rate of change of velocity, *i.e.*, the acceleration of the siphon. This had been recognised in the design of those relays for long cables, where the lever makes contact when the received current exceeds a certain value, and breaks contact when the current falls below a certain minimum. Messrs. Siemens had adopted a relay in which the lever was carried on the suspended coil of a D'Arsonval galvanometer by a pivot with a small amount of friction. If contact was made, the coil could, nevertheless, continue in a given direction. If that direction altered, contact was immediately broken, and the lever passed over to the opposite stop, thereby reversing the local circuit. It was possible that, in the process of hearing, something akin to this took place, the ear behaving as a mechanism responsive, not by resonance to the complete waves, but by its sensitiveness to changes of direction of the received impulses.

Dr. S. P. Thompson thought that a mechanism similar to the relay described by Prof. Ayrton was contained in the telautograph of Elisha Gray; it was a "Prony" mechanism. In the acoustical problem the ear was probably sensitive to abrupt changes of shape in the waves as well as to reversals. In the case of mistuned octaves, something is heard that suggests "revolving" in the ear, indicating a cyclic change. In this regard, it was necessary to take into account the phase relations as well as the relative intensities of the component tones.

Mr. E. H. Barton then read a paper on the "Attenuation of Electric Waves Along a Line of Negligible Leakage."

It forms a sequel to a paper communicated to the Physical Society and printed in their *Proceedings* of December, 1897, and January, 1898. Shortly after the publication of the earlier results, Mr. Oliver Heaviside drew attention to Lord Rayleigh's high frequency formula for the "effective resistance" of wires to alternating currents, and suggested that the formula might be approximately applicable to the case; but he thought the experimental value of the attenuation would be considerably higher than the one derived from calculations. Mr. Barton here repeats the work, with special precautions as to the mode of insulating the parallel copper wires through which the wave-train proceeds. The value of the attenuation constant deduced from these experiments is 0·000013. By applying Lord Rayleigh's formula for the effective resistance of the circuit, and using this value in Mr. Heaviside's expression for the attenuation, the calculated constant is 0·0000062. To account for the discrepancy, the author points out that the effective resistance formula was originally developed for a wire placed at a considerable distance from other parts of the circuit, and for currents following the harmonic law. Whereas, in the experiments, the conditions are (1), wires 1·5 mm. diameter, only

8 cm. apart; and (2), the waves are propagated in the form of a damped train, with the large end leading; they are extinguished after ten or a dozen vibrations.

Mr. Oliver Heaviside (communicated) pointed out that, as there was human interest in error, it might be worth mentioning that at first it was supposed the previous experiments of Dr. Barton made the index of the alternation factor to be six times that of the long-wave theory for simple periodic waves. And it was hard to account for so large a discrepancy. The discovery of an error in the figures reduced the result from six to two. The small depth of the surface-layer of effective conduction, and the distance apart of the wires, seemed now to make it improbable that Dr. Barton's first reason, (1), was adequate to account for the doubling of resistances. The second, (2), was, of course, a substantial reason for increased resistance. A third one, Mr. Heaviside suggested, was the external resistance at the boundary of the waves. A combination of the second and third reasons, with a little of the first, might account for most of the extra attenuations observed, and, if more was wanted, one could "*try the K R law.*"

Mr. Appleyard said it was rather to be regretted that in all the experiments the distance between the wires had been the same, *i.e.*, 8 cms. By taking a few different values, (1) might have been checked. Lord Rayleigh's formula for the effective-resistance, involved the square root of the magnetic permeability of the wires. The author had, throughout, used copper, a paramagnetic metal, and had assumed $\mu = 1$. It would be of advantage to try other metals.

Mr. Barton, in reply, said he would make further experiments with the two conductors at different distances apart, and he would also try iron wires. With iron, the thickness of the surface-layer of the effective conductor was about one-thirteenth that of copper. Iron should therefore give a greater value of the attenuation than copper.

LEGAL.

The New Motive Power Syndicate.

Testing Guittari's Patent.

Mr. Justice Bigham and a common jury had before them on Thursday and Friday, the 9th and 10th inst., in the Queen's Bench Division, an action brought by Sir Samuel Canning and Mr. Tom E. Gatehouse, consulting engineers, against the New Motive Power Syndicate, Limited, in which it was sought to recover 75 guineas, balance of account for tests, and a report upon Guittari's patent mixture for generating steam in boilers, and which ultimately resulted in a verdict for plaintiffs for the full amount. Defendants counter-claimed for damage alleged to have occurred to their boilers.

The counsel engaged in the case were:—For plaintiffs, Mr. McCall, Q.C., Mr. Macaskie, and Mr. Howard Spensley (instructed by Mr. J. E. Lickfold); for defendants, Mr. Tindal Atkinson, Q.C., and Mr. A. B. Shaw (instructed by Messrs. Robinson & Stannard).

Mr. McCall, in opening the case, stated that the plaintiffs were requested by defendants, who were interested in a certain patent, to test and report upon it. They did so, and now said that they were entitled to the sum claimed, which was the balance due to them. The main question to be decided was, whether or not plaintiffs had carried out the work they were employed to do. The substance of the patent was that by a mixture of carbonic acid gas and Dutch liquid with water in a boiler, Mr. Guittari claimed the motive power would be increased, and steam would be generated more rapidly, besides which there would be an enormous saving of fuel. Defendants, who were interested in the invention, were anxious to obtain a report from a firm of leading engineers like the plaintiffs, with the ultimate object of placing it before the public. Therefore on July 23rd last year. Mr. Bale, one of the directors of the defendant syndicate, wrote to Sir Samuel Canning on the subject of tests, and the fee for that and the report thereon was fixed at 150 guineas, half of which was paid at the time the arrangement was entered into. The tests took place on July 29th and August 2nd and 4th last year at the defendant's works, when an engine was supplied with steam from two boilers all constructed by Messrs. Davey, Paxman & Co. On August 2nd, one boiler was supplied with Guittari's patent, and on the 4th the other with pure water. The results were taken, and would be put before the Court. The substance of the tests was that Mr. Gatehouse and the other seven or eight gentlemen present with him, who constituted his staff, came to the conclusion that the results obtained from Guittari's mixture were no better than those obtained from plain water, and plaintiffs reported accordingly. Mr. Bale objected to the way the tests had been carried out, and then refused to accept the report or to pay the money due.

Mr. T. E. Gatehouse, A.M.I.C.E., M.I.M.E., Editor of the Electrical Review, &c., Mr. W. H. Booth, Member American Soc. C.E., a former inspector of the Manchester Steam Users Association, Sir Samuel Canning, M.I.C.E., Mr. J. Christie, engineer to the Brixton Electric Lighting Station, and a certificated chief-engineer of the Mercantile Marine, Mr. Webster, for some time chief draughtsman and assistant to Mr. Bryan Donkin, and Mr. W. H. Massey, engineer to Her Majesty the Queen, who had also made tests, were then examined at considerable length, and tabulated statements showing the results of the tests were put into Court.

Mr. Tindal Atkinson, in addressing the jury for the defendants, said Guittari's patent consisted of a secret mixture which made the water extremely volatile, so that it gave off steam with a much less consumption of fuel than would be required by plain water. Plaintiffs were duly consulted as to proposed experiments, which should have consisted of a series of practical and exhaustive trials before the practical utility of the process was arrived at. Upon a previous report made by the plaintiffs to another gentleman, a syndicate was formed, and £1,500 was subscribed by them for the purpose of carrying into effect, and rendering the process a popular success. Before they asked the public to subscribe, they were very anxious to be satisfied beyond all possibility of doubt of its actual value. They were entitled to have the very best information, through the means of exhaustive trials, which Sir Samuel Canning had assured them would occupy at least 10 days. Instead of that, only two days were occupied in the trials, which were unfair in every respect, and hence the present action.

Mr. A. J. Bale, one of the directors in the defendant syndicate, was then called, and he bore out the statement of Mr. Tindal Atkinson. The plaintiffs agreed, he said, to make the trials in such a manner as to test the points included in a previous trial of Guittari's patented process made by the syndicate's consulting engineer, and they did not do so. Moreover, the stoker provided by plaintiffs was not competent, and the firing was inefficiently done.

In cross-examination, Witness was asked whether there were any letters, from the beginning to the end, in which defendants said that the tests were not sufficiently prolonged.

His Lordship: It is quite clear that there are none.

Witness said he made a protest against the way in which the whole thing was done. He admitted that he saw nothing wrong in the stoking by Guittari personally. He did not take the trouble to see whether the proper weight of coal was supplied during the tests.

What do you say about the blower being used. Supposing the atmospheric conditions on August 4th were worse than on the 2nd, do you say they ought not to be allowed to use artificial draught in order to equalise the conditions?—It would be quite contrary to anything that I required. They ought to have reduced the load under which the engine was running.

Where is Mr. Guittari now?—He is on the Continent.

Was he asked to come and assist this syndicate?—Yes.

And he declined to come?—Yes.

His Lordship: He is behaving badly to you, then?—I daresay he is.

Another Mr. Bale was called next, and having said that he bore no relationship to the last witness, stated that he was an engineer of 28 years' experience. With regard to the tests, he admitted he was not present, but from what had come to his knowledge he would say that if they were making tests with chemicals or with the water only, and the arrangement was that they should be carried out under identically the same conditions, they should have been so carried out. He had been on trials with engines and boilers for the Royal Navy, and in no case were they allowed to use forced draught when the test was with natural draught. In the present case he should say that these were not proper tests.

His Lordship: Supposing you wanted to get the tests done as soon as possible, would it be reasonable to use the blower and get the draught similar to the natural draught?—I might if I was requested to do it, but I should not consider it fair.

Cross-examined by Mr. McCall, Witness said he did not know that the consumption of coal on the day when the blower was not used, and on the day it was, was almost identically the same.

Mr. John Humes, consulting engineer to the syndicate, said he was present at the tests, and on one of the days the stoker got his fire in such a bad condition that he ran away. Then Guittari himself stoked. Witness had known cases where boilers were seriously injured by the use of the blower. The intense heat produced by a larger volume of air being drawn into the fire was more like a blow-pipe action than anything else.

His Lordship: But the blower is a very common thing, is it not?—Yes, if used with discretion, but in this case it was not. To show what an intense heat there was in the boiler I may say that for 12 feet the iron chimney must have been very nearly red hot, for it was all scaled, and the expansion through the heat of the chimney broke one of the stays. At the end of the test in this case the plaintiffs left the boiler and I went and opened the fire-door and saw the water streaming down, with very little fire in the box, and nearly all clinker. I should say that the value of the boiler after the test was depreciated quite £25.

Cross-examined by Mr. McCall, Witness said he considered the use of the blower had very little effect on the consumption of coal.

His Lordship: Has the syndicate sold this process yet?—No, I believe not.

Have they had any other experiments made except that which was made by plaintiffs?—No.

So you cannot say at present whether the process is worth anything or not?—No.

Mr. McCall, in replying upon the evidence, said that what the syndicate desired was a good report, and they could not get it. They wanted one which would have enabled them to pass off to the public the invention which they had bought from Guittari. Finding they could not obtain it, they immediately found fault, and objected to what they had practically ordered, and had honestly been given them. They had transferred the process from one syndicate to another—what for, the learned counsel admitted that he could not say—and Mr. Bale and his co-adventurers again started with the matter. Plaintiffs could not conscientiously give a report to the effect that Guittari's patent showed a great saving. Guittari had now gone away, preferring Belgium to this country, and would not now assist the syndicate. The process was one which they could not sell, could not use, and could not get a report proving the alleged value of it, and were therefore anxious to avoid paying plaintiffs their fee. Had the report pointed out that the process was of advantage, defendants would not have resisted payment, but on the contrary, a big company might have been floated by this time, and the members of the syndicate would have put into their pockets a considerable sum of money.

In summing up, his Lordship said the question the jury had to decide in this case was whether the plaintiffs, who were suing for certain money promised for certain services, did their work in a proper and conscientious manner. If they did, they were entitled to be paid the balance; while if they did not they would not be entitled to it, but, on the other hand, would be bound to refund the 75 guineas which had already been handed to them. If a skilled person was employed to do a job he must do it with the skill which a person in his particular business would be expected to do it. If anyone employed a doctor to cure one of a disease, the doctor must bring, in the discharge of his duty, the skill which was expected, not of an ordinary layman, but of a doctor. Just in the same way when a civil engineer had to conduct a test or an experiment, he must do it with such skill as a civil engineer was supposed to have, and not with the skill only of a more ordinary individual who could not deal with it. Therefore, the question here, and the only question, was, did the plaintiffs bring to bear upon the tests of August 2nd and 4th the skill which the defendants had a right to expect from them. Defendants complained that such skill had not been brought to bear. When work was done and the person for whom it was done refused to pay for it, alleging that it was not done in the way he was entitled to expect, it was always as well to look at all the circumstances to see whether there was any other motive likely to influence him to make complaints. Some people, after having ordered a thing to be made for them, did not like the thing—not because it was badly made, but they did not like it, and found all sorts of excuses. Now the jury had better consider what, in this case, the plaintiffs wanted, and whether they liked it when they got it. The defendants were the New Motive Power Syndicate, Limited, and had apparently bought the process of Mr. Guittari, whom they had not seen in Court during the hearing of the case. It was described as a process by which, if one mixed with water a mysterious compound, and then put it in a boiler, much better results could be obtained than with water only. A syndicate, which he would call No. 1 syndicate, bought the process, and raised amongst themselves £4,000, with the object of making certain tests to see whether the mixture was really worth what was claimed of it. That £4,000 seemed to have been spent; how, his Lordship did not know. Then it was thought wise to sell the process, and it was proposed that somebody else would come in and find more money; consequently, syndicate No. 2 was formed, the object from the very beginning being that the proper thing to do was to sell it to the public—that was to say, to form a public company. Before they could hope to do that, however, they must get from a good firm of engineers, who possessed a good name, a favourable report, which would have been subsequently printed in a prospectus, and probably he (His Lordship) and the jury might, in due course, have found some of the prospectuses upon their breakfast tables one morning inviting them to subscribe. Defendants wanted that favourable report from a good firm, which he believed the plaintiffs to be, and for a favourable report they were willing to pay a certain price. There had been one report in the past, made to a member of syndicate No. 1, and the attention of the jury ought to be called to it, for it might be of some importance. It was made in December, 1896, by Sir Samuel Canning and Mr. Gatehouse, who, after dealing with the process, wrote the following:—"At the same time we think from the result of our trials that there is sufficient promise in the Guittari method to warrant a further expenditure to allow of a thoroughly practical and exhaustive series of experiments with an engine and boiler of reasonable horse-power." Bearing that in mind, counsel for the defence had indicated that the tests which formed the subject of this action were not sufficient. Well, the jury could put such value upon that as they thought proper. Following the course of events, it appeared that after they received the first report from Sir Samuel Canning, they approached him and his partner again, and further tests were arranged, which were supposed to be under as nearly the same conditions as possible, otherwise the whole thing failed. The first of the tests took place on August 2nd, and was substantially under Guittari's control, for the stoker, a man named Steele, who should have attended to the firing, under the pretext that he was frightened through having a number of Italians round him, left his work, and Guittari raked out the fire, remade it, and stoked till the end of the trial. It was important that that fact should be borne in mind, and that once they got the result of the Guittari experiment they could from scientific books ascertain fairly well whether the process was satisfactory or not. It was suggested by the plaintiffs that as soon as the result of the test with Guittari's mixture, Guittari himself stoking, was seen by Mr. Humes and Mr. Bale, who represented the defendants, they saw at once that they were not likely to get a report which would be of any marketable value to them. The only report which would have any commercial value to them was a favourable one. The Guittari test having been made, it did not appear that any objection was taken by defendants, except that it was not long enough, the objection being based upon what Sir Samuel Canning wrote in December, 1896, to an entirely different party, as to "exhaustive tests;" and certainly that objection was not made until plaintiffs asked for the balance of the fee agreed upon. With reference to the second test, on August 4th, and the conditions not being proper according to the defendants, there was no doubt contradictory evidence as to who did the stoking in the earlier part of the day; but his Lordship thought that did not matter. The real objection to that test was, that the blower was occasionally used to keep up the draught through the furnace. Well, a blower was a common appliance for the purpose of increasing and regulating the draught. Apparently there were conditions of the atmosphere where the draught was not so good at one time as at another, and sometimes the blower was used. Now, who put the blower there? The plaintiffs did not. It was part of the machinery which they found there when they made the test. What was it there for, unless it was to be used as occasion required? Did the jury think that Sir Samuel Canning and Mr. Gatehouse, and the people they employed used the blower unfairly? Why should they? They had no object in making an unfair or a wrong report. They said that they used the blower in such a way as to compensate for the difference in the atmosphere between the first test day and the second. No doubt there were changes in the character of the draught; it rose and fell, and had to be regulated as the changes occurred. But the real question in the case was this, was the work properly done? There had been a volume of evidence on one side that, notwithstanding the use of the blower the tests were properly carried out. A large number of witnesses testified to that, while, on the other hand, the defendants had called Mr. Humes, who said that in his opinion the test was not a fair and proper one. With regard to the report which plaintiffs prepared, his Lordship said he could not assist the jury very much as to that. He had it, but they had not seen it themselves. It was a very long report and had been handed up to him. Plaintiffs sent it to defendants in September, the month following the tests, and defendants at once said to them: "Take it away, we won't look at it, and we certainly won't pay you for it." Mr. McCall, plaintiffs' counsel, had suggested that the reason defendants refused to have it and pay for it was that they knew very well it was not favourable; and it might be that Mr. McCall's suggestion was right, and that the real reason was that it was not the sort of report the syndicate required. If the jury were of opinion that plaintiffs did their work in a proper and skillful way they need not be afraid to give them a verdict entitling them to the balance of their contract money. If, on the other hand, the jury came to the conclusion that they were neglectful, and did not go about their work as properly skilled men ought to have gone, by all means say so, and let them be made to give back to defendants the half of the fee which they had already paid, together with the sum which was claimed for damage done to the boilers, which was said to have occurred through the excessive use of the blower. That damage was laid at £25, which, to his Lordship's mind, seemed extraordinary. However, if the jury agreed to that figure, let them by all means allow it.

The jury considered for two or three minutes, when the foreman said they found a verdict for the plaintiffs for £78 15s., and also on the counterclaim.

Judgment was entered accordingly, with costs.

THE TELEPHONE INQUIRY.

(*Continued from page* 818.)

Mr. Hanbury presided on Thursday last week over a further sitting of the Telephone Committee.

Major-General Webber, Past President of the Institution of Electrical Engineers, said he had a considerable experience with regard to telegraphy. In 1867 he was deputed to examine the Prussian telegraphs, and made a report on that subject, and in 1870 he was instructed to take charge of a military contingent placed at the disposal of the Post Office, partly to assist in the instruction and maintenance of telegraphs, and partly to train soldiers for military purposes. In 1879 he left the Post Office, and having had experience of the earlier telephones, was asked to become a director of the Bell & Edison Telephone Company.

The Chairman: The information we want in the first place is as to the possibility of cheapening the present telephone service. Will you explain to us the defects and the cause of the high price of the present arrangement?—I would like to combine my answer under two heads. One is that a large amount of interest has to be paid on the capital expended on the system existent in this country, as was given in evidence by Mr. Forbes before the Committee presided over by Mr. Morley. That makes it clear that the rates cannot be reduced to anything like what is found in other countries. That, I think, is the prime reason why we have not got cheap telephony in the United Kingdom.

How far would that apply to the way the Post Office works them?—That comes under the other head, and is the cost of the construction of the plant. In 1870 the Post Office established a rate of charges for private wires in connection with telegraphy. I have always regarded these rates, which are more or less continued in connection with private purposes, as being almost prohibitive, and has made the telegraph and telephone only accessible to the rich. Owing to the cost of construction of telegraphic lines, and the same thing applies to telephonic lines, and owing to the heavy charges which have to be added, I am not prepared to say these rates are unfair, unless the Post Office are prepared as they are in the case of the Press to give special facilities.

Continuing, Witness said that in towns it cost more to lay wires underground than overhead, and the underground wires were laid more generally in England than abroad. He did not think that it was a distinct advantage to have underground wires unless the wires were very heavy. In all towns it was recognised as the right thing to have a metallic system, and that increased the weight. Before Mr. Morley's Committee he showed that wires laid in the City of London, estimated by Mr. Preece to cost £55, did not cost more than £15 or £18. It was cheaper to lay wires in the country than in a town.

As to the cost of working a system. Does the cost increase very much when you have very large exchanges?—That is a question which, I think, only those who have had the management of large exchanges, such as the Paris exchange, and the large exchanges in America can give an answer to. I am not competent, as I have never had charge of a very large exchange. I do not think it is very great, one way or the other.

Questioned by the CHAIRMAN as to how it would be possible to cheapen the telephone service and bring it into greater use, WITNESS said that they had had 28 years of telegraphy in charge of a public department in which everything was worked on business lines, and attention paid to the minutest details. It appeared to him that the National Telephone Company had had an example before them to try and vie with the Post Office in accuracy and minute attention to details and efficiency, but they had overlooked that which was attended to in other countries, viz., the day-by-day wants of the people. He was afraid, however, that he must admit that London must be dealt with differently from other parts of the country. What he meant by London was 300 square miles. Things had gone too far in London really to make any change. In a paper which he read before the Society of Arts in 1895, he showed the way to solve the difficulty, which was to provide a system for those who wished to communicate all over London at one rate, and provide a system for those who wanted to communicate within a given area. Every day that became more difficult in London, and three years ago he urged that the Post Office should take it over. He would have the regional system in London. At present he believed there were 11,000 subscribers in London to the National Telephone Company, and they all had communication with each other. He considered that there were two markets, so to speak, for the telephone. There were the people who wanted the use of the telephone over the whole area, and those who wanted it for their daily wants. He supposed why the company had not supplied the latter demand was the difficulty of wayleaves and the disinclination to bring down the charges. What he meant by the daily wants of the people was the facilities which should be given for a lady to speak to her tradesmen or her doctor. He would divide London into 11 areas, making the City and a certain district round it one area by itself, with a high subscription. The minimum subscription should be applied to a system of speaking within a given area.

Does the present service of the National Telephone Company lead to an increased cost of plant?—I think that London was never originally laid out except by myself, and that was in 1880, when I allowed for 200,000 subscribers and the length of lines.

So the cheapness would not come in there. Where does the cheapness come in?—The cheapness would be to the subscriber for facilities which the undertakers would provide by giving minimum facilities at a minimum rate. It is not right that if I wish to speak in Kensington I should pay the same rate as those who wish to speak all over London.

You bring in a large number of additional subscribers; what would that mean in the way of additional plant?—It would depend entirely on the number of people who wished to come in on the smaller system. That you could not find out until the scheme was before the public.

Do you argue that the larger the number of subscribers the cost per subscriber would be reduced?—The actual cost of inter-communication would be much reduced.

As I understand, your complaint is that the National Telephone Company serve at the present moment a particular class; that is, the rich commercial class, and the rate of subscription is high; but you think a proper telephonic service ought to cater for other classes, to come down to small tradesmen, for instance. I understand that it is said on one hand that the cost of working the telephone service actually increases very rapidly for every additional subscriber?—Yes, when every additional subscriber wants to speak over the whole system.

That is to say, supposing you get a system as in London, where every one of the 10,000 subscribers is put into communication with each other, the more additional subscribers you get the greater is the cost?—There comes into the question whether you provide the maximum facility only.

Let us get it quite distinct. I suppose one of your objections to the present system in London is that every subscriber is put in direct communication with the rest of the subscribers, and that gives facilities which are not wanted, and facilities never made use of by certain classes of the community. You think the service ought to be made more local, so that people might communicate with their tradesmen. As I understand under the present system supposing any large increase in the number of subscribers took place the cost of working would be very much increased. Is that so?—I do not think it would be more than a very small amount.

Was not evidence given before the Committee in 1895 to that effect?—It was.

On behalf of the National Telephone Company?—Yes.

I would like your experience on that point.—My experience of the working of large telephone exchanges is not sufficient to enable me to give an answer.

What I want to get out of you is this. You are an advocate of a cheap telephonic system. Will you give an explanation as to how that is to be carried out?—In London by having regional telephony, and by the Post Office taking it over. They have wayleaves and underground wires, and it seems to me to be eminently a case in which, for the future of London, the Post Office should take it over.

Continuing, WITNESS said he did not think if the London County Council worked a rival system they would gain much by competing with the National Telephone Company on the present lines, but there was the want he had mentioned which the company had never met. He did not see why Marylebone or Kensington should not have their own local telephone services. He advocated a cheaper telephone service for a local area, and if anyone wanted to communicate at a distance, they would have to have a separate telephone and separate wires, which should be of such a quality as to be passed by the Post Office.

Would it not be a disadvantage to have two services?—That disadvantage, whatever it is worth, has forced itself upon the practice of the country.

Do you distinctly recommend to the Committee that there should be two services; one set of subscribers to communicate only with the subscribers in a local area, and the other able to send messages to different parts of the kingdom?—Most distinctly.

But you recommend that on the ground that in the first place, by limiting it to a locality, you get it cheaper?—Localities who want to have services of their own might have a system constructed in a cheap way. If they required to speak outside their own area they must have a metallic return and a first-class instrument, such as is necessary to speak over the trunk wires.

Mr. BARTLEY: Would there not be an obvious objection to such a local system where the areas are close together? How would Islington communicate with St. Pancras?—I said that London must always have a metallic return.

The CHAIRMAN: We will take it that it will not apply to London, and we will take Glasgow. What is the best way to cheapen the telephone system in Glasgow?—The first thing would be to put up an entirely new system, which would not cost as much as the present one.

How would you do that?—I have not got the capital cost of the telephone in any of these towns.

We assume that there are no wires in Glasgow, and we start *de novo* putting up wires in Glasgow. Assuming that there were 10,000 subscribers, how would you start to work to construct a cheap telephone service—an efficient one—not only of use locally, but to enable every subscriber to communicate with London?

WITNESS replied that he had not come prepared to answer a question like that off-hand, but he would draw up an estimate and hand it in.

The CHAIRMAN said he would like the witness to draw up an estimate of a local service and a service for trunk communication.

Mr. COHEN: Would the metallic return apply to Glasgow as well as London?—To a degree, but I do not know what the electrical disturbances are in Glasgow.

WITNESS was then questioned by the CHAIRMAN as to a telephone service for country districts, and explained a scheme he had drawn up to apply to the County of Suffolk. He proposed that there should be 29 exchanges, which would require the construction of 524 miles of new lines along the roads not already occupied with lines by the Post Office, and it would require wayleaves also for wires of 252 miles on telegraphic poles belonging to the Post Office. The total mileage of wire required would be 3,970. This provision was almost entirely for call offices, and there was an estimate that there would be a certain proportion of private connections as well. The cost of the system of 29 exchanges provided, with 50 per cent. for spare connections, would be £4,375; 351 call stations, at an average of £7 10s., £2,633; 524 miles of new line, at £20 a mile, £10,480; 3,970 miles of wire on new and existing poles, at £5 a mile, to provide double conductors with metallic returns in the case of 950 miles, £23,820; contingencies, £4,130; total, £45,435. The interest and sinking fund, at 4½ per cent., would be £933; renewal of poles, £733; renewal of wires, £238; wayleaves, £574; wayleaves on existing poles, £675; management, £300; salaries for maintenance, £1,880; rent and sundries for 351 call offices, £3,159; rent, and sundries, and salaries for 29 exchanges, £2,958; contingencies, £593; total annual outgoing, £11,973. He estimated a profit of £990 a year on private lines, further, he would make a charge of £8 a year, and calculated to make a profit of £3.

Examined as to how the person going to a call office was to communicate with the person he wished to speak to at the other end, WITNESS said that a message would have to be sent to the person that he was required at the call office. He knew that was done in Canada. He estimated to make it pay in a village of 300 people, 2s. would have to be taken per day, 309 days in the year. He thought the National Telephone Company and the Post Office should have a greater number of call offices, but he could not say whether their plant would be sufficient to carry a greater number of messages.

Sir HENRY HOWORTH: Do you think if the company was to face their regional system it would get a good return on its capital?—I think it would be wise of them to expend the capital on it.

From your experience, how do you explain the enormous capital of this company in comparison with the cost of its plant?—I think when a system of this kind is administered for the whole of a large area like the United Kingdom, owing to the lack of local interest and superintendence, it necessarily becomes more costly.

Do you think it would be more economical for the Government to start *de novo* with its own plant, or to take over the whole of the company's plant at its capital value?—I am quite certain if it is practical it would be better to construct it *de novo*, but it is difficult to imagine such a thing as wiring England again.

Supposing it is done piece-meal by local authorities, would it be economical for local bodies to start their own plant, or to buy the existing plant?—Undoubtedly they should start with a new plant.

Further examined, WITNESS said that, owing to the monopoly of the Telephone Company, there were at present few telephone engineers in the country who could carry out other systems. At present, an associated company made the plant for the Telephone Company, but if a demand was created it could be made cheaply in England. If the municipalities were to be authorised to work telephones, there would be no difficulty in their getting plant, but there were no other firms in the country at present who manufactured it. He did not contemplate that at the expiry of the license of the Telephone Company, the company would cease to exist, for that would be chaos. But if licenses were allowed to municipalities now, and they competed with the company, it would mean the survival of the fittest.

By Mr. NICOL: He did not advocate the Post Office taking over the local exchanges, for he did not think they could work a capilliary system at a cheaper rate than a local organisation.

Mr. Stuart: Why should the Post Office not take them over in the country if they take over the system in London?

Witness explained that London could be compared with no other city in the world, and he thought that the Post Office, with its experience of laying wires, would be able to cheapen the cost.

The Select Committee resumed its sitting on Tuesday last, Mr. R. W. Hanbury presiding.

Mr. A. R. Bennett, of Harlesden, in reply to the chairman, said he was a member of the Institution of Electrical Engineers and a general consulting engineer and electrician. He was telephone engineer to the Corporation of Glasgow, and electrical engineer to the States of Guernsey, besides being a general consulting electrical engineer in London. He had had very prolonged experience in connection with telephone installations. From 1881 to 1883 he was engineer to the Commercial Telephone Exchange in Glasgow. Afterwards he was chief engineer for Scotland and Ireland to the National Telephone Company; in the following year he was promoted to be chief manager, as well as engineer to the company in Scotland, which position he held until 1890. From 1890 to 1892 he was general manager and chief engineer to the Mutual Telephone Company, and from 1892 to 1895 he occupied the same position in connection with the New Telephone Company.

Can you give us your opinion as to the possibility of providing telephone communication at lower rates, so as to bring the telephone service within the reach of other classes of the community than those enjoying it at the present moment?—I have devoted a great deal of attention to that subject, and I can testify that a good exchange connection, using the best of instruments and materials, could be constructed at a cost varying from £12 to £24 per subscriber, according to the size of the town or district to be telephoned.

This is not merely for a local service, but for a service which would be in communication with the rest of the kingdom through trunk wires?—Quite so. The difference between the cost of first class apparatus and second class is not very considerable, and I always make a point to put in the best, so that the price I have mentioned would enable subscribers to communicate all over the kingdom by means of Government trunk wires.

Is there any difference in the cost between a large town and a small one?—Yes, the capital outlay for a small or medium sized town, where one switch room suffices, is from £12 to £14 per subscriber, but in larger towns where several switch rooms connected by junction lines are required, the cost in the absence of special obstacles should range from £16 to £24 per line, excepting in London, where I estimate the cost would be £36 per line.

Will you explain why the price varies so much in these various towns, and particularly why it is so much larger in London?—In small towns the business community is generally gathered within a small area, consequently subscribers' lines are short, perhaps not exceeding on an average a quarter of a mile, whereas in larger towns the commercial people are scattered to a very much larger extent, and if they were connected with one central exchange the average length of their lines would be considerably in excess of the average length of smaller towns. In that case it is usual to construct several switch rooms, which has the effect of reducing the average length of subscribers' lines, but which requires additional lines for junction lines for connecting the various exchanges. That accounted for the difference in cost between a large provincial town and a small town. In London asphalte and wood pavements existed to a very much larger degree than was the case in provincial towns, and the cost of making good such pavements was very considerably in excess of the cost of making good either macadam or granite blocks. It was necessary, therefore, to make special allowances for London. Continuing, witness said he did not attribute the present cost of the telephone service in London to the fact that too large a number of subscribers were put into communication with each other. As he understood it at present, every subscriber was in connection with all the others, and he did not think the telephone would be of much use if the exchange was restricted to certain localities. There were instances in which that had been done, but when they looked abroad and found the very large exchanges which existed—for instance, in Berlin, where there were 29,000 subscribers—it certainly was not time, when we had only 10,000 subscribers in London, to talk about limitations.

Does the cost increase very much as the number of subscribers to exchanges increase?—No. I know it is generally said to be so, but I always considered that to be a fallacy, and I shall be able to put figures before you dealing with that very point. Mr. Provand, M.P., has recently obtained through the Foreign Office the particulars of a good many foreign telephone exchanges, which I believe he will put in to the Committee. Amongst those reports are a very valuable series from the German Government. The German Government say that in Berlin they have 28,785 exchange instruments at work, and that the capital cost per line had been £22. In Hamburg they had 13,561 exchange instruments at work, and the average capital cost has been £23. In Leipsig there are 5,289 instruments at work, and the capital cost has been £19 2s. In Franfort-on-Main there are 5,063 instruments at work, and the capital cost has been £22 18s., and at Cologne, there are 4,701 instruments at work, and the capital outlay there has averaged £19 12s. It is obvious that the cost in Berlin is not sensibly greater than the cost in Cologne, although the number of subscribers in Berlin is very nearly 17 times the number in Cologne, and that accords with my own experience.

The service in Berlin, where there are 28,000 subscribers, costs £22, as against £36 which you estimate it ought to cost in London. Why is it?—Of course, Berlin, although a very large city, is considerably smaller than London.

But why, in your opinion, does this difference of £14 arise between the two cities?—I should say that on the whole Berlin is a much easier town to telephone. It is not so scattered as London, and it does not cover nearly the same superficial area. Then, again, the pavements there are not wood or asphalte to nearly the same extent as they are in London.

Witness, continuing, said that in Switzerland, Luxemburg, Finland, Norway, Denmark, and Sweden, there were very extensive country systems.

Does it extend to the small villages of 300 or 400 population, for instance?—Yes, in some countries there is scarcely a village of that size without a telephone exchange—especially is that the case in Switzerland and Denmark.

Do you know any country where the rates vary according to the use made of the telephone?—Yes, in Switzerland and in Guernsey, where the telephone exchange is not yet opened; the States have adopted a system of charging which will enable the subscribers to pay in accordance with the use they make of the telephone. With reference to the service in Jutland, there was no Post Office monopoly, but the Danish Government was now in process of taking over as many trunk lines as it could. The Danish Government thought with our Government that the trunk lines ought to be in the hands of the Government.

If a message is sent in Jutland from a call office from a subscriber to a person who is not a subscriber, how is the message delivered at the other end?—I cannot answer that question specifically, but in Copenhagen the operators at the call office are allowed to write down a few words on a slip of paper—practically, they are allowed to write down short telegrams, and they are delivered by the post office.

Is there an extra charge for that?—Yes, of about 1d. for 10 words. Continuing, Witness said he was in favour of making the best use possible of the telephone, and he would very much like to see the telephones and the Government working more closely together. If that were done it would have a very considerable effect in increasing the usefulness of the telephone, but so far the Post Office seemed to be possessed with a desire to restrict the telephone service as much as they could.

In London at present a man pays the same subscription, whether he sends 1,000 messages a year or two. Do you think it is impossible by any system to let people pay according to the user of their private wire?—The system of paying a lump sum is one which prevails to a very large extent, but another system has prevailed in Switzerland for a good many years past. In Switzerland, a subscriber pays £4 for the first year, £2 16s. for the second year, and £1 12s. for the third, and subsequent years of his connection with the telephone exchange, and in addition to these annual payments, he is charged at the rate of 4s. per 100 calls which he makes; the man who is called is not charged anything. Consequently a subscriber who has 365 calls per year pays the annual subscription in the first instance, and then he pays another halfpenny per day for his calls, and as he is only a small user he only pays a comparatively small sum to the Government, particularly if he has been a subscriber for three years; but a man who calls five or six times a day has to pay practically 3d. a day, and so in Switzerland they make the charge dependent practically upon the user. In Guernsey they had adopted practically the same plan, but with a smaller initial charge. In Guernsey the charge was to be 30s. per annum down, and 1d. per call up to 1,000 calls per annum, and everything over 1,000 calls at the rate of five calls per 1d. If a very small user only called once every two days his total annual charge would be £2 5s. 2d.; if he calls once a day his total annual charge would be £3 0s. 5d., if he calls twice a day the total annual charge would be £4 10s. 10d., and similarly three, four, and five calls a day would bring his charge up to £5 14s. 11d., £6 1s., and £6 7s. 1d. respectively.

By Sir James Woodhouse: At present no maximum had been fixed for an unlimited user.

Replying to the chairman, the Witness said that in Switzerland the number of subscribers was very large in proportion to the population. Norway had the largest number of subscribers to the telephone in proportion to population, where there was 144 persons to each telephone. In Sweden, the numbers worked out at 147; in Luxemburg, 160; 172 for Switzerland; 211 for Denmark; 328 for Finland; Imperial Germany (post office), 449; Bavaria, 451; Wurtemburg, 459; then came the United Kingdom with 636, which was the sum of the National Telephone Company's subscribers and the Post Office subscribers. France was very low down —1,342, and in Austria the figures were 1,640 to every telephone. With regard to Guernsey he expected the exchange would be opened shortly, and about a fortnight ago there were 325 subscribers. He could not tell exactly what the capital charge would be, but the estimated cost was £13 14s. per subscriber, and they had every reason to believe that the charge would be kept within those limits. The population of Guernsey was 35,000.

So at present you have not got a very large proportion of subscribers? —325 works out at something like 180, whereas in the neighbouring island of Jersey, which is worked by the National Telephone Company, the number of subscribers is only something like 80, and the population is over 20,000 more than Guernsey. When the National Telephone Company opened in Jersey they began with a £10 rate, with limitations as to distance, but they did not get many subscribers at that rate and they soon reduced it to £8. That was in 1895, and they had about 40 subscribers in the island. Then when Guernsey showed that it wanted a telephone system and was pressing the Post Office to grant it and the Guernsey tariff was published, the National Company reduced their rates in Jersey to £6 10s. per annum without any limit of distance. The consequence of that reduction had been that they had exactly doubled the number of their subscribers. Witness then explained to the committee that the estimate he gave before the Glasgow inquiry as to the cost of establishing a telephone service in that country was based upon estimates he had received from reliable firms. The cost of telephone material was undoubtedly falling, and there was also a likelihood of a reduction being effected in the working. There was a new automatic switch room exchange which would dispense with the services of the lady operators. He had tested the invention himself, and he thought that for exchanges up to 600 or 1,000 subscribers it was likely to answer extremely well indeed.

But you don't think it would answer for the larger exchanges?—The inventors claim that they could do it up to 5,000 or 10,000 subscribers, but they have not done it yet. At the present time, however, for exchanges up to 400 or 500 subscribers, it was actually in use in several towns in the United States. Continuing, the witness said that most of the materials used in telephony was imported from abroad. The cables were made in this country.

Replying to Sir J. Woodhouse, Witness said that the reason why the materials were not produced at home was that there was not sufficient scope to allow of manufacturers competing with firms abroad who also sold materials in their own countries. If the telephone system in England were free it would have a most important effect upon many electrical industries, and he believed that the telephone industry would be equal to the bicycle industry in importance. His estimate for Glasgow was five guineas per subscriber, which, he reckoned, would enable the Corporation to get a return upon its capital outlay; but he thought that, with careful management, local authorities throughout the country might even improve upon that amount. A local authority had no expensive board of directors to pay, and it was free from many other charges which a company would have to pay. He was decidedly of opinion that it was to the public interest that there should be competition in telephones, but he would not go so far as to say that the best competitors would be the local authorities. His idea was that local management was a very essential feature in telephones, and whether that local management came from a municipality or a local company, did not, in his opinion, affect the matter much. What was wanted was a knowledge of local requirements.

By Mr. Fry: It would be to the advantage of the public and of the electrical industry if competing services were established.

Mr. J. Stuart: He did not believe the National Telephone Company could make a £5 rate pay. It could only be done in the case of an entirely new company, or by a municipality. He thought the London County Council, which had special facilities for creating a telephone service in London, would be able to give local services for £5 or £5 5s.

Mr. J. C. Lamb, C.B., second secretary to the Post Office, was recalled, and briefly examined as to the policy which the Department had pursued in relation to the extension of exchange areas to the National Telephone Company. He said that the Post Office had acceded to the requests of the National Company for new areas when they thought they were needful in the interests of the public. Mr. Forbes refused to sign the agreement of 1892 until he obtained a verbal promise from Mr. Ferguson that it would be carried out by the Post Office in a reasonable spirit, and that verbal agreement was subsequently ratified by Mr. Arnold Morley.

The Committee then adjourned.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1898.

Compiled expressly for this journal by W. P. Thompson & Co., *Electrical Patent Agents*, 322, *High Holborn, London, W.C., to whom all inquiries should be addressed.*

12,200. "Improvements in fittings for gas and electric pendant lamps and the like." J. Morris, jun. Dated May 31st.

12,201. "Improvements in quadruplex and multiplex telegraphy and to apparatus for use in connection therewith." S. G. Brown. Dated May 31st.

12,220. "Improvements in or connected with electrically driven vehicles." C. Jeantaud and W. C. Rechniewski. Dated May 31st.

12,232. "Improvements in tele-motor apparatus for working, steering, telegraphing, indicating, and other apparatus from a distance." A. B. Brown. Dated May 31st.

12,237. "An improved A B C transmitter for telegraphic purposes." W. Milner and C. C. Vyle. Dated May 31st.

12,241. "Multiplex and duplex printing telegraph." A. Silbermann. Dated May 31st. (*Complete.*)

12,268. "Improvements in insulating means for electric furnaces." W. L. Wise. (The Aluminium-Industrie Actiengesellschaft, Germany.) Dated May 31st.

12,313. "Improvements in secondary batteries or electric accumulators." F. King. Dated June 1st.

12,321. "Improvements in electric batteries." E. Edwards. (P. A. Emanuel, United States.) Dated June 1st. (*Complete.*)

12 322. "Improvements in electric batteries." E. Edwards. (P. A. Emanuel, United States.) Dated June 1st. (*Complete.*)

12,323. "Improvements in electric batteries." E. Edwards. (P. A. Emanuel, United States.) Dated June 1st. (*Complete.*)

12,325. "Improvements in apparatus employed in wireless telegraphy." G. Marconi. Dated June 1st.

12,326. "Improvements in apparatus employed in wireless telegraphy." G. Marconi. Dated June 1st.

12,347. "Improvements in electric railways or tramways." J. J. Steinbach. Dated June 1st.

12,349. "Improvements in microphones." Siemens Brothers and Co., Limited. (Siemens and Halske, Gesellschaft, Germany. Dated June 1st. (*Complete.*)

12,350. "Improvements in electric alarums." Siemens Brothers and Co., Limited, and J. Ebel. Dated June 1st. (*Complete.*)

12,351. "Improvements in portable telegraphic apparatus." Siemens Brothers & Co., Limited. Dated June 1st. (*Complete.*)

12,354. "Improvements in microphones." J. Berliner. Dated June 1st.

12,365. "Improvements in portable electric lamps for use in mines and other places." S. F. Walker. Dated June 2nd.

12,423. "Improvements in electric switches." A. Vandam and T. H. Marsh. Dated June 2nd.

12,431. "Improvements in apparatus for the production of electricity in railway carriages and other vehicles." E. J. Preston. (The Gould Coupler Company, United States.) Dated June 2nd.

12,437. "Improvements in or relating to electric arc lamps." C. Oliver. Dated June 2nd.

12,438. "Apparatus for indicating leakages or escapes of current from electric conductors." M. Kallmann. Dated June 2nd.

12,446. "A new or improved hub for generating electricity for use with velocipedes and other vehicles." J. E. Preston and B. Wharton. Dated June 3rd.

12,461. "Improvements in, and in relation to fenders for electrical and other tramcars, motor cars, and such like vehicles." J. W. Towle. Dated June 3rd.

12,471. "Improvements in electrically-propelled motor cars." L. Coudat. Dated June 3rd.

12,562. "Improvements in or relating to electric motors and the transmission of power therefrom." Fawcett, Preston & Co., Ltd., and C. A. Matthey. Dated June 4th.

12,580. "Improvements in the manufacture of conduits for electric cables or conductors, and in the method of securing the said cables or conductors therein." F. Chiesman and S. Chiesman. Dated June 4th.

12,604. "Lunaria electric cycle and carriage lamp." S. G. Hamilton. Dated June 4th.

12,606. "Improvements in electrical firing keys." C. A. McEvoy. Dated June 4th.

12,511. "Improvements in or relating to incandescent electric lamps." O. Riebensahm, J. Pleichati, H. Friedeberg, and E. Kruger. Dated June 3rd.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free,* 9d., *(in stamps).*

1897.

996. "Improvements in and relating to accumulator plates." W. Majert. Dated January 13th, 1897. This relates to accumulator plates for high current density and capacity. This is produced by increasing the surface, which is effected by dividing up the lead core plate on both surfaces into thin strips which are formed by a suitable tool into vertical ribs. The tool has a surface situated behind its cutting edge which bends the strip that has been divided from the plate into a rib. 3 claims.

8,280. "Improvements in and relating to electro-medical apparatus and brushes for use therewith." C. Klein. Dated March 31st, 1897. The object of this invention is to enable a current of requisite strength to be applied to the body. In this apparatus there is a pivoted contact piece operated by a rod sliding in a guide and fastened to a movable core in an induction coil. This core carries a pointer which give indications upon a graduating strip. There is a screwed rod located in position in its support, one end of which engages with the commutator spring. In brushes there is a metallic support carrying a flexible plate upon which metallic bristles are so arranged as to make contact with the plate, when pressure is applied; this plate having a conducting wire attached and situated in a suitable part of the brush. 3 claims.

17,691. "Improvements in electrical conduits." H. L. Doulton and C. E. Morris. Dated July 28th, 1897. This relates to jointing butt lengths of earthenware conduits and making branch connections with the conductors in them. Metal collars are used to secure mechanical strength. Each collar is in two parts, which embrace the adjoining lengths of conduit, and are provided with lugs and clamped together by bolts. A space is left between the two pieces of the collar to allow for variation in the size of the conduit. This space is covered on the outer side by flanges. In making branch connections with the conductors within longitudinally divided lengths of conduit are used. Slots are provided for the passage of the branch cables and there is connecting piece which fits in the outer slot, the end of which is provided with a socket. Another method of making a branch connection is to substitute an iron box for a length of conduit. The box is divided, and the two portions secured by bolts, at each end is an interior annular cavity. It is provided with openings for branch cables. 6 claims.

THE

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SPEEDS OF ATLANTIC CABLES.

THE table of figures giving the speeds of transmission over different Atlantic cables, published in our issue of June 3rd, has attracted a good deal of attention. The principal feature of the table is a comparison of the speeds of the two 1894 cables laid by Messrs. Siemens Bros., and the Telegraph Construction and Maintenance Company respectively. The Mackay-Bennett cable laid by the former, with a K R of 4·671, has a speed of 40 words per minute, and the Anglo-American cable, with a K R of 2·42, has a speed of 47·4 words per minute. That is to say, the speed obtained on the Siemens cable, making allowance for its higher K R, is 63 per cent. greater than on the Anglo-American cable. This figure, sufficiently startling in itself, is still more so if closely examined. The small undulations of the syphon trace, working at 45 words a minute, correspond to those of an alternating current of about 17 ~ per second, and at 75 words a minute to about 28 ~ per second. The amplitude of alternating signals received at the rate of 17 ~ per second over a cable having a K R of 2·42 is 13·6 times as great as the amplitude when received at the rate of 28 ~ per second, the amplitude of the sent signals, or, in other words, the alternating E.M.F. employed, being the same in both cases. The expressions from which this figure is calculated were given in our Vol. 41, p. 191. Column 10 of the table we are referring to gives a comparison of the efficiencies of the Mackay-Bennett and Anglo-American cables as 77·2 to 47·4, which we have taken as 75 to 45 in round figures; which implies that a cable manufactured by Messrs. Siemens Bros., of the same dimensions as the Anglo-American, would transmit alternations with 13·6 times the amplitude of those transmitted by the actual cable laid by the Telegraph Construction and Maintenance Company. This comparison of the cables has no meaning, unless the terminal arrangements of the two are similar or equivalent, and in which case we have to meet an assertion that of two cables similar in all respects, and having the same electrical constants, one transmits an alternating current 13·6 times as well as the other. If this can be established, the accepted theory of cable transmission has to go, and with it column 10, which is calculated on the assumption of the K R law. But the explanation must be looked for in the arrangements at the terminal stations, and it would be interesting to know how, with the apparatus in ordinary use, such a marked improvement is obtained. An improvement, however, of much more than 60 per cent. in speed over the syphon recorder is probably attainable in simplex working by using a photographic recording slip and a mirror. The principal impressions we draw from the table are the difficulty of comparing the working speed efficiencies of cables, when so much difference exists between the practice of two neighbouring stations as regards the kinds of instruments used, and the methods of transmitting and receiving signals. We are not aware to what degree of exactness the accepted law of electrical propagation has been verified, but it is hardly possible that there can be any serious error in it.

On Electrolytic Corrosion of Gas and Water Mains at Glasgow.

Mr. Chamen has made a report to the Gas and Water Departments of the Glasgow Corporation on prevention of electrolysis of the gas and water mains along the Springburn electric tramway route. Mr. Chamen found the electrical resistance of the steel rails to be about ten times that of copper, or in actual figures the resistance of 42 feet of rail is ·0003575 of an ohm. The sectional area of the rail is 10 inches. The resistance of the copper bonds, including the points of junction or contact with the rails, measured with two bonds in parallel, as they are actually being laid, averages ·000066 of an ohm. The length of the line from Springburn to Mitchell Street is about 13,400 feet. With 20 cars running on this route taking each an average current of 25 amperes, Mr. Chamen estimates that the return current in the section of the line nearest the power station will be 400 amperes. The greatest fall of potential between one terminus and the power station he estimates at 5·56 volts. This is well within the Board of Trade limit of 7 volts, and the tramway department do not, therefore, intend to put in return feeders. Mr. Chamen thinks, that with good bonding of the rails, there will be no fear whatever of electrolysis of gas or water mains. We doubt whether, under all conditions, this decision would be safe. Though the Board of Trade limit of 7 volts may nowhere be exceeded, the steepness of the potential gradient at some point along the line may be such as to imply a much greater total P.D. than 7 volts. For instance, in this case the return current of 400 amperes in the home section of the line implies a P.D. of more than 11 volts. With a return current of 400 amperes, as much as 100 to 200 amperes may flow through gas and water pipes situated in the neighbourhood of the line. A current of 100 amperes flowing through even a small section of a pipe system should not, we think, be regarded by the gas and water departments of the Glasgow Corporation with equanimity. If the nature of the soil is favourable very little harm may be done for many years, but, on the other hand, if the conditions are unfavourable the gas and water pipes may be rapidly corroded at joints, or at the place of exit of the current. The use of the insulated return feeder, with supplementary E.M.F., which has already been so successfully applied, would obviate all these risks, and considering only the data given in Mr. Chamen's report, we are somewhat surprised to find that he is of opinion that no return feeder is necessary.

An Electrical Gear for Motor Cars.

The *Western Electrician* of Chicago, of May 14th, published an account of a proposal by William Morrison, "the Chicago inventor," for driving motor cars and similar purposes, which is interesting and suggestive. The prime motor, a 4 H.P. gasoline or oil engine, drives directly, and at a constant speed, the field magnet system of a small 4-pole dynamo built in a circular form, and enclosed in a cylindrical case of gun-metal. The armature of the dynamo is connected to the driving gear of the vehicle. Thus the field magnet system and the brushes revolve at a constant speed, 600 revolutions per minute, while the armature revolves at a speed proportional to that at which the carriage is travelling, and in the same sense as the field magnets. Access is obtained to the dynamo circuit by contact rings and brushes, so that regulating resistances can be inserted. The only connection between the engine and the wheels of the carriage is the action between the field magnets and the armature, producing a torque on the axis of the latter; and this torque depends partly on the excess of the speed of the field magnets over that of the armature, and partly on the resistance inserted in the dynamo circuit. When the carriage is at rest, or just starting, so that the armature is at rest, the difference in speed between the field magnets and the armature has its greatest possible value, and the arrangement is then most favourable for producing a large starting torque, while the torque is under complete control at all speeds by means of a rheostat in the dynamo circuit. The speed of the oil engine is maintained nearly constant by means of a governor regulating the admission of oil. So far as it is possible to form an opinion of such an arrangement without practical experience of it, the principle of action greatly commends itself. The insertion of an electrical link between the prime mover and the wheels of a motor car, giving flexibility and simplicity of regulation at the expense of a certain loss of efficiency is the idea of the Heilmann locomotive, but Mr. Morrison's arrangement is by far the simpler and more ingenious of the two, and appears to be well suited to its object. No system of mechanical gears for different speeds seems comparable to it in simplicity, while it allows an engine running constantly at full speed to be thrown into and out of gear with the carriage without shock or jerk of any kind, and without any movement of mechanical parts beyond those of the switch required to break or make the dynamo circuit. No description is given of the connection of the dynamo armature to the wheels of the carriage, but evidently some reversing gear is required. The article in the *Western Electrician* is illustrated, and shows the construction of the dynamo clearly.

Cheating the Cabbages.

Readers of the *Westminster Budget* may remember an article bearing this title which appeared a short time ago, in which an experiment in plant growing under the influence of electricity rays was popularly if not very accurately described. There is no doubt that in America, France, Russia, and other countries, much more attention has been given to the investigation of the effects of electricity on plant culture than in our own country, and though many inconsequent experiments have been carried out and made much of, our knowledge of the subject is certainly the richer for them. At the present moment an important experiment is being carried out in Finland by Prof. Lemstrom, of the University of Helsingfors, with a view to determining the influence of atmospheric electricity upon plant life. Prof. Bailey, of Cornell University, is, we understand, advising with Prof. Lemstrom in this investigation, which, we may say, has been suggested by the observations that in northern regions vegetation is very rapid, and this rapidity may be determined by atmospheric electricity to which it is contended the aurora borealis is due. Although in this country we have not paid much attention to the subject, it has recently been proposed to utilise the Cabot Tower, which is in course of erection on Brandon Hill, Bristol. The land around consists of about 20 acres, is uncultivated, and appears to be well situated for the purpose of experiments. The proposition is to collect atmospheric electricity, and to pass it into certain trial gardens in which plants shall be grown. For this purpose instead of fitting the lightning rod of the Tower with a single point, it is proposed to give it a crown of points. It is conceivable that by this method the supplies of electricity, if we may use such an expression, existing in the atmosphere, could be tapped and conducted by means of wires into small plots of ground, where they would end in earth plates. Dr. E. M. Cook, of the Clifton Laboratory, Berkeley Square, has offered to give his services in carrying out a proper scheme of experiments and to make the necessary observations. The cost of these experiments would be very slight, and it is certainly to be hoped that the good citizens of Bristol will be enterprising enough to accept Dr. Cook's offer. Very little accurate knowledge has been obtained concerning the action of electricity upon vegetation, and it seems to us that here is an opportunity for increasing it.

AN EXHIBIT OF THE MOORE VACUUM TUBE LIGHTING.

We have more than once referred to the ingenious system of vacuum tube lighting invented by Mr. D. McFarlan Moore. Mr. Moore's energy and perseverance in overcoming the practical difficulties connected with this new departure in electric lighting has evidently been rewarded by a considerable amount of success, if we are to judge from the unique exhibit at the New York Electrical Exhibition, of which we give an illustration.

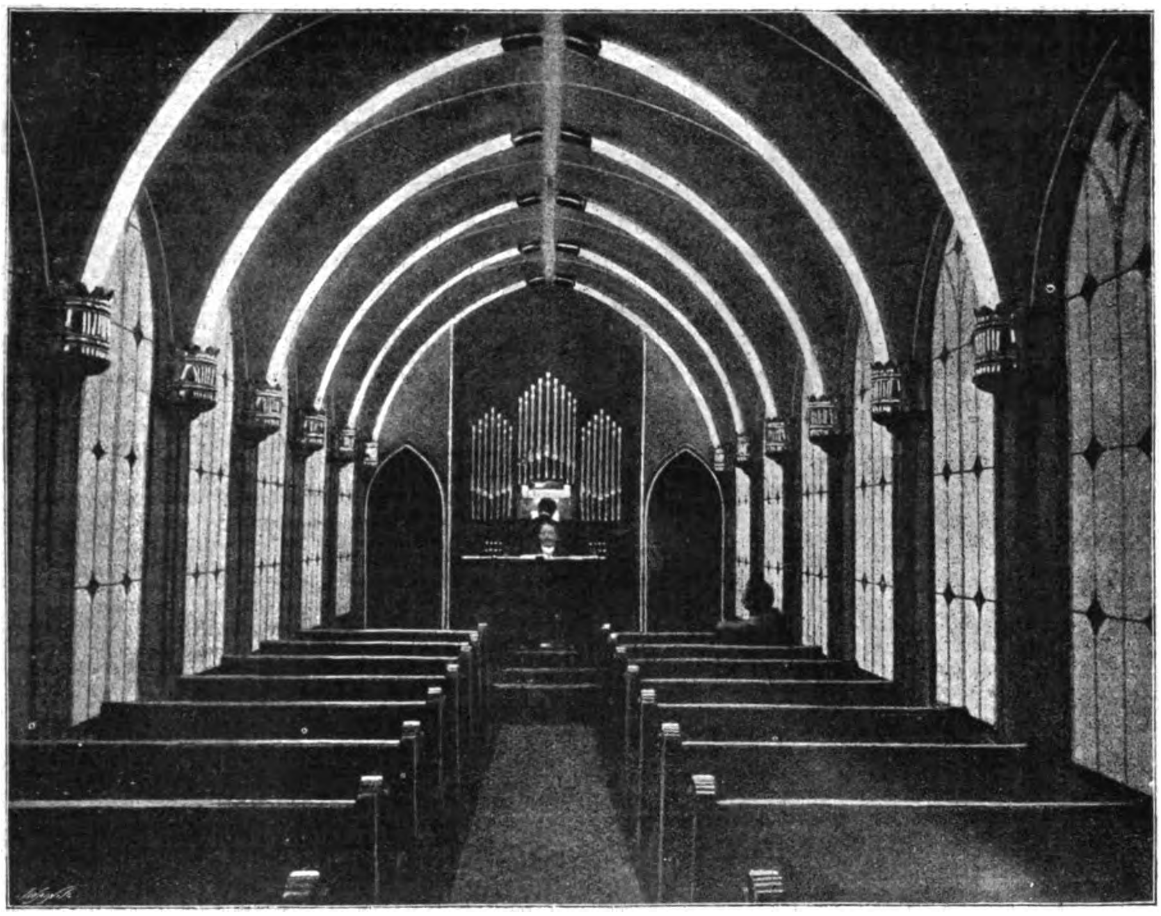
Mr. Moore has erected in the Exhibition a model chapel, complete in every detail, in which he shows to perfection the manner in which vacuum tube illumination can be carried out in practice. The front doors are open, and above their arches shine forth in vacuum tube letters the words: "Moore Vacuum Tube Chapel." The vaulted roof is ribbed with veritable arches of light consisting of long curved tubes of glass about 2 inches in diameter, and glowing their entire

It will be remembered that one of the salient points in Mr. Moore's system is the breaking of the current in a vacuum. This he accomplishes by means of a beautifully constructed rotator. Surrounding the rotator proper, which is of glass, 3 inches in diameter, and a foot long, is a Gramme ring, with its highly polished brass mountings, the whole constituting a beautiful piece of practical apparatus.

This apparatus just described is all that is necessary where multiphase currents are available; but in the exhibit the lower compartment of the cabinet contains a small rotary transformer.

According to Mr. Moore, the system, at its present stage of development, has an efficiency about equal to incandescent lighting; but the inventor looks for better results with the improvement of the tubes.

Besides the rotary vacuum break, Mr. Moore has got into commercial shape a vibratory vacuum break. This apparatus will be extensively used for advertising purposes. It can be used either on direct current circuits or alternate current circuits.



length with a pure white light. The tube arches spring from pilasters, each capped with a highly-polished specially-designed brass fixture, which may be seen in the figure. At the apex of the chapel ceiling where the tube arches meet, they are joined by a highly-polished decorated brass cylinder bent at its centre. The fixtures supporting the longitudinal tubes at the apex of the ceiling are also seen in the figure.

The church is wired with the Moore three-wire system of vacuum tube lighting; that is, all of the tubes—10 arch and 3 ridge tubes—are connected in parallel between three wires. The common or positive wire extends along the ridge, while each of the two negative wires extends horizontally along the side of the chapel back of the side fixtures, which rest on top of the pilaster caps. The three wires enter the top of a polished cabinet 2 feet by 2 feet 4 inches, which contains all the lighting apparatus, and is situated on one side of the entrance passageway. There also enters this cabinet at the top the three wires connecting with the street service of the Edison Electric Illuminating Company.

There are also many other applications for this system of lighting. For example, the colour of the light, even to the most delicate shades, can be changed simply by changing the degree of vacuum of the tubes, making it the ideal light for special decorative lighting. Another large field is in connection with photography—for photographers have long been longing for a light which could be regulated to a nicety, and thereby give uniform results. At the Electrical Exhibition in 1896, Mr. Moore took instantaneous portraits by his light.

It has long been a matter of expectation as to when and by whom vacuum tube lighting apparatus would first be placed on the market, and the fact that Mr. Moore is now taking orders is extremely interesting, since it is the beginning of a new departure in electrical work, which is destined, without doubt, to have a wide application.

The above account of Mr. Moore's recent achievements in vacuum tube lighting is abstracted from the *Electrical Engineer*, N.Y.

A SHORT METHOD FOR DETERMINING TRANSFORMER EFFICIENCY.*

By FREDERICK BEDELL.

That the common method for calculating transformer efficiency is laborious, and liable to error on account of long multiplications and divisions, has been pointed out by Mr. S. E. Johannesen in the *Electrical World*, p. 588, May 14th, 1898. He suggests a method which reduces somewhat the labour and liability to error; but his formula obtains the efficiency from the ratio of two quantities which differ from each other by only a few per cent., and consequently for accuracy each of these quantities must be very accurate and the long division carefully performed. Evidently, if instead of determining the per cent. efficiency direct we do so by determining the per cent. loss and subtracting from 100, the same degree of accuracy in the work will give greater accuracy in the result, and this may be done with less labour.

Let W represent the rated output in watts; let H denote the watts core loss and C the watts copper loss at full load. Let h_2 denote the core loss as per cent. of rated output W; that is, $h_2 = 100$ H/W. Let c_2 denote the full load copper loss as per cent. of rated output W; that is, $c_2 = 100$ C/W. (The subscrip 2 denotes that per cents. are referred to secondary output rather than to primary input.) Thus in a 2-kw. transformer W = 2,000. If the core loss is H = 30 watts the per cent. core loss is $h_2 = 1·5$. If the copper loss is C = 48 watts the per cent. copper loss is $c_2 = 2·4$.

Let g denote the fraction of full load, as $\frac{3}{4}$, $\frac{1}{2}$, &c. Obviously the per cent. copper loss varies directly as g, being $g\,c_2$ at any load. Thus at one-half load the per cent. copper loss is $\frac{1}{2}\,c_2$. (In watts, the copper loss at half load is one-quarter copper loss at full load.) The core loss in watts being constant, the per cent. core loss is greater as the load is less, being h_2/g at any load. Accordingly at any load g the total loss (t) as per cent. of secondary output is

$$t = g\,c_2 + h_2/g.$$

The total loss as per cent. of primary input is $t - t_2/100$. This must be subtracted from 100 to give the efficiency. Hence

$$\text{Efficiency} = 100 + \frac{t^2}{100} - t$$

To compute the efficiency accurately to four places, it is only necessary to compute t to three places and t^2 to two places. This may be quickly and accurately done by means of the following table:

EFFICIENCY COMPUTATION TABLE.

c_2 = ... = per cent. full load copper loss } as per cent of rated output.
h_2 = ... = per cent. core loss

Fraction of load.	Losses as per cent. of output. Copper.	Core.	Total, t.	$\frac{t^2}{100}$	Efficiency.
$\frac{5}{4}$	$\frac{5}{4}$ c_2 = ...	$\frac{4}{5}$ h_2 = ...	...	...	...
1	c_2 = ...	h_2 = ...	...	...	...
$\frac{3}{4}$	$\frac{3}{4}$ c_2 = ...	$\frac{4}{3}$ h_2 = ...	...	...	...
$\frac{1}{2}$	$\frac{1}{2}$ c_2 = ...	2 h_2 = ...	...	...	...
$\frac{1}{4}$	$\frac{1}{4}$ c_2 = ...	4 h_2 = ...	...	...	...
$\frac{1}{10}$	$\frac{1}{10}$ c_2 = ...	10 h_2 = ...	...	...	...

$$\text{Efficiency} = 100 + \frac{t^2}{100} - t.$$

The all-day efficiency, if the transformer is x hours on full load each day and on no load the remainder of the time, is

$$\text{all-day efficiency} = \frac{100}{100 + c_2 + (24 \div x)\,h_2}.$$

If the transformer is five hours on full load and 19 hours on no load, the all-day efficiency is

$$\text{all-day efficiency} = \frac{100}{100 + c_2 + 4·8\,h_2}.$$

* *Electrical World*, New York.

The facility with which these computations can be made may be seen from the following example:

EXAMPLE.

2-kw. transformer. Copper loss = 48 watts.
Core loss = 30 watts.

EFFICIENCY COMPUTATION TABLE.

c_2 = 2·4 = per cent. full load copper loss } as per cent. of rated output.
h_2 = 1·5 = per cent. core loss

Fraction of load.	Losses as per cent. of output. Copper.	Core.	Total, t.	$\frac{t^2}{100}$	Efficiency.
$\frac{5}{4}$	$\frac{5}{4}$ c_2 = 3·0	$\frac{4}{5}$ h_2 = 1·2	4·2	·18	95·98
1	c_2 = 2·4	h_2 = 1·5	3·9	·15	96·25
$\frac{3}{4}$	$\frac{3}{4}$ c_2 = 1·8	$\frac{4}{3}$ h_2 = 2·0	3·8	·14	96·34
$\frac{1}{2}$	$\frac{1}{2}$ c_2 = 1·2	2 h_2 = 3·0	4·2	·18	95·98
$\frac{1}{4}$	$\frac{1}{4}$ c_2 = ·6	4 h_2 = 6·	6·6	·44	93·84
$\frac{1}{10}$	$\frac{1}{10}$ c_2 = ·24	10 h_2 = 15·	15·24	2·32	87·08

$$\text{Efficiency} = 100 + \frac{t^2}{100} - t.$$

$$\text{All-day efficiency} = \frac{100}{100 + c_2 + 4·8\,h_2} = 91·24.$$

FURTHER BOARD OF TRADE REGULATIONS.

"Coming events cast their shadows before," and in this connection No 5 of the Minutes of the Special Committee on Electrical Energy is particularly interesting, as it contains the examination of Major Cardew on question 957, respecting danger to employés.

With modest hesitation, and only after considerable coaxing, Major Cardew admitted that he had a set of draft regulations for the protection of employés, but he said:—"I am hardly prepared to hand these regulations in; it is some years since I drew them out, and they may not touch every point which has turned up with the experience we have to-day." Nevertheless, they were handed in and, as will be seen in the "definitions," although they may have been originally sketched out several years ago, they have evidently been carefully kept and brought up to date. The title is as follows:—

"Regulations for the protection of employés in electrical supply works and other places wherein electrical energy is generated, regulated, transformed, or connected."

Amongst the "definitions" is to be found that of "high pressure supply," and is the same as that given in the regulations for the safety of the public, viz., anything exceeding 500 volts continuous, or 250 volts alternating.

Clause No. 1.—Provides that all metal work, not forming, or intended to form part of a circuit, whether structural or otherwise, whether in the generating station or sub-station, shall be efficiently connected to earth and to each other; luckily, nails, screws, or small fittings fixed so as to be in contact with dry wood or other non-conducting substance only, are excepted; but as the roof trusses, ties, &c., are not mentioned, we presume they are included as well as the firing irons and coal bunker doors!

No. 2 requires all high-pressure conductors to be completely enclosed in a tube of highly insulating material properly protected, or in earthed metal casing—this to be done as far as is consistent with the intended use of the conductor. Concentric mains with earthed outer are exempted.

No. 3.—Where it is not possible to entirely enclose such conductors, this clause provides that they shall be properly guarded, so as to prevent accidental contact, and shall also be conspicuously marked as dangerous by being labelled or painted red, and no such conductors shall be fixed within 3 feet of a doorway or other access to the generating station or sub-station. In the event of these rules being adopted and being retrospective, this clause will necessitate increasing the dimensions of a large number of sub-stations, and so abolishing what are now little better than man traps.

No. 4 requires an insulated floor or platform around switchboards, &c., and is a reasonable and proper precaution; but to so arrange the floor or platform that the attendant, when standing upon it, cannot possibly make accidental contact with earth, is a more difficult matter, and in some cases practically impossible.

No. 5 deals with switchboards, and states that they must be formed of highly insulating and incombustible material. We presume this refers to the bases of the switches or facing of the board, and not to the frame upon which they are erected, and is in this case a reasonable requirement. Connections must be made in front of the board, or, if taken behind a passage, at least 4 feet wide must be left, and the doors leading thereto must be kept locked, the key being in the charge of the chief engineer or other responsible person. The next paragraph is as follows:—"All leads and connections between which any difference of electrical potential greater than 5 (five) volts may exist must be easily distinguishable by position, colour, or other distinctive mark." We have tried to imagine what this is all about, but, in the absence of any explanation, we can only presume that it has something to do with fire risk, and refers to low tension stations. The last paragraph of this clause requires that adequate means shall be provided to enable an employé to ascertain when all electrical pressure has been removed from all metal he may be required to examine, clean, or alter. Very good.

No. 6. *Instruments.*—This clause will, we venture to say, raise some opposition on the part of station engineers, and is, to put it mildly, absurd!

"All instruments used, or intended (!) to be used, for measuring or indicating electric energy, current, or pressure, within any generating station or sub-station, shall be of suitable pattern and construction *and accurate in their readings within an error of 2½ per cent. at any point of their range*, in terms of the electrical standards deposited at the Board of Trade Standardising Laboratory; *and such accuracy must be constantly maintained.*" (The italics are ours.) This is simply Governmental regulation gone mad! and if enforced, would probably result in the scrapping of 99 per cent. of all the station switchboard instruments in existence. What on earth can be the object of such a regulation, and how can it possibly affect the safety of the staff either one way or the other! As we have said, the thing is absurd and could not be seriously entertained by anybody with reasonable intelligence, and after thinking the matter carefully over. It must be always remembered that these draft regulations are avowedly intended to protect the lives of the staff, and although our condemnation of the last regulation is strong, we think it quite justified until it can be shown that an error of, say, 3 per cent. in the reading of an ammeter, is going to jeopardise the lives and safety of anybody; even an error of 20 per cent. in a voltmeter could not do so, the idea is sheer nonsense. Surely any serious error in indicating or recording instruments would be corrected by the station engineer without any regulations; but, in any case, we fail to see in what manner it concerns the Board of Trade.

After the momentary mental aberration shown in the drafting of the last clause, it is with considerable satisfaction that we note *Regulation* 7, which provides that all generating and sub-stations shall be adequately illuminated, especially where attention is required to any high tension machinery, apparatus, or instruments. Not more than 50 per cent. of the total artificial illumination shall be supplied by the running machinery in the station, or from the mains, in case of sub-stations. This is very good indeed, so far as it goes, but the spirit of the clause, although obvious, could be evaded by lighting the works from storage batteries or similar source, quite independent of the running plant. Far better that the regulation should provide that the illumination be divided into two parts, each being supplied from separate and independent sources, so that in the event of the temporary failure of one part the station would not be left in darkness. As regards sub-stations, the provision of candles and matches as required in the regulation would suffice in addition to electric lighting from the mains.

No. 8 requires that when work other than switching, &c., is being executed in sub-stations, all high pressure mains and plant shall be discharged of electrical pressure or efficiently screened. Perfectly right.

No. 9 requires that rubber gloves shall be provided and kept in good condition; this is obviously necessary, and we should hope universally adopted.

No. 10 provides that printed instructions for dealing with persons in case of electric shock shall be conspicuously exhibited in the station, which, we believe, is now the general rule.

No. 11, and last, should be unnecessary, and we think would somewhat complicate the arrangement of shifts, while it would undoubtedly meet with strong opposition from those in whose interest the regulation is drafted. We give it in full.

"No employé in any generating station or sub-station shall be required to remain on any duty connected with the regulation of high pressure supply for more than four hours consecutively, or for more than eight hours in any day; and no employé shall be allowed to take over such duty until he has been inspected by an engineer or other competent official as to his fitness to undertake such duty."

As the regulation stands, a switchman or electrician may be required to work four hours, say, from 8 p.m. to 12 midnight, to go off duty until 4 a.m., and then to resume duty until 8 a.m. Without doubt he would much rather work eight hours, and then go off for 16 hours, as is now usual, and we do not think "the engineer, or other competent official," would care to become a sort of medical officer.

Taking the regulations as a whole, they are, with the exceptions noted, very reasonable; but they seem to be somewhat familiar, and we believe several of them were suggested by the committee appointed by the Home Office, whose draft regulations, by the way, seem to have been forgotten. The question is whether such regulations, dealing with the staff, should not be left to the Home Office; but in any case two sets are not required.

The report of the Select Committee on Electrical Energy ignores these rules altogether, and they must be looked for in a special Bill, which will probably be promoted by the Board of Trade, as the outcome of the inquiry.

ELECTRIC TRACTION.

The paper presented to the Municipal Electrical Association by Mr. R. C. Quin can hardly be said to contribute anything new to the common stock of knowledge on electric traction.

We were unaware that there was any considerable difference of opinion as to whether the rails should be 48 lbs. per yard or 92 lbs. per yard when electric tramcars are used. Considering the greater weight of electric tramcars, the maintenance of the bonding and the joints, there can be no doubt but that rails of at least 90 lbs. per yard are best suited for electric traction under ordinary municipal conditions.

In dealing with the subject of rails, we should have appreciated a discussion on the present rules of the Board of Trade limiting the width of the groove. In other countries a wider groove has been satisfactorily used, and better wear of the car wheels realised.

The mechanical construction of the rail joint is a matter that will stand a great deal of discussion, and traction engineers the world over seem undecided as to the best form of rail joint, this being the weakest part in electric permanent way construction.

The electric welding of the joints has not been entirely satisfactory. The nearest approach to a satisfactory rail joint is the Falk joint, and it does not seem improbable that a cast joint of this type will, sooner or later, come into general use in England. The advantages of a perfect rail joint are two-fold; first, that the mechanical construction becomes perfect, and secondly, the bond, no matter of what type, will be found more durable, on account of the greater rigidity of the joint.

The explanation of the type of rail joint used at Hamburg is not clear. We judge, however, it would be objected to by many traction engineers, since from what we gather of the description, the joint would be difficult to handle where rails have to be cut into unequal lengths.

We are unable to understand Mr. Quin's reasoning as to generators and fly-wheels. That there is considerable inertia in the car there can be no doubt, but this inertia is to be overcome by the prime mover. In the case of engines, the available force to overcome the inertia is the force exerted by the steam against the piston and the fly-wheel effect. If the steam cylinders are given sufficient capacity for doing the maximum that may occur by several cars starting at once, then they must be excessively large compared with the average load on the engine, which in traction work would not ordinarily be much beyond one-third of the maximum work to be done momentarily. Obviously, then, the only way to economically get the force required for momentarily overloading is by means of heavy fly-wheels. This agrees with practical experience, since engines have frequently fail-d to be satisfactory for electric traction until they have been equipped with heavier fly-wheels, and with heavy fly-wheels practice has fully demonstrated that the cylinders may be smaller, and consequently an economic gain under average working.

We do not understand why uniform E.M.F. in the line is not conducive to a uniform speed of the tramcars. Certainly the speed of an electric motor exerting a given horizontal effort varies directly with the E.M.F. at its terminals. There can be no doubt that in a system having practically constant voltage, the consumption of energy by the cars will be less than one having a varying voltage.

Further, constancy in voltage is important to secure good lighting of the cars in the night time. It is a most disagreeable sensation to see the lights go down when the cars start.

There has been much discussion as to the comparative values for quick and slow speed engines for traction purposes. Undoubtedly, in smaller sizes, the moderately quick speed engine has decided advantages as to cost over the Corliss or slow speed engine, but in the case of large machines there can be no doubt that the slow speed machinery will be found more efficient and more economical to maintain. That quick speed engines have been built beyond a proper size is sufficiently illustrated by a recent test on most approved high speed engines, and in which a 700 H.P. machine was found to have a mechanical efficiency of less than 85 per cent., whereas a Corliss engine of the same output, and with 90 or 100 revolutions, would have had a mechanical efficiency of 92 per cent. The best records of steam consumption so far published have been accomplished by slow speed engines, having very moderate piston speed.

In the discussion of motors there remains much to be said as to rating. A leading American firm in electric traction gave the capacity of a motor in terms of the horizontal effort at a given number of miles per hour. The motor was supposed to give a corresponding output for two hours, no part heating more than 50° C. We think such a method of rating if standardised would be most convenient. Owing, however, to the methods not coming into general use, it has been abandoned by those who established it from commercial considerations. It seems the great desideratum in connection with traction motors is to get the widest possible range of load at high efficiency. More recently, advances have been made in this direction by lessening the fixed loss due to hysteresis and eddy currents in the armature core, the amount of iron has been diminished and the amount of saturation correspondingly increased. It has been found that under average load the core loss is much smaller than in the case of a non-saturated armature, the effect upon sparking by greatly increasing the magnetisation of the armature core has been favourable. Another practical advantage of importance is the diminishing of the weight of the armature, and consequently increasing the durability of the bearings, and making the armature much more easily handled in the case of repairs and renewals. Undoubtedly great improvements have been made in using machines with cut steel gears, enclosed from the dust, and running in oil. There has been, however, a tendency on the part of some manufacturers to cheapen the motor, by using too great a reduction in the gears. Considering the gears by themselves, the reduction should not be more than four and a half to one.

The matter of control seems to be pretty generally agreed upon. In municipal working, where the cars have to be started and stopped at frequent intervals, the series parallel control possesses great advantages. It becomes unimportant, however, when the stops are infrequent, and cars run over long distances. It might be inferred from the paper that the maximum traction effort was dependent upon the method of control, that is, whether it was a series parallel, or an ordinary rheostatic control. This, however, is not the case. The maximum effort that may be given by a motor is limited to its safe current carrying capacity. If two motors were started in parallel with the same starting effort, double the current would be taken, but the current through each motor would be the same as though they were operated in series.

Undoubtedly the suggestion of a ton mile is in the right direction, but there seems to be no finality in discussing the unit of motive power. Some companies prefer double bogie trucks, others prefer the use of extra long wheel bases, regardless of the curvature, while others properly advise limiting the wheel base according to the radii of the curves. Practical engineers seem to have been slow in finding out that an abnormal long wheel base is uneconomical in the consumption of current on the curves, and in the wearing of the rails and flanges of the wheels.

We are at a loss to understand why a trolley should be more liable to leave the line at section insulators than at any other part. A properly constructed section insulator should present exactly the same form of surface to the trolley wheel as to any other part of the line.

There remains much to say on the subject of guard wires. Preferably the guard wires should be placed alongside the telephone wires. Two guard wires properly placed with cross wires every 10 or 15 feet would catch any telephone wires before they had fallen any great distance. The placing of the guard wires above the trolley wire is objectionable in appearance, more or less ineffective, and has the disadvantage of being at some distance from the telephone and telegraph wires, so that when a wire falls upon the guard wire it has acquired sufficient energy, under the best circumstances, to make it a source of danger.

The rule given for bonding by Mr. Quin seems rather a radical one, in that it is specified that there should be 2½ inches of contact area in the head of the bond, regardless of the current which it has to carry. Having in view that the web of an ordinary rail is not more than ½ inch thick, this rule would be equivalent to saying that under all conditions the head of a bond should be something over 1½ inches in diameter. We doubt whether many engineers would be willing to put such a regulation into force. A more satisfactory way of dealing with the problem would be to specify the maximum current density, since this determines the drop in the contact, and the liability of deterioration.

It is stated that 20 per cent. should be allowed for loosening of the joints. Such a recommendation does not seem to be consistent, since if the bonds loosen at all there seems to come between the joint and the rail a film of oxide, so that the contact is completely destroyed. Considering, however, that the body of the bond is of much less conductivity than the rail, the drop in the rail should be calculated, and allowance should be made for the drop in the bonds themselves.

The discussion on conduits is somewhat limited. From the municipal point of view, where there is no "21 years' purchase" clause to be considered, it seems possible that conduits may find favour in England in the future, especially in those cities where gas and water pipes will not be generally interfered with. The advantages of the double insulated conduit system are, that the trouble of dealing with the Board of Trade as to volts drop in the earth return disappears, and there is gained the great advantage of an entirely insulated return circuit.

While there is a great difference in figures as to the cost of maintenance and depreciation of accumulators, and the extra cost of running an accumulator system over that of the overhead trolley system, there can be little doubt that such extra cost exists in most cases to a practically prohibitive extent. The difficulties to be overcome in accumulators are first, to lessen the cost of maintenance; second, to lessen the first cost; and third, to lessen the weight, since the excessive weight of an accumulator car is objectionable, either the track or the rolling stock considered.

Various methods of charge and discharge have their advocates, according to the type and weight of battery, but the ultimate commercial result seems to be about the same in all cases. While figures more or less satisfactory have been coming from the Continent, we have to bear in mind the most prominent case in England, one in which various companies in turn came forward, believing that they could show the required result; each in turn failed to make a commercial demonstration, and advanced the opinion that they could obtain the desired result had the conditions been different, and while we have no particular faith in accumulator traction at the present stage of development of the electrical accumulator, we would be interested to see under what conditions of electric traction each accumulator company would consider that it might make a commercial success of electrical traction with its own type of battery. In the case of overhead lines it frequently takes some two or three years to so perfect a system of operating that the works' cost may be reliably made out and reduced to a minimum. The figures, then, as to accumulator traction on the most favourable basis would be misleading unless extending over a period of years, since the cost of maintenance of an accumulator is far more uncertain than any feature connected with the trolley or conduit system of electric traction.

The conclusion reached by Mr. Quin seems to be the only one warrantable, and the only one that will be reached for some time to come.

PROPOSED STANDARD DIAGRAMS OF ELECTRICAL APPARATUS.

By Prof. ANDREW JAMIESON.

You were kind enough to send me a copy of the *Western Electrician* and of *Electricity*, both of America, containing reports of a committee of the Chicago Electrical Association for February, 1898, wherein it was stated—

"The time has arrived when the diagrammatic illustration of electrical apparatus should be reduced to an art. A uniform code should be established containing a diagram for each piece of apparatus, each diagram being at once simple and, so far as possible, suggestive of the particular piece of apparatus which it is designed to represent."

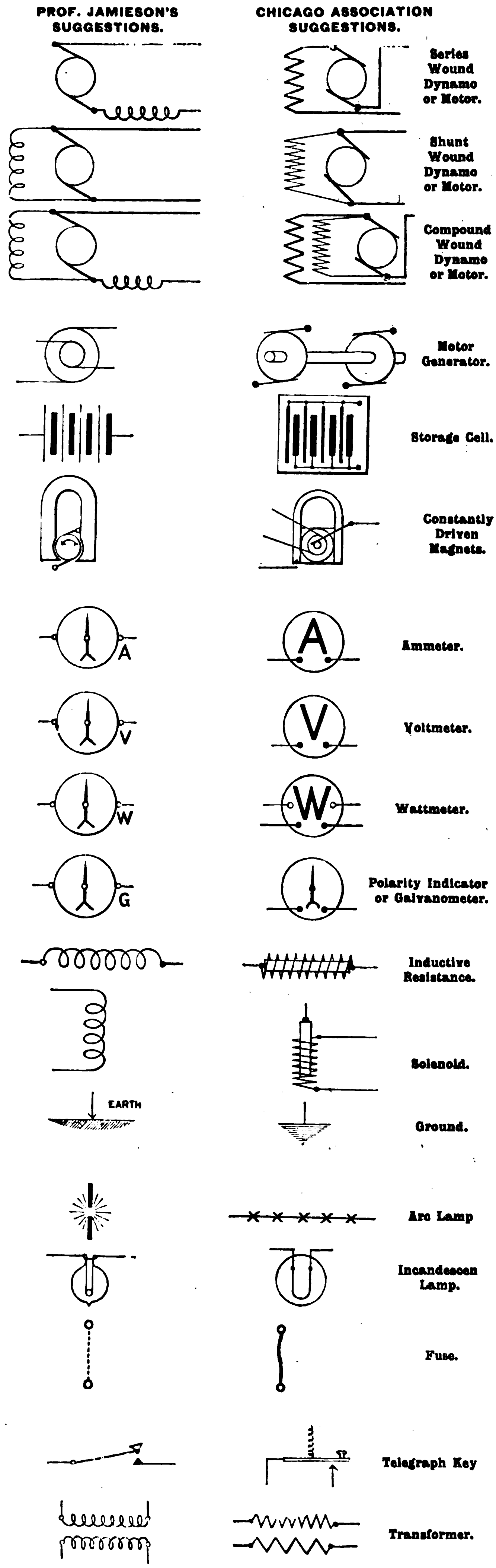
"A decided improvement has been made in this direction during the last few years, yet at the present time the system is far from perfect. Its development has suffered through a lack of unity among the various makers of these diagrams."

"The electrical divisions in the Patent Office have done more toward the development of this art than any other one agency. Often in a drawing accompanying an application for a patent, when a circle was used to represent a battery, and another circle exactly like it to represent a dynamo, and still another, differing in no respect, representing the ground, the drawing was necessarily confusing, and was followed with difficulty, if at all. In such cases it has not been infrequent for the Patent Office to suggest to the inventor or his attorney that he submit a new drawing, using a certain adopted form or diagram to represent his battery and another to represent his dynamo, and so on. In this way, and with the well-directed efforts of a number of patent attorneys, a great improvement has been made. These diagrams are to further assist in this direction."

Then follows some 55 diagrams of electrical apparatus with an explanation thereof. I have looked over these diagrams, and have read the remarks as published in the American papers, and herewith offer some suggestions for improvement in the proposed figures. I do so from having taken a special interest in this matter for a number of years, and from the fact that I read a paper in May, 1885, before the British Society of Telegraph Engineers on "Electrical Definitions, Nomenclature, and Notation," and when we had the benefit of M. Hospitalier's discussion thereon.*

Since then I have frequently advocated an International uniform system of definitions, symbols, and electrical diagrams, and have from year to year published in "Munro and Jamieson's Pocket Book," a few of the simpler figures.

* For M. Hospitalier's views, see "Communication faite à la Société Internationale des Electriciens, le Novembre, 1884," and for my paper see *Journal of Society of Telegraph Engineers*, p. 297, 1885, Vol. xv.



Consequently I have much pleasure in complimenting the energy and ability shown by the Chicago Electrical Association in going one step further than any other similar association has hitherto done. I have, therefore, taken the liberty of cutting out a few of their figures and pasting alongside thereof what appears to me to be improvements thereon.

In the first place, their figures for series, shunt, and compound wound dynamos or motors, have the objections of representing the field coils by zig-zag lines which have hitherto been universally adopted to represent non-inductive resistances, whereas the field coils of such dynamos are anything but non-inductive. Further, in the case of the series and compound wound dynamos or motors, their diagrams are unnecessarily complicated by drawing the leads from each brush with two right angles, whereas in the diagrams usually adopted by electricians, and shown in my figures to the left, the leads come straight away from the brushes.

Their figure for a motor generator is greatly simplified, and conveys the full meaning desired to be imparted by that which I have shown on the left.

With regard to the storage cell, I think all that is necessary to distinguish it from a primary battery are the letters S and B respectively, placed underneath the usually accepted sign of long thin and short thick parallel lines.

Granted that there are cases where it might be necessary to distinguish between the hand generators at subscriber's stations and the power generators at a central office, I don't see the slightest necessity of complicating the figure of a constantly driven magneto by inserting lines to represent the belt when a mere arrow on the armature spindle would be sufficient, as shown by my figure to the left of theirs.

With regard to ammeters, voltmeters, wattmeters, and polarity indicators, or galvanometers, I think you will agree with me that those shown on the left are much simpler, neater, and sufficiently distinguished from each other by the letters A, V, W and G.

In the representations of an inductive resistance and a solenoid, it will be noticed that the iron core is omitted in my suggestion as shown on the left. Surely, the fact of a wire being coiled in a spiral form is sufficient to convey the idea of the presence of a certain amount of self-induction ?

With respect to the next diagram, we do not in this country speak or write of a connection to the "*ground*," but to the *Earth*, and what could be more in harmony with the well-known and long-accepted telegraph symbol as shown on the left ?

There can be no objection to a number of crosses, as shown, to represent arc lamps in series, but for the indication of a single lamp I should recommend the diagram on the left.

My next three diagrams, as representing an incandescent lamp, a fuse, and a telegraph key, are also more in conformity with practice than the corresponding ones indicated by the Chicago Congress.

Finally, we have again to find fault with their use of the well-known symbol for non-inductive resistances in the representation of a transformer.

Other objections might have been found, but these are sufficient to show a diversity between American, British, and Continental practice, and hence the need for coming to an early state of uniformity.

STANDARD METHODS OF ENGINE TESTING.

More than ourselves, Americans have aimed at standardising everything, and they have fairly well agreed on a standard method of testing boilers and also pumping plants, but, so far, without including power engines, excepting locomotives. Mr. Geo. H. Barrus, a well-known expert, pleads for a standard method of engine testing in a paper to the American Society of Mechanical Engineers. It is desirable that something of this sort should be arranged with a view to bringing experimenters into line and expressing results on a system whereby one test can at once be compared with others, so far as comparison is possible. Such a system involves, of course, an adherence of the engine builders who should turn out no engines unless suitably provided with testing facilities.

The present writer was recently testing a plant by a first-class firm which was provided with means for taking the temperature of the boilers. The means of doing this had not been placed there by the makers but by the owners, and consisted of iron tubes screwed into the manhole cover and filled with mercury. The tubes did not, however, extend into the boiler as they should have done for at least 6 inches, in order to secure that the mercury should be practically as hot as the steam in the boiler. Between the steam gauge and the thermometer reading there was a very serious discrepancy which completely vitiated the readings, and they were discontinued. The fault was pointed out to the owners at the time. If tests are to be standardised and a given system or method should thus come to be a kind of official recognition, it will behove testing engineers to be exceedingly careful in even such small matters. In the case in point the rendering of false figures might have satisfied the owner, in that he could not have known their inaccuracy.

Of course these remarks apply more particularly to the testing of special inventions generally. A man who agrees to pay for a report which he has been hoping will be a good report on which to sell a patent, is disappointed when he gets an unfavourable report, and sometimes will snatch at the veriest straws of an excuse in order to avoid payment, and it is by no means always easy to bring clearly out in a Court of Law that a test has been fairly conducted, company promoters seeming to think that engineers are made for the purpose of reporting within lines to be laid down by the promoters, and which cannot give fair results. Having so far protested against standard methods, we may fairly consider Mr. Barrus's proposals.

As regards efficiency tests, the requirements are the weight of steam consumed and the power developed, and these two elements are fundamental, whatever the type of engine, and whatever the class of work performed. Tabular results may thus come under the above two heads, the one dealing with such data as apply to the working of steam in the cylinder, and the other with the data pertaining to the special duty of the engine. Thus the first section would contain all data of feed measurement, the steam consumed in jackets and reheaters, the quality of the steam, the weight of steam used by auxiliaries, and all data as to pressures, temperatures, and speed, with further figures to be obtained from the indicator cards. It would also present the efficiency as per the standard method.

In the second section the figures and data would be recorded under one of five classes, according as the engine came under the head of factory driving, pumping, locomotives (*a*) in shop, (*b*) on the road, electricity generation, marine engines.

Under the first section a simple expression of efficiency could be employed, based on the amount of heat used per gross or net horse-power per unit of time. Such a section would present the results of a coal test if such were made, in the shape of weight of coal burned and all the results deduced therefrom. Under the head of pumping the duty could be expressed in foot-pounds of duty per million heat-units. Freed from the friction of long mains, the pumping engine is a simple machine to measure, or even then the use of pressure gauges will enable resistance to be measured. Indeed, it may be recorded continuously. Locomotives would be reported as per the consumption of coal per dynamometer pull, a standard coal being employed.

Electric engines would be reported on the basis of quantity and intensity of current generated, the electrical H.P. generated, and the generator efficiency, and, on railway work, the current delivered to the motors; this, to us, however, seeming to be somewhat external to the steam engineer, as also does the item, in marine engine tests, of tonnage moved a given distance per power unit, a matter depending rather upon the build and fineness of the ship than on any quality of its engines.

As to obtaining the results, one of the most important is the work performed by the steam. Mr. Barrus rightly lays stress on the importance of the indicator, and in a system of standardising, he would have the calibration of springs, the operation of the instrument, the method of diagram measurement, all determined and placed on a uniform basis. Much depends on the placing of an indicator; there are no accepted methods of calibrating springs, and so on, to which we might add that of equal importance are brake strap details, the comparison of the brake and the indicator being essential to a determination of engine mechanism efficiency. Mr. Barrus desires to set the ball rolling, and suggests a committee of investigation to place the subject on a firm basis.

REVIEWS.

Automobiles sur Rails. By G. Dumont. Paris: Gautier-Villars et Fils.

This is a little book on tramway motors or automatic vehicles. It is a brief description of the various kinds of mechanical tramway motors. The importance of tramway traction is apparent when it is known that in Paris the annual journeys per inhabitant were 50 in 1856 and had mounted to 155 in 1891. One of the earliest motors was that constructed in 1838 or 1840 by Andraud and Tessié. It was furnished with a compressed air engine and carried eight persons. This worked successfully at Chaillot, but never came to a practical success.

In 1848 a steam motor carrying 60 passengers ran at Bristol. In 1859 the first steam trams were run in the United States. After that progress became more marked. At the present time there are seven types of tramway motor, viz, steam, compressed air, gas engines, carbonic acid, ammonia motors, cables and electricity.

The different systems are described, and a distinction is drawn between systems self-contained and systems in which power is transmitted from a centre. In the Rowan system of steam car the four-wheeled truck which carries the engine and boiler is placed under one end of a car of which the other end is carried by a single pair of wheels, the combination taking curves easily.

The motor truck can readily be detached from the rest of the vehicle and replaced by a similar truck, a convenience for repairs, &c. Various other steam systems are described, including that of Lamm et Francq, which has no furnace, but works from a store of highly heated water. The Mekarski and other air systems are briefly noted, also the Lührig system of gas power, of which we seem to hear so very little from its installation at Blackpool.

Carbonic acid motors are worked by carbonic acid compressed to 75 atmospheres. It is worked in cylinders of 0·10 in. diameter × 0·15 stroke (say 4 inches × 6 inches) with Corliss valves, and reheating by a gas flame is effected near the point of admission. The consumption of gas is given as 4½ kilos. per H.P. day of 24 hours, or 190 grms. per H.P. hour. Liquified gas costs 0·37 fr. per kilo. The cost is 0·07 fr. per H.P. hour.

Ammonia motors, first proposed in 1821 by Gurney, are worked by compressed anhydrous ammonia, which liquifies at about—34° C., or at 27° C., if under ten or a dozen atmospheres. The exhaust ammonia is taken up by water which absorbs 1,700 times its volume of ammonia, and the combination develops heat which is employed to heat the compressed ammonia. In 1896, there was put in service, on 22nd Street, New York, motors of 50 H.P. with 75 atmospheres pressure. The consumption of ammonia was 13·6 lbs. with single, and 27·2 lbs. with double gear, the expense being 0·03 fr. per car kilometre plus 0·044 fr. for fuel at the compressing station.

In the electric section various conduits are illustrated in a diagrammatic manner. We observe that the illustration of the Holroyd Smith conduit is placed upside down. Generally the illustrations are too small. A bibliography is appended. Largely historical, the book is by no means a full technical hand-book of tramway motors, but is useful in gathering between two covers a good deal of information as to what has been effected in the way of mechanical traction by other means than electricity as well as by the latter agent.

Radiography and the X Rays, in Practice and Theory, with Constructional and Manipulatory Details. By S. R. Bottone. Whittaker & Co., London. Price 3s.

Mr. Bottone's little volume will be of great use to amateurs and others commencing the practice of work with the Röntgen rays. Mr. Bottone himself has evidently done a good deal of work in this field, and has designed and constructed a good deal of the apparatus. Those who are not in a position to purchase induction coils and influence machines from the makers will here find instructions sufficient to enable them to make very decent instruments for themselves. Mr. Bottone is evidently an enthusiastic believer in the influence machine, and especially in the Wimshurst machine, as a source of current for exciting the Röntgen tube. In this respect we think his enthusiasm carries him too far. Unless influence machines of a very large size are used, the time of the exposure necessary to produce a good photograph is inconveniently long. For screen work the influence machine is superior, on account of the greater uniformity of its discharge. Moreover, Mr. Bottone would lead us to believe that the Wimshurst machine is superior to the Holtz for X ray work; but if he makes comparative exposures with a Wimshurst and Holtz of equally good construction, he will, we reckon, soon convince himself of his error.

When Mr. Bottone drops into theory we do not find him quite so reliable a guide as in the manipulatory department of his subject. He tells us (p. 17) that the undulations inside the Crookes tube have the property of attracting light bodies—a statement which would be distinctly misleading to the beginner, seeing that it is now well known that these effects are due to electric charges which accumulate on the walls of the tube. He also repeats an assertion, which though made some time ago by a great authority, has since been completely disproved, viz., that the electric conductivity of bodies such as ebonite and paraffin is increased by the action of the Röntgen rays. A serious blunder, which no doubt is due to an oversight, is made at p. 165, where it is asserted that by introducing self-induction coils into a circuit we shorten electric waves and quicken the oscillation: the very opposite is the case.

CORRESPONDENCE.

Visual Telegraphy; or, Seeing by Wire.

With reference to the correspondence on the above question, which has been prominently brought forward by the recent announcement of Herr Szczepanik's (of Vienna) invention, may I be allowed to say just a few words.

As to Herr Szczepanik's invention, I, like many others, doubt if it could be brought into successful application, as the speed at which the revolving mirrors would have to work would be impracticable, at least, without serious breakdowns; and besides, the apparatus as a whole looks very cumbersome in spite of its novelty. As to the practicability of "Visual Telegraphy; or, Seeing by Wire," I have strong hopes of its possibility of solution, but the difficulties in connection with it are chiefly mechanical. Selenium cells and revolving mirrors will have to be superseded by something more sensitive and constant in action. I have some ideas how I think it could be accomplished with, and which I drew up some time ago, and which I expect to be able to put into practical effect ere this time 12 months, and which, as I anticipate, if successful, would bring distant views into drawing rooms, offices, and palaces of varieties, &c. The receiver will be able to see the transmitter; the ladies in the parlour would be able to hear and see the acts and plays in the theatre, &c., without moving out of their doors; and subscribers will be able to ring themselves up in connection with any place of amusement. Notable scenes such as the late Mr. Gladstone's funeral or the Queen's Jubilee procession, will be able to be rung up into the large halls in the provincial towns for reproduction on large screens. As to what the fundamental principles of my ideas are, it would not be wise on my part to disclose them at present, as some wise individual may try to forestal me, but I am quite confident of success in the near future. There is one fact in connection with this subject, and that is, we know very little as yet of the actions and ways of light waves when conducted electrically. Some say that visual telegraphy is impossible, and some say it may be possible, but time and experiment alone will tell.

Thanking you for your kind insertion of this letter,

Geo. Smith.

June 20th.

ELECTRIC LIGHTING AND REFUSE DESTRUCTION IN BERMONDSEY.

Another Sanguine Report.

The Bermondsey Vestry on Monday evening considered a very lengthy report from Messrs. Kincaid, Waller & Manville, on the advisability of erecting a refuse destructor in conjunction with the projected electric light station. As the subject is of considerable interest at the moment, we make no apology for giving the following abstract of the report in question:—

Report of Consulting Engineers.

Referring to our report of June 26th, 1897, in which we pointed out that having consideration of the fact that at the time this report was made the cost of disposing of your house refuse was only about 1s. 2d. per ton, whilst the cost of burning it in a destructor would be more than 1s. 10d. per ton, and that under those circumstances we did not imagine that you would care to have your system of disposal of the ash-bin refuse changed, we have, in accordance with your instructions given us through Mr. Ryall, your vestry clerk, reconsidered the matter, after having consulted thereon with Mr. Sumner, the surveyor to the Vestry.

From the information that gentleman has been good enough to give us, it now appears that the cost of disposing of the ash-bin refuse is as much as 1s. 8d. per ton, and in your case, as in the case of all other London vestries, this cost of disposal of your ash-bin refuse by carting away or barging away, is likely to increase rather than to diminish.

It also appears that if a site in the vicinity of the Vestry Hall could be secured for the erection of a combined dust destructor and electric generating station, the heat produced by the combustion of the ash-bin refuse might be economically utilised for heating the baths' water, &c., and working the machinery used in the baths and washhouses, with a consequent additional saving that would be effected by the utilisation of this heat for the production of electrical power also.

We have reconsidered the matter on these new bases, and beg to append estimates, which, we trust, will put the financial position produced before you clearly.

The estimates submitted show (1) that the capital cost of additional works incidental to a six-cell destructor, to deal with 11,711 tons of refuse per annum, would amount to £10,000; (2) that the annual maintenance would be 2s. 4d. per ton of refuse, or a total of £1,359; and (3) the saving and revenue to £1,170 per annum, leaving a deficiency of £189. Against this would be set the present cost of £975 incurred in disposing of 11,711 tons of house and trade refuse at 1s. 8d. per ton, leaving an estimated net saving of £786 per annum.

After detailing the manner in which the above figures have been arrived at, the report proceeds:—

In the estimate of annual maintenance, we have taken the labour and superintendence on the basis of the destructor only being run six days in the week in place of seven, enabling you to work two shifts a day only. We have taken the cost of the removal of the clinker at 1s. 10d. per ton of clinker removed. (In this figure we do not quite agree with Mr. Sumner, who has estimated the cost of this, including both carting and tipping, at 2s. 8d. per ton). From our actual experience at Shoreditch, however, where the cost of removing clinker must be at least as great as in any other part of London, and where only 1s. 10d. per ton is paid for this service, we have no hesitation in expressing an opinion that you will be able to dispose of such of your clinker as you require to have removed for no greater charge than this. The amount of clinker is arrived at on the assumption that only 25 per cent. of the refuse burnt will be produced as clinker. At Shoreditch the percentage of clinker is about 30 per cent., but there can be little doubt that the refuse at Bermondsey is richer in combustible material than at Shoreditch, and we have therefore taken 25 per cent. as the residue. Of this 25 per cent., it is estimated by Mr. Sumner that one-third can be utilised for the purposes of the parish.

We, therefore, believe that this inclusive estimate of maintenance for the burning of refuse, amounting to about 2s. 4d. per ton, is one that can be worked to in practice.

The saving and revenue per annum takes the credit for the steam which may be utilised for the baths heating purposes, and also supplying power there, which at present consumes coal to the value of £431 19s. per annum. We have allowed in this estimate, as a debit to this item, the interest and sinking fund on £1,000, which sum it might be wise to spend in providing apparatus to enable the baths to be heated by the utilisation of the exhaust steam from the electric light engines, in place of using live steam from the boilers for this purpose; for you must bear in mind, that for all heating purposes, where the water is not required to be raised above boiling temperature, exhaust steam is practically as useful as live steam, leaving only live steam to be used for the actual boiling in the washing troughs. Credit is taken for one-third of the clinker produced at 2s. per ton. This price, Mr. Sumner estimates it will be worth for other parish purposes. There is a credit for 2,180 tons of combustible trade refuse which we have taken at 2s. 6d. per ton, but which is included in Mr. Sumner's figures at only 1s. 8d. per ton. Here, again, we feel sure, from our experience at Shoreditch, that at least 2s. 6d. per ton can be obtained for the burning of trade refuse on the average.

Then comes the estimate of coal saved in the electric generating station, which is calculated on the basis of the destructor running only 6 days per week, coal being used on Sunday. We have no hesitation in stating definitely that the 11,000 tons of refuse you have to burn will produce all the power required for the plant you are proposing to put down in the first instance in your station, as the proportional amount of power produced at Shoreditch per ton of refuse is greater than this, notwithstanding that probably their refuse has a smaller calorific value than that at Bermondsey.

Finally, you must bear in mind that during a great portion of the day the live steam produced by the dust destructor will not be utilised, as the electric generating station will then be producing but a small output, unless a day load is found in the shape of a supply of current for motive power purposes.

The financial statement shows you that under these estimates a net saving of £786 15s. 4d. per annum will probably be made on the combination of a dust destructor with the electric generating station and baths, which is so considerable an amount as to cover all contingencies and still leave a certainty of a considerable annual saving being made, whilst, on the other hand, you will be sure that the price of disposing of the refuse will remain a constant quantity year by year.

Mr. Cox, chairman of the Electric Lighting Committee, formally recommended that, in the event of the Bill being passed confirming the Vestry's provisional order, the report of Messrs. Kincaid, Waller and Manville should be adopted, and a refuse destructor erected with the electric lighting station. After some discussion the recommendation was unanimously agreed to.

LONDON COUNTY COUNCIL.

At the weekly meeting on Tuesday, the Council approved a loan of £2,950 to the Vestry of Islington for the purpose of acquiring the fee simple and subsidiary interest in six houses in order to enlarge the electric light station in Eden Grove.

Forthcoming Boiler Contract.

It was resolved, on the recommendation of the Main Drainage Committee, to invite tenders for the supply of four high-pressure Lancashire boilers to work at 150 lbs. pressure for the Western pumping station.

Lighting of Theatres.

The Theatres Committee reported that the requirements of the Council in regard to electric lighting arrangements have been carried out at the following places:—Adelphi Theatre, Strand; London Music Hall, 95 to 99, Shoreditch High Street; Royal Cambridge Music Hall, 136, Commercial Street, Whitechapel; Salle Erard, 18, Great Marlborough Street; and Standard Theatre, Shoreditch High Street.

New Central Station.

The Building Act Committee announced that they had conditionally approved the plans submitted with the application of Messrs. Kincaid, Waller and Manville on behalf of the South London Electric Supply Corporation, for the construction of a generating station and works on a site adjoining Bengeworth Road, Loughborough Junction, and authorised the erection of the generating station and works as shown upon the plans.

Electric Lighting Provisional Orders.

The Highways Committee, reporting upon the provisional orders considered during the 1898 session, said:—Of the 11 provisional orders applied for this session, the Board of Trade has granted only four, namely, those applied for by the Vestries of Bermondsey and St. Marylebone in respect of their respective parishes, and an order each to the Charing Cross and Strand Electricity Supply Corporation and the County of London and Brush Provincial Electric Lighting Company in respect of portions of the Holborn and St. Giles districts. The Board has adopted many of the amendments suggested on behalf of the Council; but as we have reported to the Council, has declined to insert the suggested clause for the protection of the Council's tramways. The limit of price in the companies' orders has been reduced to 7d. per unit, but in that of the Vestries the price is as in previous orders, 8d.; in the companies' orders the provision as to continuous current has been omitted, but it has been inserted in the Vestry orders, from which, moreover, the clause enabling the undertaking to be transferred to a company has been struck out. Two or three of the suggested amendments, which have not been adopted by the Board, we consider of some importance; and we are endeavouring to induce the Board to insert them, but the Council has obtained substantially the principal amendments for which it asked.

In a further report the Committee stated that the Board of Trade has intimated that with regard to the power of purchase by local authorities, it has not been the practice of the Board to vary the term of the years prescribed by Section 2 of the Electric Lighting Act, 1888, except in special cases, at the request of the local authorities and with the concurrence of the promoters, and that, as in the case of these orders, no request has been made by the local authorities concerned for a variation of the term, the Board is unable to concur with the suggestion that the term should be seven years; and that the Board proposes to take the necessary steps to secure the insertion in the No. 2 Order of the other amendments suggested by the Council.

ELECTRIC SUPPLY IN BULK.

Reporting on the recent conference with London local authorities on the telephone service and generating stations for the supply of electrical energy in various districts, the Highways Committee referred as follows to the latter question:—

"The object of the Central Electric Supply Company's Bill, deposited this session, is to enable the company to supply electrical energy in bulk to local authorities and companies authorised to supply in the areas defined in their respective orders under the Electric Lighting Acts, and for this purpose to acquire lands compulsorily and to erect and maintain generating stations thereon. Power is also sought to break up streets for the purpose of laying what may be termed trunk mains from the generating stations to the point at which the energy is to be distributed by the receiving local authority or company. Thus the streets under the jurisdiction of one or more local authorities may have to be disturbed in order to afford the supply in bulk to a local authority or company at some distance from the source of supply. This is shown clearly by clause 8 of the Bill which proposes that the company shall have power to break up streets and to lay electric lines and place boxes and apparatus for all purposes of electrical supply, and 'do all other acts which they (the company) may deem necessary for supplying electrical energy to any company, body, or person, authorised to generate or supply, or generating or supplying, such energy for any public or private purpose within the County of London, and may supply such energy accordingly.'"

"The Chelsea Electricity Supply Company's Bill is to empower the company to take lands in the parish for the erection of generating stations, for use in connection with the supply of electrical energy in the area under the company's order; and the Metropolitan Electric Supply Company's Bill has two main objects, viz—(a) to authorise the company to hold certain lands, recently acquired by the company, at Acton and Willesden for the erection of generating stations to supply districts included in the area of supply under the orders granted to the company; and (b) to authorise the company to lay down cables and other necessary apparatus from the generating station to the company's station at Amberley Road, in the parish of Paddington. The Bill provides, however (clause 9), that the consent of any local authority, through whose district it may be necessary to lay mains, shall be obtained before the mains are laid. The effect of the clause, as drawn, would appear to be to repeal the provisions of the company's orders which forbid supply beyond the areas defined therein.

"The proposals in these several Bills form a new departure; the policy hitherto pursued having been, in view of the ultimate purchase by the local authority of each undertaking authorised by an order granted to a company, to provide that the whole of the undertaking, including the generating station, should be within the area of supply."

The Committee then proceeded to refer to the appointment of the Parliamentary Committee and to its conclusions, and mentioned that they proposed to report to the Council again on the subject, in the meantime giving the text of the resolutions passed at the Conference of local authorities held last week.

BUSINESS NOTICES, &c.

Announcement.—Messrs. A. & W. Hopkins state that they have taken Mr. Montague H. Galsworthy in as partner in their fittings manufactory carried on at 7, Hill's place, Oxford Circus, W., and that the business will in future be carried on under the name of "The London Electrical Fittings Co.," and under the same management as at present. The accessories supply business will be carried on as heretofore, under the name of A. & W. Hopkins, at 30, Parliament Street, Westminster, S.W.

Annual Outing.—The Aberdeen Electricity Works' staff went for their annual outing to Benachie.

Arc Lighting.—Mr. G. Braulik, of Upper Thames Street, E.C., informs us that Messrs. Korting & Mathiesen now manufacture a continuous current arc lamp which burns three in series on 110 volts with resistance.

The Ariel Arc Lamp Syndicate, Limited.—In the Chancery Division of the High Court of Justice on Wednesday, June 22nd, Mr. Justice Byrne made a compulsory order winding up this company, on the petition of Mr. J. Jones and others.

Books Received.—"A Text-Book of Zoology," by H. G. Wells and A. M. Davies. Published by W. B. Clive, University Correspondence College Press, London. 6s. 6d.

"Electrical Testing for Telegraph Engineers." By J. Elton Young, M.I.E.E. *Electrician* Printing and Publishing Company, Limited, London. 10s. 6d.

The General Power Distributing Company's Bill.—A Select Committee of the House of Lords, presided over by the Earl of Northbrook, on Tuesday entered upon the consideration of the scheme of the General Power Distributing Company Bill, the object of which is to enable the company to supply electricity for lighting, traction, and other purposes to a district embracing an area of 2,000 square miles, including the towns of Sheffield, Rotherham, Lincoln, Gainsborough, Newark, Nottingham, Ilkeston, and Worksop. The central generating station is to be at Worksop, in the midst of a colliery district, and the promoters state that by the use of coal slack for generating purposes, which they will be able to procure at 2s. per ton, they will be able to produce electrical energy at an extremely cheap rate. In view of the large average demand which they hope to develop in the area of supply, they expect to be able to sell electricity at 1d. or 1½d. per unit, whereas the present charge in Notts, where the electric lighting undertaking is in the hands of the Corporation, is 4d., having been reduced from 6d. to 4d. since the Bill was introduced. The measure is opposed by a large number of local authorities, including the Town Councils of Sheffield and Nottingham, but it is supported by a numerous body of traders in the district. Over 70 petitions have been presented in its favour. The case was opened, says the *Times*, by Mr. Pember, Q.C., for the promoters, and among the witnesses called in support of the Bill were Mr. Bainbridge, M.P., Mr. Lupton, C.E., and a representative of the Nottingham Chamber of Commerce.

The Committee on Wednesday heard further evidence in support of the proposal. The Duke of Newcastle said that if the scheme were carried out he would employ electricity for the lighting of Clumber and for other purposes. The Duke admitted that the Corporation of Nottingham had lately put down mains to supply his estate in the city of Nottingham with electricity under an agreement, but he would prefer to have two strings to his bow, so that his tenants might have the advantage of a cheap supply. Mr. Thomas Bayley, M.P., also gave evidence in support of the scheme, which would benefit the mining and agricultural interests in the Chesterfield Division of Derbyshire.

Changes of Address.—The Wheeler Condenser and Engineering Company have found it necessary to extend their office accommodation, and have taken new premises at 171, Queen Victoria Street, E.C.

The Blake & Knowles Steam Pump Works, Limited, have found it necessary to remove from 117, Queen Victoria Street, to larger premises at 179, Queen Victoria Street.

Conduit Wiring.—The Simplex Steel Conduit Company, Limited, of Birmingham, who, as stated in our issue for May 27th, have published lists describing their "ideal" method of wiring for lighting and other electrical work, have sent us some samples of tubing, T junction bends, and elbows used in their system, which, upon examination, appear to be well made of light enamelled steel tubing. It is claimed that the Simplex conduit affords complete mechanical protection, and preserves the insulating property of the dielectric in a highly efficient state, enabling the circuits to be drawn in and out of the conduits with ease and freedom, and without possibility of abrasion. The process of enamelling renders the tubes and fittings very durable, impervious to rust and consequent depreciation, and is claimed to give them a perfectly smooth exterior and interior insulating coating. The accessories have been designed to meet the requirements of concealed and surface work. It is claimed that a wireman of average intelligence would find no difficulty in erection, as no screwed couplings are used, and consequently, no special tools are required. Mr. L. M. Waterhouse, A.I.E.E., is the company's engineer and manager.

Dividend.—Messrs. Schuckert & Co., of Nurembourg, is declaring a dividend of 14 per cent. for the past financial year.

Electric Cabs.—We understand that a contract has been given to the Gloucester Railway Carriage and Waggon Company, Limited, by the London Electrical Cab Company, Limited, of Lambeth, for the building of a number of their cabs.

Electric Lighting in Chili.—Die Electricitäts Gesellschaft Santiago-Chili is the title of a company which has just been formed in Berlin, with a capital of £1,200,000. The Allgemeine Electricitäts Gesellschaft and Messrs. Ludwig Löwe & Co. are interested in the new undertaking.

Electrical Progress in Milan.—Our Consul, in his annual report, remarks that although electric traction has not yet been applied to all the tramway lines in Milan, the first year's working under the new arrangement has resulted in a net profit for the municipality of £38,000, as compared with about £14,000 under the old system, and it seems probable that the current year will give even more satisfactory results. In the course of the next few months the Edison Company, which works the electric tramways on account of the municipality, will bring into Milan a force of nearly 10,000 H.P., obtained from the River Adda, at Paderno. Six turbines, each of 2,160 H.P., with a seventh as a reserve in case of accidents, will be employed for developing the water-power, and conveying it to the dynamos, which will be seven in number, and the electric current will be carried from Paderno to Milan, a distance of 20 miles across country, by means of overhead wires. These turbines are said to be the most powerful hitherto in use in Europe, and are being constructed by the local firm of Riva, Monneret & Co. It is estimated that the loss of power in transit will not exceed 9 per cent. Of the nearly 13,000 H.P. to be thus developed, 2,000 are already disposed of in the town of Monza. The remainder will be brought to Milan, and any surplus that may remain after providing for the public and private lighting of the city, and the working of the tramways, will be let for industrial purposes. In 1897 the Edison Company increased its capital from £360,000 to £540,000. It has just declared a dividend for last year of 6 per cent. The use of electricity, both for lighting and motive power purposes, is constantly extending, and there is consequently an ever-increasing demand for all kinds of electrical appliances. Some of these are now made in Italy, but by far the greater part come from Switzerland and Germany, two countries which appear to have made this industry, which has undoubtedly a splendid future before it, quite a speciality of their own, and they must find it a very profitable one. *British engineering firms, it is stated, do not seem to be making any effort to secure a share of this business in Italy.*

Exhibition.—At the Royal Agricultural show, which closes to-day at Birmingham, Messrs. John Fowler & Co. (Leeds), Limited, have been exhibiting a variety of agricultural traction engines, road locomotives, and other light railway plant, &c.

Messrs. Ruston, Proctor & Co., Limited, of Lincoln, are also exhibiting at Birmingham a number of prize steam engines and machines, including the Ruston oil engine.

Fire.—A fire of a very destructive character broke out at a quarter past one o'clock on Thursday morning last week, causing the destruction of 19 and 21, Heddon Street, Regent Street, W., the premises of Messrs. Davies, Kent & Stewart, manufacturers of electric light supplies, flexible wire, &c. From the first the fire spread rapidly, and Commander Wells, R.N., assisted by Supt. T. Smith, ordered a large force to the scene, and set 19 steamers to work. The firemen had to complain of short supply of water in the early minutes of the fire. A huge telephone derrick on the top of the burning building suddenly collapsed, and the mass of metal, weighing some 40 tons, crashed into the centre of the roadway, but, marvellously enough, no firemen were injured. As announced in another part of this issue, Messrs. Davies, Kent & Stewart have secured premises at 17, Berners Street, W., where all communications should be addressed.

Harvie & Co., Limited, v. Gavin.—In the Glasgow Court of Session on 17th inst., this appeal was heard and judgment given. It was an action raised in the Sheriff Court at Glasgow by Wm. Aloysius Gavin, proprietor of the *Register of Leading Marine Manufacturers*, 57, Gracechurch Street, London, against Wm. Harvie and Co., Limited, electric light engineers, and patent ship lamp manufacturers, 222, Broomielaw, Glasgow. The pursuer sued for £65 as fees due, at the rate of 12s. 6d. per week for 104 weeks, for the insertion of the defender's name in the *Register*. The defenders said that their name was not inserted in the *Register* upon their order; that a representative of the pursuers called upon them, and they agreed to the insertion being made provided no other firm appeared under the head of "Ship Lamps," and that the insertion of the word "Scottish," if inserted in the order before the word "firm," was inserted in breach of the agreement. The pursuers, in reply, said that the addition to the condition was made by arrangement with Mr. Harvie, and was read over by Mr. Harvie's manager before he signed it. Sheriff Substitute Guthrie gave decree for £61, to which the sum sued for had been restricted, and found the pursuers entitled to expenses. Their Lordships of the Second Division affirmed the decision of the Sheriff Substitute, with additional expenses.

List.—The Phaeton Electrical Company, Limited, of Watling Street, E.C., have issued Section No. 1 list, in which they illustrate and give prices of ordinary incandescent lamps, 16 different types of usual caps being shown. A variety of special lamps, such as etched, silvered, coloured, tubular, battery, miniature, Phaeton sun ray and surgical lamps, also improved Phaeton lamps without plaster of Paris, are all included in the list.

Municipal Electrical Association.—On Friday, the 10th inst., a party of the members of the above Association visited the works of the Incandescent Electric Lamp Company, Limited, and were shown the whole of the operations in the manufacture of the "Robertson" lamp.

The National Company for the Distribution of Electricity by Secondary Generators.—On Wednesday last week, before Mr. Justice Wright, sitting in the Companies' Winding-Up Court, Mr. Rowden mentioned this matter, which is a creditor's petition for winding up the company. The case had been twice before adjourned on the ground that the matters in dispute between the creditor and the company were the subject of litigation before Mr. Justice Sterling. The Chancery action had been set down for trial, and it was hoped would shortly be disposed of, and counsel now applied that the petition should be again adjourned and not dealt with until after the proceedings in the Chancery Division. Mr. Gore Brown opposed the application, and asked that the petition should be dismissed. His Lordship declined to grant any further adjournment, and dismissed the petition.

New Premises.—Mr. R. Needham is about to open premises in Stanley Street, Southport, as an electrical and general engineer.

Overhead Wires.—Mr. G. Stegman, an electrician, of 45, St. John's Hill, has been summoned at the South-West London Police Court at the instance of the Battersea Vestry for placing overhead wires across St. John's Hill, without providing sufficient supports, and without giving notice to the Vestry. Mr. Young, solicitor to the Vestry, stated that, according to the bye-laws, the wire should be supported at every 100 yards. Eventually it was decided to adjourn the case, it being stated that the defendant had agreed to submit plans to the Vestry.

Reynolds & Branson, Limited.—Messrs. Reynolds and Branson, of Leeds, manufacturers of electrical apparatus, have formed themselves into a private limited liability company under the above style. The present partners take the whole of the shares, and retain the direction of the business as formerly.

Ship Lighting.—A complete installation of the electric light has been made on the steamer *Ula*, the latest addition to the fine fleet of the British India Steam Navigation Company's line. The masthead and side lights are also electric, and in connection with these, the builders of the ship, Messrs. William Denny & Bros., of Dumbarton, have fitted a new device called the "Voltometre," which is for the purpose of seeing if the lights are burning properly. In the chart room is a case with three small openings in it. Each opening is provided with differently coloured glasses, the centre being frosted, whilst those to the right and left have green and red glasses respectively, these corresponding to the masthead and starboard and port side lights in colour. When these lights are burning the openings in the case in the chart room are illuminated by incandescent electric lights. If by any means either or all of the lights become extinguished this is at once perceptible in the chart room, the voltometre corresponding with the lights on the mast and sides of the vessel. An alarm bell also rings, and continues to ring until the lights are set right again. Under ordinary conditions it is very difficult to see whether the lights are burning properly, and the new invention, which has been, or is about to be patented, will probably be a very valuable one. This is the first ship on which it has been used. The inventors are Messrs. W. Denny & Bros.

The Swiss Electrical Trust.—The *Financial News* Geneva correspondent says that the great Swiss Electrical Trust, projected for some time past, has now been called into life with a capital of £1,000,000, £600,000 of which has been taken over by the Banque de Paris et des Pays Bas, and the remainder by the Union Financière. It is probable that not only Switzerland, but France, will be included in the field of its operations.

Webster v. the Cox Thermo-Electric Company, Limited.—In this case, which came before Mr. Justice Romer on Saturday (June 18th) on a motion for judgment in default of defence in a debenture-holder's action, his Lordship made the usual order in a debenture-holder's action, and directed the usual inquiries. Counsel stated that the company was incorporated in April, 1896, that the debentures were a series of £500 charged on the undertaking of the company, that no interest had been paid, and that the charge became enforcible on failure to pay interest for one month.

Workmen's Compensation.—In connection with the Workmen's Compensation Act, 1897, which comes into force on July 1st, and also in regard to the Employers' Liability Act of 1880, Messrs. Wallach Bros., of 57, Gracechurch Street, E.C., send us lists of various safety appliances and fittings which have been introduced by them from time to time for the prevention of accidents in factories, &c. The lists describe the "Evertrusty" patent gauge glass protector, described in these columns some time ago, improved automatic belt-lifting apparatus, and the "Evertrusty" nose, throat, and lung protector and respirator, the last mentioned being of particular importance in all factories where workers are likely to come in contact with lead, noxious gases, &c. This article, we understand, has been tested for some time with satisfactory results.

ELECTRIC LIGHTING NOTES.

Accrington.—The Corporation, who already possess electric lighting powers for the borough, recently granted the trustees of the New Jerusalem Church permission to obtain electricity from the local Co-operative Society until such time as the Corporation are in a position to supply it themselves. The installation, which was put in by Mr. Simpson, electrical engineer, of Hapton, was used for the first time on Sunday last.

Alloa.—The Burgh Commissioners have resolved to do nothing meantime regarding the proposal to light the streets by electricity. Baillie Arrol intends moving that the Commissioners apply for a provisional order to protect themselves.

Bedford.—Last week a Local Government Board inquiry was held *re* the Council's proposed loan for £5,400 for electric lighting extensions. The Town Clerk explained the need for the extensions, and the general details were described by the electrical engineer, Mr. Hope-Johnstone. It seems that up to the present time £49,000 has been borrowed for electric lighting purposes. Sanction had been given to borrow £58,650, and, therefore, the Corporation had still power to borrow a further sum of £6,950. The present loan was for the extension of the engine room, with the necessary foundation, transformers, extra testing instruments, mains for public lighting, standards for lighting the market places, &c. This was necessary on account of increased demand, and for the public lighting of the St. Cuthbert's Glebe Estate. The total number of lamps at present was 14,250 8-C.P., exclusive of public lighting, and this scheme included 65 additional lamps for the St. Cuthbert's Estate.

Blackpool.—From a "Blue Book" just issued by the borough treasurer of Blackpool, it appears that the income from the electric lighting undertaking during the last financial year was £14,229, made up as follows:—Public lighting, £3,457; current for tramway traction, £1,286; private lighting, £9,010; rental of meters,

&c., £279; rents and sundry receipts, £197. During the same period the expenditure was £8,080, namely:—Generating current, £5,521; distribution, £468; public lighting, £928; rents, rates, and taxes, £255; salaries, management, expenses, &c., £908. The gross profit was £6,149, which, less loan charges £4,734, left a net profit of £1,415, against an estimated profit of £1,300. The balance was carried to the credit of the general district rate account. In 1896-7 there was a net profit of £828, and in the year before £281, whilst the two first years' working was at a loss. The units generated last year were 903,558, against 575,904 in the preceding 12 months, this being an increase of nearly 57 per cent. There are now about 50 miles of electric lighting mains, and the capital outlay last year amounted to £16,085.

Bournemouth.—The Town Clerk is to write to the Board of Trade on the subject of the proposed appointment of an electric inspector. The Council has decided to reconstruct the electric call-bell system at the three fire stations, and £225 is to be borrowed for the purpose.

Distillery Lighting.—The Mortlach Distillery, Dufftown, is to be lighted by electricity, water-power available in the neighbourhood being utilised. 150 lamps will be fitted up. Messrs. P. O. Middleton & Co., of Aberdeen, will carry out the works.

Cheltenham.—H.M. Inspectors of the Education Department having recommended that the class rooms and dormitories occupied by the students of the Cheltenham Training Colleges be lighted by electricity, the governing body of the Training Colleges has decided on wiring up the college for masters situated in Swinton Road, Cheltenham, during the summer holidays. The local borough electrical engineer (Mr. H. Kilgour) has drawn up specifications, and will supervise the work.

Chester.—The Council has authorised the Lighting Committee to have arc mains and distributing mains laid for the supply of public and private electric lighting in George Street, St. Anne Street, and adjoining streets at an estimated cost, including street lamps, &c., of £1,260.

Crossgates.—A recent meeting of the Hill of Beath inhabitants resolved in favour of public electric lighting.

Dublin.—A special meeting of the Corporation was held last Friday to consider the report of the committee of the whole house in reference to the tenders for the supply, laying down, and maintenance of electric mains and apparatus, in connection with the loan of £20,000. The report of the committee of the whole house stated that the tenders received by the Electric Lighting Committee in response to the advertisements issued were submitted to Prof. Kennedy, whose views on them were set forth in an exhaustive report, and carefully considered. Certain tenders were recommended for acceptance—namely, those which had been approved of by Prof. Kennedy—and the committee of the whole house adopted the recommendation of the Lighting Committee, and decided to act on it without delay. They submitted the following recommendations for the approval of the Council:—That the tender of the Callender Cable and Construction Company, for the supply and laying down of concentric cables, be accepted for the sum of £12,505 13s 2d., the company binding themselves to maintain the whole of the concentric mains, together with the boxes and accessories as supplied and laid by them for a period of 12 months free of cost to the Corporation. That the offer of the same firm to maintain the cables for a further period of 10 years, on consideration of an annual payment to them by the Corporation at the rate of 10s. per £100, or ½ per cent. on the invoiced value of the work, be also accepted. That either of the following tenders for transformers be accepted, viz.:—Tender of Messrs. Johnson & Phillips, amount £2,996, with the addition of £100, approximately, for cartage and fitting up; tender of the British Thomson-Houston Company, amount £3,340 11s. 3d., subject to the receipt in the meantime from that firm of a satisfactory telegram as to the delivery of the transformers within a specified time. Alderman Meade said the matter had been very carefully considered by the Electric Lighting Committee, who were thoroughly conversant with the urgent necessity there is for having the contract accepted, and the work placed in hand at once. It was absolutely necessary that new cables should be put in, and that the contractors should be urged to go on with the work with all speed, so that the contract would be completed for the coming winter lighting. A committee of the whole house had considered the acceptance of tenders, and they determined that the citizens of Dublin should get the best cables that could possibly be got, and that they should cost the lowest possible price. They applied for tenders, and the result of their deliberations, with the assistance of the borough surveyor and Prof. Kennedy, was a recommendation that the tender of the Callender Cable and Construction Company, at the sum of £12,505 13s. 2d., should be accepted. He believed that the cables of this company were the best possible value that could be obtained for the citizens of Dublin. Furthermore, he was informed that these were the cables which the Board of Trade would require to be used in Dublin, because the engineer of the Board of Trade in London had called on Prof. Kennedy, and told him that these concentric cables of the Callender Company should be used, and he even went so far as to say that this would be one of the conditions which the Local Government Board here would put on the Corporation before they allowed them any loans. He moved:—"That the tender of the Callender Cable and Construction Company, for the supply and laying down of concentric cables, be accepted for the sum of £12,505 13s. 2d., the company binding themselves to maintain the whole of the concentric mains, together with the boxes and accessories as supplied and laid by them for a period of 12 months free of cost to the Corporation. That the offer of the same firm to maintain the cables for a further period of 10 years, on consideration of an annual payment to them by the Corporation at the rate of 10s. per £100, or ½ per cent. on the invoiced value of the work, be also accepted; and that the law agent be instructed to prepare the necessary contract." The Callender Company, Alderman Meade continued, had undertaken to complete the work within 18 weeks, while none of the other companies who tendered would engage to complete it within 26 weeks. The question of time in this matter would mean a great deal to the Corporation and the citizens.—Alderman Sir Robert Sexton, in seconding the motion, referred to the saving of time as a most important matter. Although there was a lower tender than that of the Callender Company, the saving of time would considerably make up for the difference of cost.—The resolution was unanimously adopted.—Alderman Meade then moved that the tender of Messrs. Johnson & Phillips for transformers, amounting to £2,996, with the addition of £100 approximately for cartage and fitting up, be accepted. The firm guaranteed delivery within a specified time. The resolution was carried.

Dundee.—At last week's Town Council meeting Treasurer Ritchie submitted the annual report of the gas and electricity departments. In regard to the electricity accounts, the estimated revenue was £6,000; the actual, £6,269 13s. 8d.; leaving a surplus of £269 13s. 8d. The estimated expenditure was £5,284 6s. 7d., the actual being £4,941 9s. 5d., showing a gain of £342 17s. 2d. Adding these two items, the balance of income over expenditure is £612 10s. 10d. Added to a surplus of £715 odd, this made a balance of £1,328 to carry forward. The estimates of the same department for next year, including the large balance of £1,328 4s. 3d. mentioned, less a charge of £381 6s. 7d., the remaining balance due to the gas department, amounts to £7,553 17s. 8d., and the expenditure £7,039 6s. 7d., showing an estimated surplus of £514 11s. 1d. In the year's expenditure provision has been made for a contribution of £1,000 towards the formation of a contingent fund. The Committee advised the reduction of charges for current from 4½d. to 4d. per unit for lighting, and 2½d. per unit for motor purposes. The accounts were criticised by Mr. Brownlee, who thought £1,000 was far too large to devote to a contingent fund, and they were then adopted.

Ealing.—In further reference to the alleged trouble among the electricity works' staff, the Electric Lighting Committee issued a report on its investigations into the affair last week. The report, which recommended that Mr. Recano's resignation be accepted, that Mr. Bush be asked to resign, and that Mr. Saunders should be re-instated, was adopted.

Epsom.—The Urban Council are now issuing a tender for lighting 207 public lights in their district. The advertisement is a formality, as the gas company alone tender; but in the near future the light is expected to be altered, as the Council have purchased a site for erecting public offices, electric lighting station, &c., and have, it is understood, consulted an electrical engineer on the matter.

Glasgow.—Last week at the Corporation meeting, Mr. Maclay, in moving the approval of the minutes of the Electricity Committee, stated that the Committee had now placed the contract for the excavation and concrete work for the electric station at Port Dundas, as well as the contract for the mason work at Pollokshaws. They were resolved to push on the erection of these works without delay.

Last week the Watching and Lighting Committee recommended the Corporation to have 218 gas lamp pillars removed from streets which are now lighted electrically.

Glossop.—Last week a special meeting of the Council was held to consider an electric lighting scheme for the borough. Captain Partington, J.P., chairman of the sub-committee, brought up a report which stated that the scheme submitted comprised an electric station and works on a site adjacent to the Glossop iron foundry, from which centre electric light would be supplied to the whole borough. The cost of working, maintenance, rent of site, and the redemption and interest of the capital would amount to about £1,975 per annum, and the income would be about £2,000, which would give a clear margin of £25 profit. The capital estimated to be expended is about £15,000. Capt. Partington thought they were not justified in spending the money until they were sure they would have enough consumers. It was resolved to adjourn the matter until 29th inst., and in the meantime, a canvass is being made of the district.

Godalming.—The Local Government Board has refused its sanction to the loan of £15,000 asked for by the Town Council for electric lighting purposes. As there was much opposition to the scheme, it is stated that the Board thought it was doubtful whether it could prove remunerative, or even self-supporting, particularly in view of the smallness of the compulsory area. The Council has yet to consider the letter, but the Mayor has expressed an opinion that a poll of the residents will be taken.

Hastings.—After going fully into the matter of the appointment of an electrical expert to report upon the Hastings Electric Light Company's undertaking, the Public Lighting Committee withdrew their proposal to appoint Mr. Grenville, and recommended that Prof. Hy. Robinson be appointed to make the report. This was agreed to by the Council by 19 votes to 1. The Council has approved of the company's proposals to extend mains in a number of roads.

Keith.—The Aultmore-Glenlivet Company, Keith, have just decided to introduce the electric light at their fine new distillery at Forgie. Paraffin is used for lighting purposes at present, and besides being unsatisfactory so far as the light is concerned, is also highly dangerous when the inflammable nature of many parts of the distillery are considered.

Kensington.—The Vestry last week had a discussion on electrical matters, and appointed a Committee to consider the report of the Select Parliamentary Committee. The Vestry has allowed the House-to-House Electric Light Company to erect a trial arc lamp in Kensington Road.

Killarney.—The Killarney Union is unable to find out what profit is being made by the Killarney Electric Lighting Company. The matter was discussed last week, and a resolution was passed drawing the attention of various Members of Parliament and others to the question.

Leeds.—The Bill to confirm the provisional orders granted by the Local Government Board to the Corporation of Leeds for power to create sufficient stock to acquire the undertaking of the Yorkshire House-to-House Electricity Company having been referred to a Select Committee, objection has been taken, on behalf of the Corporation, to the right of the electricity company to be heard before the Committee. The question will, therefore, have to be decided by the Court of Referees.

Leith.—The work of laying mains is being rapidly proceeded with. A sub-committee has been planning the positions for the public lamps. Brackets will be used in Kirkgate.

Liverpool.—The Corporation Bill was before the Parliamentary Committee last week, and the clause asking for power to borrow £200,000 for electric lighting purposes. The Town Clerk pointed out that under the Electric Lighting Act and a provisional order, they were under certain conditions obliged to give a supply to anybody in Liverpool who was entitled to receive it, and to give it up to the required quantity. They could not do that without spending capital, and they could not spend capital without the sanction of the Local Government Board.—Replying to Mr. Hutton, Mr. Fitzgerald and the witness said there were precedents for this clause.—The Town Clerk, answering Mr. Fitzgerald, said it would not be possible to submit a detailed estimate for electric lighting purposes, because in such matters as mains they never knew where they were from day to day.—Mr. Fitzgerald said what was proposed was exactly what was done in Bills relating to gas and water undertakings; they produced a lump and not a detailed estimate. At the present time the Corporation had only £556,355 authorised borrowing powers, and, with the estimated capital expenditure of the present year, the expenditure would be £660,355, and further capital powers were therefore very necessary.—The Chairman intimated that the committee were by a majority against giving the power sought by the clause.—Mr. Fitzgerald asked the committee to give the Corporation sufficient powers, at any rate, to carry them over the present year.—After consultation with his colleagues, the Chairman announced that the committee could not grant the powers which related to electric lighting.

Llandrindod Wells.—The electric light company at Llandrindod Wells want to put up a chimney stack at their works, but the Llandrindod Urban Council are not quite agreeable, for fear an impression may get abroad that there is a manufactory at Llandrindod.

Local Bills in Parliament.—A petition on behalf of the Great Western and London and North-Western Railway Companies, praying to be heard by counsel against the Shrewsbury Electric Lighting Provisional Order, when the committee stage is reached, has been deposited in the Private Bill Office of the House of Commons.

London.—At yesterday's meeting of the City Corporation, Mr. Brooke Hitching was to move in favour of a reference to the Streets Committee (or to a special electric light committee of 12 members) "to consider and report as to the desirability of approaching the directors of the City of London Electric Lighting Company, Limited, with a view to acquiring the whole or part of their undertaking by friendly purchase, and empowering the committee to ascertain on what terms, if any, the directors would sell the undertaking." The law officers of the Corporation have reported that the Corporation has no power to enter into competition with the company, and hence the proposal to buy out the monopoly.

At a recent meeting of the St. George's, Hanover Square, Vestry, a resolution was passed that a special committee of 12 members be appointed to consider the best means of lighting the parish by electricity, and to approach the Electric Light Corporations. A speaker said that the ratepayers had lost a great opportunity of making a good profit for themselves in allowing private companies to get a footing in the parish. The committee appointed includes Lord Hobhouse, Col. the Hon. H. Legge, Mr R. C. Antrobus, L.C.C., and Messrs. Bradford & Macdonald.

Long Eaton.—A town's meeting has requested the Council to oppose the Bill of the General Power Distributing Company, and stated that the town ought to have a municipal plant.

Lowestoft.—At the last Council meeting the Electric Lighting Committee reported that a letter dated April 26th was received from H. S. Foster, Esq., M.P., stating that he had a long talk with Mr. Ritchie on the subject of the electric lighting provisional order, and that the Board of Trade say that the undertakers, in their opinion, have the power already (empowering the Corporation to supply electrical fittings and fixtures, &c.) under the 1882 Act. But if they have not, the Board of Trade advise Mr. Ritchie that the Board of Trade have not the power to give it them by a provisional order. They deny that a meter is a fitting, or in any way analogous, and he thought that the wisest thing is to accept the decision and act upon the advice of the Board of Trade and exercise the power. The Town Clerk reported that he had approved the draft order as altered by the Board of Trade, and had received the bill confirming the order.

Mansion Lighting.—Moor Hall, Kidderminster, has been fitted throughout for electric lighting. A gas engine and dynamo have been put down in an outbuilding. A battery of accumulators is placed in a cellar. There are over 230 lights fitted, some of the fine old gas and other fittings being utilised. The work was done by Messrs. Whittaker Bros.

Mexborough.—The District Council has appointed a committee to go into the electricity supply question.

Morecambe.—There is much disappointment at the delay which has arisen in carrying out the contract for the installation of electric light. At last week's meeting of the District Council it was resolved to approve the Electric Lighting Committee's recommendation "that Messrs. Thomas Parker, Limited, be allowed to deliver the steam dynamos and exciter, which Mr. Parkinson has tested, and which he has reported as not being in accordance with the contract, subject, however, to the question of compensation standing over." The Local Government Board has sanctioned the loan of £8,821 for electric light purposes, being the sum of £10,000 applied for, less a deduction of £1,144 10s., the sum awarded to the Council in respect of defective cables, and £34 10s. for articles not forthcoming in connection with the purchase of the portion of the plant of the Morecambe Electric Light and Power Company, Limited, for which the Local Government Board sanctioned a loan of £3,900 on September 20th, 1897. Mr. Parkinson, the electrical engineer, has been authorised to engage the necessary additional staff, including assistant electrical engineer, engineer and switchboard hand, engine driver, battery man for three sub-stations, two trimmers, fireman, and labourer. At the Council meeting Councillor John Brown said they had got the first set of engines at the works, and the resident engineer expected being ready last Monday to switch on to the arc lights on the Front.

New Brompton.—In the High Street of New Brompton standards have been erected for the purpose of supplying the streets with electric light; but up to the present the electric light has not permanently appeared. It is stated that the present lamps are not quite suitable for street lighting, but that others will shortly take their place, and then the full light will appear.

Newcastle.—Last week Mr. Colamb and Dr. Hopkinson paid a visit to Newcastle to inspect the district, and to take notes for the purpose of their reports on cable and electric traction. Dr. Hopkinson is stated to have thought that the Corporation ground in City Road would suffice for one power station to supply current for the whole of the lines, and plant for 5,000 H.P. could be installed there.

Newport (I.W.)—An application from Edmundson's Electricity Corporation, asking the Council to sanction application for a provisional order on condition that they supply current for lighting the streets and public buildings at 4d. per unit, has been referred to the Finance Committee.

Newington.—According to our contemporary, the *Contract Journal*, the following tenders were submitted for the supply and erection of engines, dynamos, and public lighting plant at the new electric lighting station in Penrose Street for the Vestry of St. Mary, Newington:—

Sharp & Piper	£9,575
Siemens Bros. & Co., Limited	9,375
Brush Electric Company	9,090
Johnson & Phillips	8,975
Crompton & Co.	8,803
Fowler & Co., one section only	5,200

The tender of Messrs. Johnson & Phillips is recommended for acceptance.

Northwich.—Applications for current are coming in so well that the supply company is about to make further extensions. One main, three-quarters of a mile long, is to be laid to supply "The Brockhurst," Sir Joseph Virdin's residence. The Guardians decided on Saturday last to light the workhouse, and Messrs. Ames, Garrard and Co. have been asked to prepare a specification for the work. Feeder mains are to be laid from the electricity works to the Bull Ring, a distance of a mile. The supply company has now running two 100-B.H.P. Crossley engines, two 60-kilowatt dynamos, and one 19-kilowatt balancer, by Messrs. Laurence Scott & Co., Limited, with a 200 ampere-hour battery by the Chloride Syndicate, Limited. Lamps equivalent to 2,500 of 8-C.P. have been applied for, and about 2,050 connected to the mains.

Petersfield.—The District Council decided, at its meeting on 16th inst., by six votes to two (both of the latter being votes of directors of the local gas company, who urged the Council to await the result of the new incandescent gas burner), to instruct Mr. A. H. Preece, of Westminster, to furnish a report as to the practicability and cost of an electric lighting scheme.

Plumstead.—The Vestry has informed the Woolwich District Electric Light Company that it has decided to oppose any application for a provisional order to extend their supply to Plumstead.

Poplar.—The Board of Guardians do not agree to hold back their electric lighting scheme until the Poplar District Board of Works' undertaking is put down. We referred to this matter last week.

Portsmouth.—The principal business at last week's Council meeting was the presentation by Alderman G. Ellis, chairman of the Electric Lighting Committee, of the balance-sheet and revenue accounts for the year ending March 31st last. The receipts were as follows:—Private consumers, £10,833 16s. 3d.; public lighting, £4,645 19s. 2d.; sales by contract, £144 3s. 1d.; meter rents, &c., £641 4s. 6d.; total receipts, £16,265 3s. On the other side, the expenditure has been:—Generation of electricity, £5,909 10s. 5d.; distribution ditto, £1,006 15s. 7d.; repairs and renewals, £1,454 2s. 6d.; rents, rates, and taxes, £397 2s.; management expenses, £1,177 18s. 11d.; law charges, £11 15s. 4d.; interest on overdraft, £112 9s.; total expenditure, £9,469 13s. 9d. This leaves a gross profit of £6,795 9s. 3d. on the year's working. Of this sum £6,750 is carried to net revenue, leaving a balance of £45 9s. 3d. to be carried forward to next year's working. Out of the £6,750, the Committee have paid £3,180 19s. 4d. for interest on borrowed capital, and £2,793 13s. 7d. towards redemption of loans, leaving the sum of £776 to the good. With regard to the capital account, the total amount sanctioned to be borrowed is £142,000. Of this sum £119,651 has already been borrowed, leaving a sum of £22,349 yet to be called up. Out of this gross sum of £119,651 already borrowed, there has been expended £112,174 7s. 10d., which has been disbursed as follows:—Land and building, £14,009 15s. 6d.; machinery, mains, meters, transformers, &c., £95,620 18s. 5d.; engineers' commission, £2,196 5s.; furniture expenses, &c., £347 8s. 11d.; total, £112,174 7s. 10d. Alderman Ellis, in moving the report, said that he was disappointed with the revenue made. In the first part of the year they would remember that permission was given to reduce the price of the current ½d. per unit, and the Committee felt that they would have a large influx of customers, which would more than compensate. The customers did come, by dozens and by hundreds, but unfortunately for them and for the nation, the strike and lock-out upset all their plans, and prevented them taking any customers on up till January 1st of this year. To show them that they would have progressed, he would mention that from January 1st up to that morning the increase of lights amounted to 5,872. Every one of these might have been joined up last year had they had the plant. But there was another point. When they reduced their price, they practically brought their revenue down to 3⅔d. per unit sold, because they sold the units for street lighting at a much smaller price than that paid by the ordinary consumer. Portsmouth was almost the lowest in the whole of the United Kingdom, and he thought it must be very satisfactory to the inhabitants to know that while they were making a profit of £6,795 gross, they charged as low as or lower than any other town in the United Kingdom. What had they done with the profit? There were the extraordinary charges due to the lock-out, £654 for replacing the arc mains in the town, which were not strong enough, £112 interest on bank charges, £3,180 interest on the loan, and £2,793 for the sinking fund. There was a net profit of £820 16s. 4d. During the past few weeks they had had a good deal of criticism upon the balance-sheet, and they had been told by certain people that they ought to have a large fund for maintenance. He would agree with that view if they were dealing with the gas company, water company, or an electric light company. But they were not dealing with anything of the sort. He would go further, and say that if they were dealing with the great city of Glasgow or the large city of Leeds, he would agree. But the case of Portsmouth was different. Why did he make this difference?—Because Glasgow borrowed money in ordinary stock for 42 years. Leeds took over a company and paid £2 for every pound paid, and the Local Government Board had permitted them to borrow the money for 42 years. That was not the case in Portsmouth. They had borrowed the money for engines for 15 years only. And if anyone said that the engines would be worn out in 15 years, and would have to be replaced by new ones, he did not know anything about it. It was not necessary to provide a sinking fund of any dimensions for renewals. To ask them to pay in 15 years the sinking fund and interest, and to hand to the Council on that date a sum equivalent to the sum equal to rebuild the whole thing again, would be monstrously hard on this generation, and would be totally unnecessary. It was the consensus of opinion throughout the country that there was no necessity for a renewal fund sufficient to replace the machinery. They were quite at liberty at the end of the 15 years to re-borrow the money, and allow the generation of that date to pay their own charges for their own benefits. He moved the adoption of the balance-sheet. After discussion the report was adopted.

Rhyl.—Mr. H. W. Buddicomb, Penbedw Hall, Nannerch (N.W.) has written to the District Council stating that he noticed that at most seaside and holiday resorts the authorities were adopting the electric light for public lighting purposes, and he asked, in the event of the Council not having powers of their own for supplying electric light, whether they would approve of an application by him for such powers, and agree to take electric light for illuminating the sea front. He also asked their consent to an application for laying down a system of electric tramways. The letter was referred to the Road Committee for consideration and report.

Russia.—A company has just been formed in St. Petersburg, with a capital of six million roubles, to be known as the Russian Union Electrical Company. The new concern will acquire and take over the central electric lighting station in the town of Riga, and also propose to establish similar stations in other Russian towns.

Saltburn.—Last week the Urban Council had before it the report of Mr. Burstall (Burstall & Monkhouse), *re* electric lighting. It is pointed out in the report that Saltburn is smaller in area and population than any town in which a public electric lighting installation is already at work, and it was therefore difficult to estimate the number of lamps required. For a specified area in the first year there might be a demand for 1,800 8-C.P. lamps, and in the second year 2,500 to 3,000. He advises, as suitable for a site, land lying to the west of the Whitby branch railway. Low tension continuous current system, with 250 volts at consumers' terminals, is recommended. The dynamos would be driven by 50-H.P. steam engine. The utilisation of water-power at Marske mill is out of the question. Capital expenditure is estimated as follows:—Generating plant at station, £3,200; buildings, £1,500; mains and fixings, £2,500; public lighting, £500; meters and other apparatus, £250; legal and professional charges, £1,000; total £7,000, plus cost of land; 7d. per unit would be charged for current and public lighting at 3½d. per unit. The total income is put at £834 per annum, working expenses, £573; gross profit, £261. Interest and sinking fund would cost £460 for the first year, leaving a deficit of £199. The matter is to be laid before the ratepayers, who are to vote upon it. A provisional order will be applied for in November.

Shoreditch.—The Lighting Committee reported at the Vestry meeting on Tuesday evening that Mr. H. E. Kershaw had been re-appointed chairman of the committee. The committee had had under consideration the correspondence between the chief electrical engineer and the contractors, on the subject of the automatic gear to the Willans engines, which had not proved to be satisfactory, and which the contractors had agreed to take back. At the suggestion of the committee the Vestry approved the return of the gear as sanctioned by the consulting engineers. Mr. Kershaw, chairman of the committee, in moving the adoption of certain alterations in the charges for electric current, stated that the reductions amounted to 25 per cent. to the average customer. The chief electrical engineer (Mr. Russell) had submitted to the committee an estimate of the liabilities and income for the next 12 months. That estimate was based upon the reduced rates, and showed that they would have a substantial surplus of income over expenditure to the extent of over £4,000. Thus the committee, who were practically unanimous on the reductions, were justified in asking the Vestry to approve the projected new charges. Among other changes, the committee proposed to reduce the charge for current from 6d. to 5d. per unit for the first two hours, and to 2d. afterwards, whilst consumers would have the option of being charged a fixed rate of 4½d. per unit. It was also intended to abolish meter rentals, to reduce the charge for public lighting from 5d. to 3½d. per unit, and the charge for current for motive power purposes to 2d. per unit for all hours, all alterations commencing on the 26th inst. Mr. Winkler moved that the proposals should stand over for two months; but after some discussion, the Vestry adopted the various recommendations made to effect the alterations in the scale of charges. On the motion of Mr. Kershaw, the Vestry Clerk was instructed to supply the members with copies of the report of the Parliamentary Committee on the supply of electrical energy, in order that the Vestry might consider what action should be taken in the matter of opposing the clauses in that report.

Shrewsbury.—The Council has authorised the Town Clerk to make application to the Local Government Board for sanction to the raising of a loan of £35,000 to complete the purchase of the undertaking of the Shropshire Electric Light and Power Company, Limited.

The Board of Trade have issued copies of the new provisional order, which they have just forwarded to the Corporation of Shrewsbury, authorising them to supply electricity throughout the area of their borough.

South Africa.—The electrical engineer of the Bulawayo Electric Light Company (Mr. J. H. Meikle), has lately been on a tour in the southern colonies, and had inspected the electric lighting plants in the various towns. Those at Johannesburg and Durban struck him as being the most up-to-date installations. They were both high tension alternating, the same as at Bulawayo. The only plant with accumulators was that at Cape Town, which was at least five years old, and had given trouble from the day it started. He considered that at Bulawayo they had a thoroughly efficient and up-to-date installation. It is interesting to note that the maximum charge for house lighting is 2s. 6d. per unit for small consumers, reducible to 2s. for large consumers, churches, Government buildings, &c., pay 1s. 7d. per unit.

Stockport.—Mr. A. J. H. Carter, late clerk of works, and chief assistant engineer for the Brighton Corporation, has been appointed clerk of works for the electric light installation in course of erection at Stockport. There were 54 applicants for the appointment.

St. Pancras.—The Electric Lighting Committee reported at the Vestry meeting on Wednesday, that they had instructed the chief electrical engineer to make experiments with a view to the utilisation of the surplus steam from the refuse destructor for the purpose of driving the electric light engines. Mr. Sydney W. Baynes, the engineer, had carried out a number of tests, but owing to the irregularity in the supply of the steam, it was not possible to depend upon it for the particular purpose in question. It had therefore been decided to abandon the idea of utilising the steam for electric lighting purposes. The report was passed without comment. It was resolved that the Vestry should be represented on the Municipal Electrical Association.

Swinton and Pendlebury.—The District Council will not allow the Salford Corporation to supply electric current to Swinton Cottage, Swinton Park, but the Council will be itself going into the matter of electric lighting shortly.

Taunton.—The Electric Light Committee has reported that the total connections made during May were equivalent to 623 8-C.P. lamps.

Teddington.—The District Council has agreed to confer with the Twickenham Council before coming to any decision regarding the proposal of Edmundson's Electricity Corporation to form a company for lighting the two districts.

Towyn and Aberdover.—A Colwyn Bay resident recently offered to prepare a scheme and estimates for electric lighting, and the District Council referred the matter to a committee.

Walsall.—The Midland Electric Corporation for Power Distribution has notified its intention to omit Walsall from its proposed area of supply.

A tender has been accepted for laying the foundations for the new engine and dynamo at the generating station.

Winchester.—The works of the Winchester Electric Light and Power Company are now completed. They will be formally opened on the 30th inst., and invitations have been issued.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Barking.—The engineer has submitted to the District Council plans, estimates, and report, upon his scheme of light railways from Barking to Beckton, and has attended before the Lighting Committee to explain details. The committee had resolved that such scheme be approved, and that the clerk supply a copy of such estimate and report, as well as of the draft order and book of reference, to each member of the Council. It was resolved that Mr. W. C. C. Hawtayne be appointed electrical engineer, to act in conjunction with Mr. Barker, in connection with the light railways scheme, upon terms to be subsequently arranged. The Light Railway Commissioners have notified that they will hold an inquiry on the 23rd inst.

Blackpool and Fleetwood.—The Board of Trade inspection of the new electric tramroad connecting Fleetwood and Blackpool was expected to take place this week. Open cars will be used during the summer months, and already several trial runs with these have been made, the distance between Uncle Tom's Cabin, Blackpool, and the centre of Fleetwood being covered in 23 minutes.

Bristol.—Last week in the Commons the Bristol Tramways (Electrical Power, &c.), and the Bristol Tramways (Extensions) Bills were read a third time.

Cardiff.—The Electric Tramways Committee held a special meeting last week to consider what steps should be taken with regard to the proposed electric trams now that Parliament had granted the powers asked for by the Corporation. After discussion it was decided that nothing further could be done in the matter of the proposed trams until the question of overhead wires *v.* conduit system had been settled. A deputation will shortly report on the question.

The City and South London Railway.—According to the *Times*, in consequence of representations from Mr. Austin, the President of the Board of Trade has promised to make inquiries concerning the alleged overcrowding on the City and South London Electric Railway. At the same time steps will be taken to ascertain whether there is any foundation for the complaint that insufficient means of ingress and exit are provided for passengers at the King William Street and Stockwell stations on the said line.

Enfield.—Mr. B. Godfray, solicitor, and Mr. J. W. Ransome, engineer, appeared before a committee of the District Council last week, representing the company which is promoting the light electric railway scheme (overhead trolley) for this and the surrounding district. It is stated that the Light Railway Commissioners will hold an inquiry on July 13th. It has been decided at present to proceed with only the lines running from Wood Green to Enfield, from Wood Green to Tottenham, and from Enfield to a junction with the lines of the North Metropolitan Tramways Company in Hertford Road.

Gillingham.—At the fortnightly meeting of the Gillingham Urban District Council (16th inst.) the question of electric trams was again discussed, and the clerk (Mr. F. C. Bowlen) reported the favourable result of the adjourned inquiry held by the Light Railways Commissioners as to a scheme for light railways in the district.

Glasgow.—The general manager of the Tramways Department (Mr. John Young), last week submitted to the Tramways Committee a statement of the revenue and expenditure account for the year ending May 31st, subject to final audit. Though these figures have no direct connection with electric traction, they will be interesting in view of the great attention which electrical men have been and will be giving to the Corporation trams here. The statement showed that the gross revenue amounted to £394,111 12s., and the working expenses to £293,594 11s. 9d., leaving a balance of £100,517 0s. 3d as compared with £84,596 3s. 1d. for the preceding year. The fixed charges, such as rent of Govan lines, interest on capital, statutory sinking fund, and payment of £9,000 to the Common Good, amounted to £38,465 0s. 9d., leaving a balance of £62,051 19s. 6d., to be deducted for depreciation and to be added to the renewal and general reserve funds. The total number of passengers carried during the year was 106,864,437, as compared with 98,966,638 for the preceding year, 86,462,594 for the year ending May 31st, 1896, and 57,104,647 for the first 11 months ending May 31st, 1895. The balance of revenue, after deducting working expenses, was £84,596 3s. 1d. for year ending May 31st, 1897, £83,267 7s. 11d. for year ending May 31st, 1896, and £35,699 3s. 3d. for 11 months ending May 31st, 1895.

The Great Northern and City Railway.—We understand that the company has succeeded in effecting arrangements with all the opponents to the Bill of the present session. This Bill will now pass as an unopposed measure through its remaining stages in the House of Commons.

Greenock.—The Greenock and Port-Glasgow Tramways Company are contemplating the introduction of electric traction on the tramway system. The present lease is almost expired, and it is stated that, should it be renewed, application will be made for Parliamentary powers.

Harrogate.—The Town Council last week had a discussion with reference to the proposed light tramways from Harrogate to Knaresborough, and it was resolved that the decision of the committee averse to the scheme be endorsed, Harrogate not being adapted for tramways.

Hendon.—The committee appointed by the District Council to consider the project of the London, Edgware, Hendon and Barnet Light Railway has reported that the promoters proposed to construct a line along the Edgware Road to the Old Church, Edgware. The gauge would be 4 feet 8½ inches wide—double in parts—and presumably with poles in the centre of the road for carrying overhead wires. It was proposed to acquire three acres of land adjoining Edgware Churchyard for works. The promoters understood to carry passengers, cattle, stone, minerals, fish, &c., the rates to be subject to revision triennially. The committee came to the conclusion that although better means of communication were required, they did not consider the proposed scheme was the best for the purpose. The District Council has adopted the report.

Johnstone.—The British Electric Traction Company have laid several communications before the Town Council relative to connecting Johnstone with the proposed tramway to Glasgow. Provost Thomson said he would give the proposed tramways the most uncompromising opposition. The Council has agreed to meet with the representatives of the company with a view of receiving information *re* the proposals.

Light Railways and Tramways.—In the House of Commons last week, in reply to Mr. Hazell, Mr. Ritchie said: There is nothing in the Light Railway Act to prevent the consideration of light railway schemes in urban districts. The Light Railway Commissioners and the Board of Trade have ample powers to impose on promoters as a condition precedent to entertaining an application powers of purchase as large as those defined in the Tramways Act of 1870. The Light Railway Commissioners have the scheme promoted by the Metropolitan Tramways and Omnibus Company, Limited, under consideration, but, as they have an independent jurisdiction, I am not in a position to say what steps they will take with regard to it.

Limerick.—A committee of the whole house of the Corporation last week had the following items under consideration:—Electric trams, &c.—Letters from (1) H. Bickerdike, Montreal, proposing to introduce the "American electric trolley system" into the city, on terms to be arranged; (2) Mr. J. E. Palmer, Ballybrack, Co. Dublin, applying for a lease for 150 years of the sole right to construct, equip, maintain, and work electric tramways in the city, and proposing certain routes for which the lease is asked; and (3) M. Zeitz, Hamburg, offering to supply cars, completely fitted out, for the overhead system of electric traffic. In connection with above to consider advertisement of the Limerick Electric Tramways Company, Limited.

Liverpool.—The laying of the rails for the experimental electric line from Castle Street to the Dingle is on the eve of completion, and the cars will soon be given a trial.

London United Tramways Bill.—On Friday last this Bill was again before the Select Committee of the House of Commons. Evidence against the Bill was given on behalf of the Middlesex County Council, and by Mr. J. W. Benn on behalf of the London County Council. Mr. Benn said that the L.C.C. most heartily joined with the Hammersmith Vestry in opposing the attempt to take away from a local authority the right of veto conferred upon it by Parliament. Under the Tramways Act of 1870 it was provided that local authorities should have power to purchase the lines at the expiration of 21 years. In the case of the London County Council that period had been modified in several instances, so that the lines should become purchaseable about the same time. In 1890, 4½ miles came under the purchase clause. Since then the London County Council had become the owners of about 68 miles out of the 114 miles which would become purchaseable under the Act. The London County Council were very anxious that any form of traction adopted should, as far as possible, accord with the system which it was hoped presently to determine upon as the best. It was very desirable that the veto should be maintained especially in the case of the London County Council, which would presently be ground landlord so to speak, of the complete tramway system of London. In three cases the Council had given its consent to the use of electricity on London lines. In his opinion, it would be a very serious thing to allow a tramway company to erect a generating station and supply electricity in bulk except under the same regulation which applied to electric lighting companies.

On Monday, when the consideration of the Bill was resumed, Mr. J. W. Benn, chairman of the Highways Committee of the London County Council, said the scheme of the company was excellent, but the promoters ought to sacrifice a little in order to meet the wishes of the county of London.—Mr. Pope, in addressing the committee on behalf of the London County Council, said the object of the County Council was not to impede the growth of electrical tramways, but to preserve its authority over such undertakings within the county of London.—Mr. Littler, replying on behalf of the promoters, said they were quite prepared to leave the question as to whether the overhead or the conduit system should be applied to King Street west to the decision of the Board of Trade, and, inconvenient as it would be to have a part overhead and part culvert system, they were quite willing to work the small portion of the proposed line within the county of London by the latter method. In America, electric tramways on the overhead system had increased from 1,200 miles to 14,000 miles, whilst the mileage on the culvert system had decreased. Counsel read reports on the trolley system from Belfast, Glasgow, Sheffield, Birkenhead, Liverpool, Manchester, and Dublin to show that the consensus of opinion was greatly in favour of the overhead system as opposed to the culvert system.—The committee decided, according to the *Times* report, that the preamble of the Bill with regard to tramways No. 6 and 7 (the Boston Road and the Kew Bridge to Hounslow sections) was proved, but did not impose upon the promoters any condition as to simultaneous construction. The committee were of opinion that the preamble was not proved with regard to tramway No. 8 (the Ealing section), and were further of opinion that a sufficient case had not been made out for overriding the principle laid down by Parliament requiring the consent of the local authority, and therefore Clause 27 (repealing the veto) must come out of the Bill. The committee were strongly of opinion that the congested state of London made the speedy adoption of electric traction on tramways necessary, and they earnestly trusted that arrangements might be made between the London County Council and the promoters by which the benefits of one system or another of electrical traction might be secured to the public at the earliest possible date. With the view of enabling the promoters and the London County Council to discuss the matter so far as it related to the lines within the county of London the consideration of clauses was deferred.

The Bill was before the Committee again on Tuesday, Mr. Earle, for the Middlesex County Council, urged, says the *Times*, that that body should be put on the same footing in the matter of veto as the London County Council, so that they could insist upon the same system of traction being used in Acton as was employed in the county of London. Mr. Coward replied that the promoters had met the London County Council, but had not been able to arrive at an agreement, and a further consultation had been arranged. The promoters had suggested to the County Council that the tramways which had been acceded to by the committee should be worked by accumulators, but the Council had not yet had sufficient time to consider the proposal. The promoters did not know whether the County Council would accept the suggestion or not. The chairman explained that the committee in giving their decision had not intended that the agreement to be arrived at between the County Council and the promoters should be embodied in a clause to be submitted to the committee. Their desire was merely that the parties should agree. Mr. Earle maintained that the Middlesex County Council had a right to be so heard, as they were the persons who, under the Act of 1888, had to pay the expense of maintaining the roads. The committee decided not to sanction a dual authority, and therefore rejected Mr. Earle's application. The committee then proceeded with the consideration of clauses.

Our contemporary says that the committee on Wednesday presented a special report to the House of Commons stating that, in their opinion, a sufficient case had not been made out for overriding the principle laid down by Parliament in the London United Tramways Order, 1895, which requires the consent of the London County Council to the use of mechanical power upon tramways in the County of London, and that they had, accordingly, rejected Clause 27 (repeating existing provisions as to motive power), so far as it affects the County of London; but they are strongly of opinion that the congested state of London makes the speedy adoption of electric traction on tramways necessary, and they earnestly trust that arrangements may be made by the London County Council with the London United Tramways Company whereby the benefits of one system or another of electric traction may be secured to the public at the earliest possible date.

Manchester.—The Manchester Carriage and Tramways Company's Bill is to be opposed before the House of Lord's committee by the Manchester Corporation, the Stalybridge Corporation, the Eccles Corporation, Salford Corporation, Levenshulme Urban District Council, Moss Side Urban District Council, Stretford Urban District Council, Withington Urban District Council, Heaton Norris Urban District Council, Stockport Corporation, Aston-under-Lyne Corporation, Denton Urban District Council, Gorton Urban District Council, Failsworth Urban District Council, Oldham Corporation, and the Swinton and Pendlebury Urban District Council. The London and North-Western Railway Company and the Lancashire and Yorkshire Railway Company have also petitioned against the measure.

At a meeting of the special committee of the Corporation *re* tramways, held on 20th inst., a recommendation to be made to a special meeting of the City Council convened for Wednesday last, was approved. For some time past a sub-committee has been in negotiation with the various outside local authorities in regard to the taking over of the tram lines in their areas by the Corporation, and the result was the drawing up of an agreement. By this agreement the Corporation will next session apply to Parliament for authority to lease the tramways from the local authorities, and to work the lines "either with animal or mechanical power, including power, with the consent (hereby granted) of the local authority, to equip the tramway for electric traction on the overhead system, in the same manner as tramways within the city of Manchester shall hereafter be equipped by the Corporation on that system." This application is to be supported by the local authorities, who will give the Corporation a 21 years' lease at an annual rental, the Corporation to pay all local rates in respect of the tramways. If the terms of the lease are not settled by mutual agreement, the Board of Trade, or a referee appointed by that Board, will decide. These arrangements do not apply to Withington and Moss Side, where the local authorities own their own tramways. An endeavour is being made, however, to conclude arrangements by which these lines also shall be leased to the Corporation. The committee has confirmed the report of the sub-committee, and approved of the terms of agreement.

At Wednesday's special Council meeting it was decided to confirm the committee's proceedings, the lines to be reconstructed so as to be worked by electricity. An amendment after the words "electric traction," to substitute the words "on any system which may hereafter be decided by the Corporation," was lost.

The Metropolitan Railway and Electric Traction.—The Metropolitan Railway Bill came before the Lord's Committee on Wednesday. The Bill under which powers are sought for the purchase of additional land for ventilation purposes was opposed by various vestries. Mr. Littler in opening the promoters' case, said there was a prospect of electric traction being adopted on the railway in the near future, and the promoters were now acting upon the report of the Board of Trade, which recommended as a temporary measure that a few more openings should be constructed as a satisfactory means of ventilation which might afterwards be useful in the event of the adoption of electric traction. The time had not arrived when it would be wise to substitute electric traction for the present means of locomotion, but arrangements were in process with the District Railway for experiments to that end. Colonel Bell, the chairman of the Metropolitan Company, said that arrangements had been concluded with the Metropolitan District Company for the experiments with electricity. Sir Benjamin Baker stated that the electrical experiments referred to would occupy at least 12 months.

Paisley.—Mr. Teague, the Council's electrical engineer, recently submitted a report prepared by him on the proposed construction of electric tramways by the British Electric Traction Company, Limited. A sub-committee was appointed to consider and report upon it. At a meeting of the sub-committee the report was laid on the table, and it was unanimously agreed to recommend that, in the event of the electric tramways being constructed, the overhead system of traction be adopted, and that in the carrying out of the work it should be done by the Corporation under the direction of the undertakers. Bailie Nicolson moved, at the Council meeting last week, that the minute be remitted for further consideration. The motion was agreed to.

At a meeting of the sub-committee of the Renfrew County Council last week, a conference was held with several members of the Paisley Town Council and the Tramways Committee anent the proposed electric tramways between Paisley and Johnstone. The convener having stated the object of the conference, Councillor Gondie explained the position of the Paisley Town Council regarding the proposals of the British Electric Traction Company to construct electric tramways in that burgh, and also on Beith Road between Paisley and Johnstone; and Mr. Mann having similarly explained the position of the District Committee, a general discussion ensued and interchange of views. Mr. Sellon, of the British Electric Traction Company, afforded information as to the project of the company, and in reply to queries by members of committee stated that in the meantime they proposed to lay only a single line of rails, with passing places; and in reply to a further question by the convener, he stated definitely that the company would not undertake to lay a double line of rails, even on the road between Glasgow and Paisley, until the company were satisfied that their traffic could not be accommodated by a single line. The committee, after consideration, agreed that the granting of the order to the Traction Company should be strenuously opposed.

Sheffield.—It will be remembered that the City Council recently instructed Mr. F. Nell, of London, to report upon the advisability of utilising the compensation water of the city reservoirs to produce electricity for traction purposes. Mr. Nell's report was last week before the Tramways Committee. In it he discusses the amount of power available at the Damflask, Rivelin, and Redmires reservoirs, and in the case of the first two gives the approximate cost of utilisation, and in regard to the latter no power could be obtained. The committee, after considering the report, passed the following resolution:—"That this committee, having considered the report of Mr. Nell, the expert, which confirms in all respects the reports presented to this committee by the water engineer and the electrical engineer, is of opinion that as at present advised it is economically impracticable to utilise the compensation water at the disposal of the Water Committee for generating electricity for electric tramway traction."

Stoke-on-Trent.—The Board of Trade has written to the Town Council respecting the dispute existing between local authorities interested and the British Electric Traction Company as to the setts to be used for paving the tramways. The company applied under Section 33 of the Tramways Act, 1870, for the appointment of a referee to settle the matter in difference. The Council has replied asking to be represented before such referee.

Surrey Light Railway.—The London United Tramways Company have withdrawn their application for a light railway from Kew to Kingston and Hampton Court over Richmond Bridge. The intimation was given the Town Clerk of Richmond by letter on Wednesday last week. The action of the company is due to the amount of opposition they have met with the Richmond Corporation, Richmond Vestry, private owners, and large landowners, including the Duke of Cambridge and Lord Charles Beresford, the Ham District Council, the Kingston Corporation, Kingston Bridge Commissioners, Hampton Wick District Council, and the County Councils of Middlesex and Surrey, the whole of the public authorities covering the proposed route were opposed to the order being granted. The withdrawal of the scheme follows but a few days the abandonment of the Bill in Parliament by the same company to carry a tramway with overhead electric traction over Kew Bridge, connecting Richmond with Brentford and joining the starting point of the light railway.

Sunderland.—Last week the Corporation tramways deputation journeyed to the Continent to inspect tramways in various cities.

Swansea.—The sub-committee on tramways has considered whether any concession should be made to the British Traction Company in consideration of their widening certain streets, and proposes that the Corporation should make the same offer as in the Act of 1887, and provide the £22,000 required for the purpose on loan at 3 per cent. interest for 30 years. The Council, after discussion, resolved to favourably consider the offer if the security was deemed by a sub-committee sufficient.

Waterford.—The preliminary work in connection with the new electric tramway in the city of Waterford has not yet commenced. The promoter who has got running powers from the Corporation is Mr. Palmer, Dublin.

West Derby.—Messrs. F. J. Leslie & Co. submitted plans, &c., to the Parish Council of a light railway which their clients, the Lancashire Light Railway Company, Limited, were applying for powers to construct between Liverpool and Prescot, the intention being to unite by a light railway or tramway worked by electricity the St. Helens tramway, which terminates at Prescot, with the Liverpool tramways. The Council was asked to support the suggestion as to the proposed tramway to connect St. Helens with Liverpool over that part of the high road commencing at the city boundary and going in the direction of Prescot. The Council sees no objection to the proposal, but has asked for fuller information.

Yarmouth.—The Electric Lighting Committee has had a conference with a deputation from the Yarmouth and Gorleston Tramway Company with regard to the working of the tramways by electricity. The conference was adjourned.

TELEGRAPH AND TELEPHONE NOTES.

The National Telephone Company and the St. James's Vestry.—With reference to the communication recently addressed by the National Telephone Company to a large number of their subscribers in the West End, whose telephone lines have been disconnected as a result of the recent fire in Heddon Street, in which an attempt was made to throw the responsibility for this interruption in the telephone service upon the St. James's Vestry, Mr. T. H. Munsey, the vestry clerk, writes to the *Standard*, stating that the facts are these:—"In March, 1897, the company made application to the Vestry for permission to lay pipes in Regent Street in accordance with plan submitted, to which the Vestry resolved to give their sanction, on condition that the company entered into the usual agreement, embodying payment of a nominal rent and power to require the removal of the pipes on six months' notice. The draft agreement was submitted for the company's approval, but they refused to accept it (although they had entered into a similar one with respect to Piccadilly in the previous year), and altered the draft so as to extend it to a general permission to lay pipes in the future. Considerable correspondence ensued, and when at length the draft agreement was returned it was discovered that the plan which was originally submitted and attached to the draft had been retained by the company. After repeated applications, an entirely new plan was sent in to be attached to the agreement, when it was found that this plan differed very materially from that sanctioned by the Vestry, and on getting back the original plan this also, on examination, was proved to have been considerably varied since passed by the Vestry. Under these circumstances, the Vestry declined to proceed further in the matter until the company had given a satisfactory explanation of the alterations which had been made in the plans. The explanation given was not deemed to be satisfactory, and the Vestry accordingly, in July last, having regard to this fact and to the delay of the company in entering into the agreement, and to the great inconvenience and delay which would then have been caused in the repaving of Regent Street, about to be commenced, by the laying of the company's pipes, withdrew their consent to the laying of the pipes in the thoroughfare in question. Amended applications, dealing with various parts of the parish, were afterwards submitted for the Vestry's consent, but, after the experience gained, the Vestry declined to consent to the same, the company not making any proposals for the benefit of the ratepayers, and, in fact, declining to pay any material rent for the privilege sought."

If the above statements represent the actual facts of the case, it would seem that the National Company is not going the right way to work to make friends.

The New Gotland Cable.—The c.s. *H. C. Oersted* has returned to Henley's Telegraph Works, North Woolwich, after laying the new Gotland cable for the Swedish Government. This cable extends from Ahr, in North Gotland, to the Island of Sandö, thence to Hufvudskar, thence to the Island of Ornö, and thence finally to Dalarö. From the cable station on the southern side of Ornö, an aerial line, some miles in length, is about to be built to the northern side of the island to connect with Dalarö, and thence by the existing system of aerial lines to Stockholm. One main object of the new cables just laid is to connect the various lighthouses on the islands in question with the Swedish mainland. It may be mentioned, as an interesting fact, that telephonic communication was successfully established between Ornö and Ahr (the cable ends at the intermediate stations being joined together), through some 80 knots of cable. The core is $\frac{107 \text{ lbs. Cu.}}{150 \text{ lbs. G.P.}}$ per knot. During the cable-laying operations, considerable care had necessarily to be used in navigating the ship through the numerous rocky islets and shallows which stud the Baltic coast at this part; and some difficulty, moreover, was experienced from fog, but the submersion of the cable was effected without a hitch. The expedition was in charge of Mr. Theophilus Smith, Messrs. W. T. Henley's submarine engineer, while Mr. J. F. Hall had control of the electrical testing and speaking arrangements.

Stockport Telephones.—The Corporation has declined to grant to the National Telephone Company, Limited, permission to lay pipes or conduits beneath certain main streets of the borough for the purpose of placing telephone wires underground. The ground of refusal is that the company does not possess statutory powers, as in the case of tramways and electric light undertakings.

Telegraphic Interruptions and Repairs:—

CABLES.	Down.		Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1898	...	...
West Indies—			
St. Croix-Trinidad ...	Nov. 30th, 1898	...	...
Mole-St. Nicholas-Caimanera	June 10th, 1898	...	...
Caimanera-Santiago de Cuba	June 10th, 1898	...	...
Amazon Company's cable—			
Cable beyond Gurupa ...	June 8th, 1898	...	...
Cyprus-Latakia	Feb. 10th, 1898	...	...
Bolama-Bissao	April 12th, 1898	...	June 21st, 1898.
Maranham-Para	„ 17th, 1898	...	...
Hong Kong-Manila	May 3rd, 1898	...	...
Loanda-San Thomé ...	June 3rd, 1898	...	...
Mozambique-Lourenco Marques	June 14th, 1898	...	June 20th, 1898.
LANDLINES.			
Trans-Continental line beyond Masol	March 12th, 1896	...	...
Cartagena-Barranquilla ...	July 4th, 1896	...	...
Volo-Larissa	June 8th, 1898	...	June 17th, 1898.

Yarmouth Telephones.—Last week the Town Council passed a resolution in favour of municipal control of the telephone service which it was said might be trebled and the cost reduced.

CONTRACTS OPEN AND CLOSED.

OPEN.

Barnet.—June 24th. The Lighting Committee want tenders from firms willing to undertake such installation for lighting the district by electricity. Particulars at the Council offices, and see "Official Notices" June 10th.

Belgium.—August 1st. The municipal authorities of Stavelot are inviting tenders until August 1st for the concession for the supply of electrical engines for lighting and power purposes in the town during a period of 30 years. Tenders to be sent to L'Administration Communale de Stavelot (Belgium). Particulars from the Secretariat de la Ville on payment of 4 francs.

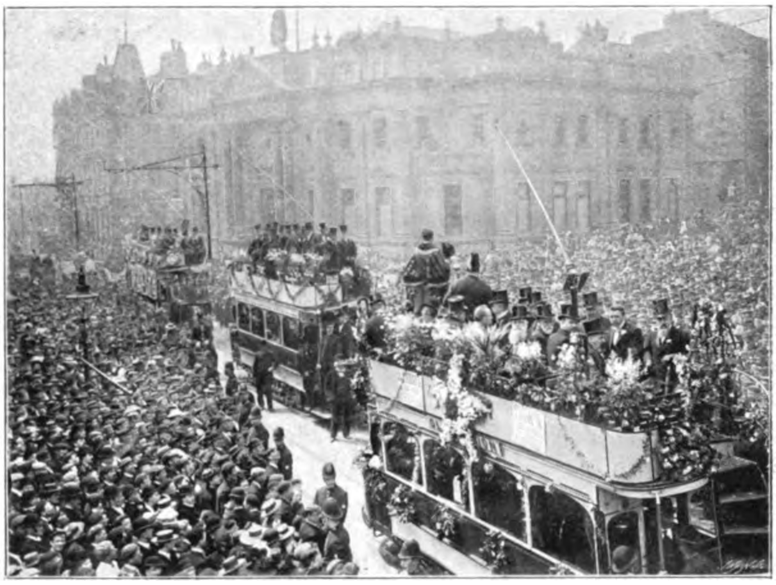
Bethnal Green.—June 28th. The Board of Guardians invite tenders for supplying the necessary plant and installing the electric light at the new infirmary, Palestine Place. For particulars see our "Official Notices" June 10th.

Bootle.—June 28th. The Corporation wants tenders for the erection of an electric light station in Pine Grove. Particulars from the borough engineer, Mr. J. A. Crowther.

(*Continued on page* 889.)

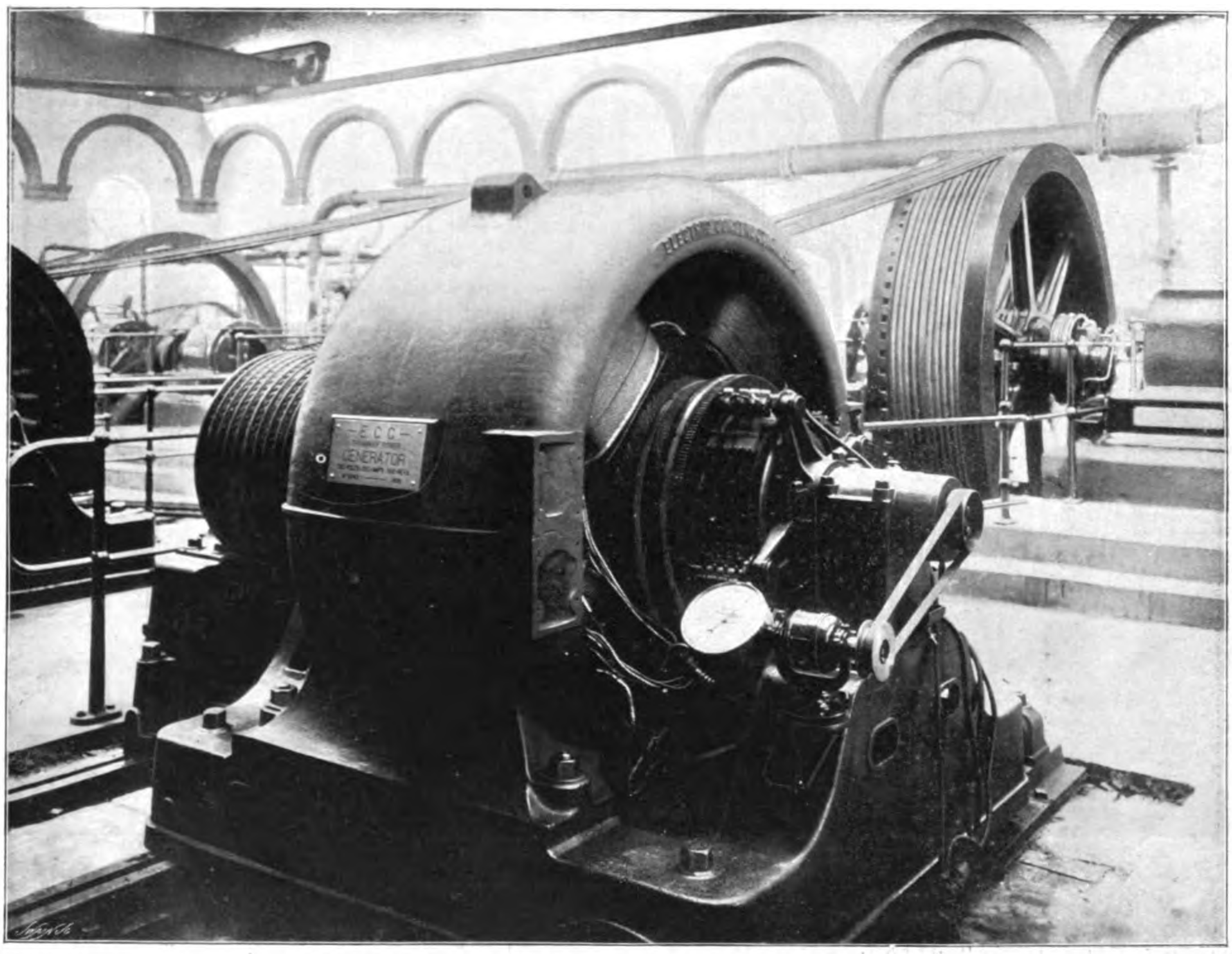
THE HALIFAX MUNICIPAL ELECTRIC TRAMWAYS.

The completion of the Halifax municipal electric tramways is of special importance at the moment, because it constitutes what we may fairly term the first combined lighting and tramway system in the country in which the plant is entirely controlled by a municipality. It is scarcely necessary to say that it is the forerunner of many others, for constructive work on similar lines is being carried out at Glasgow, Hull, Bradford, and Plymouth. The advantages of combined schemes are too well known to be recapitulated here, and though we cannot go so far as to say they are likely to show any startling economy, it is undeniable that some benefit will accrue to the arrangement.



An Imposing Ceremony.

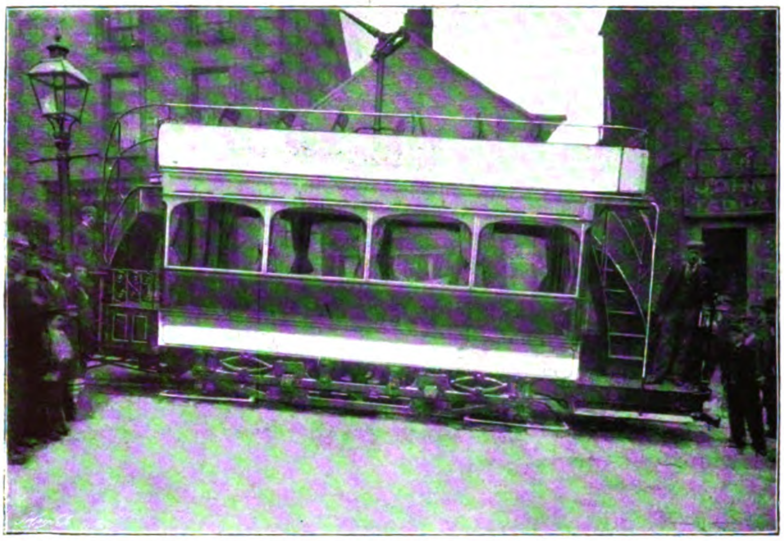
Prior to the introduction into Halifax of the present electric lines, no system of tramways existed in the town, and we are not surprised. "Up the street" and "down the street" are phrases that have some real significance in Halifax. The 'buses that traverse some portions of the town require teams of five horses; even then the tenure of life is so limited, that a horse is not expected to be in active service for more than three years, and it is a frequent occurrence for one to make a quiet protest by dropping dead in the street. Under such conditions a cable tramway would at once suggest itself, but it is doubtful whether such a system would have been flexible enough, especially when taking into consideration the development that was likely to occur. A suggestion was made, we believe, to have a combined scheme of cable and electric line, but piecemeal systems are always best avoided, moreover, in spite of the advantages offered by a cable on severe gradients, we are, after a close examination of the Halifax lines, doubtful whether even a cable system would have given a more satisfactory performance than we witnessed last week. We will, however, again return to this phase of the subject; in the meantime, we would observe that the Parliamentary Bill giving powers to the Halifax Corporation to lay down, equip, and operate electric tramways, was granted last year. When the scheme of electric tramways was entered into by the corporation, it was clearly accepted that it was to be in conjunction with the existing lighting system, and it was estimated that the capital cost on the alteration of the existing buildings and provision of additional plant would be about £8,000. It



View of Tramway Generator.

was also held that the cost of providing separate plant and buildings would in all probability amount to £40,000, and there would be a proportionate increase in the cost of working.

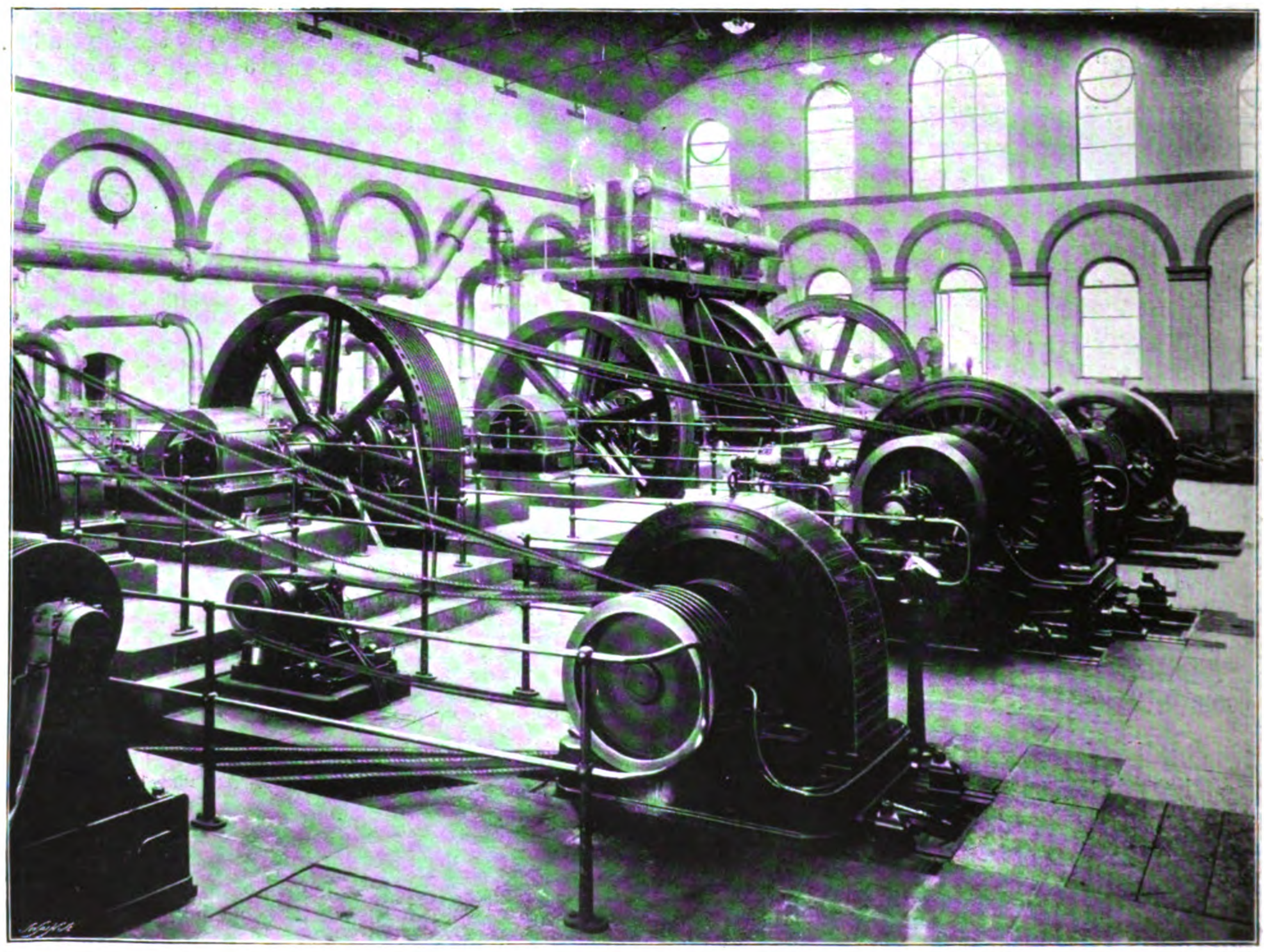
When we described the Halifax Municipal Electricity Works some three years ago,* the principal features noted were that the system was a high pressure alternating one, with sub-station and house transformers. The plant consisted of three Lancashire boilers, fitted with mechanical stokers, while the generating machinery consisted of three horizontal compound condensing engines, driving alternators by ropes. Two sets were of 100 kw. each, the third of 50 kw., and though the aggregate kw. capacity was not excessive, it proved sufficient to meet the requirements of Halifax for some time. Since our description appeared there has been some considerable extensions to the plant, chief of which is a fly-wheel alternator of 350 kw. This is driven by a compound vertical condensing engine of 600 I.H.P., fitted with Corliss valves. The dimensions of the cylinders are 18 inches × 35 inches × 3 feet, and the speed is 130 revolutions per minute. The alternator is of the fixed iron cored armature type, the revolving field magnets consisting of one winding with the poles staggered. A similar set is in process of construction, the only difference being in the dimensions of the cylinders.



Car descending Gibbet Street.

The original design of the Halifax municipal system paid great regard to the future expansion of electric lighting, and we need hardly point out that where engineers consider future developments, and arrange their buildings accordingly, the profit earning stage is not reached so early as in those systems which merely regard the demand of the moment. The lighting system has not shown a profit, though one would have been made last year if further reductions in the price of electricity had not been made.

In considering the tramway side of the undertaking in more detail, it will be convenient if we refer at this stage to the generating plant. It would be following precedent to refer to the steam-raising plant first, but in this case no additional boilers have been necessary, the spare boiler which had been provided to meet the development of the lighting having been utilised. As we have already remarked, Mr. Wilmshurst, in laying down the original plant, took some

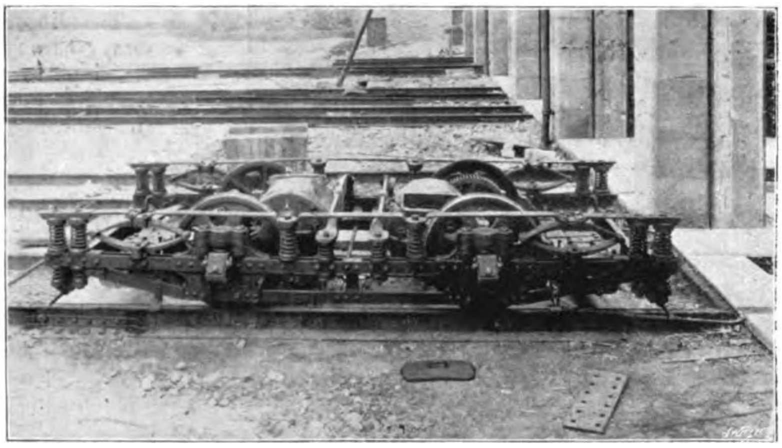


General View of Generating Station.

* February 1st, 1895.

heed for the morrow, and the addition of the tramway plant has not necessitated the extension of the buildings by a single yard, even the present considerable increase to the lighting machinery being accommodated in the original building.

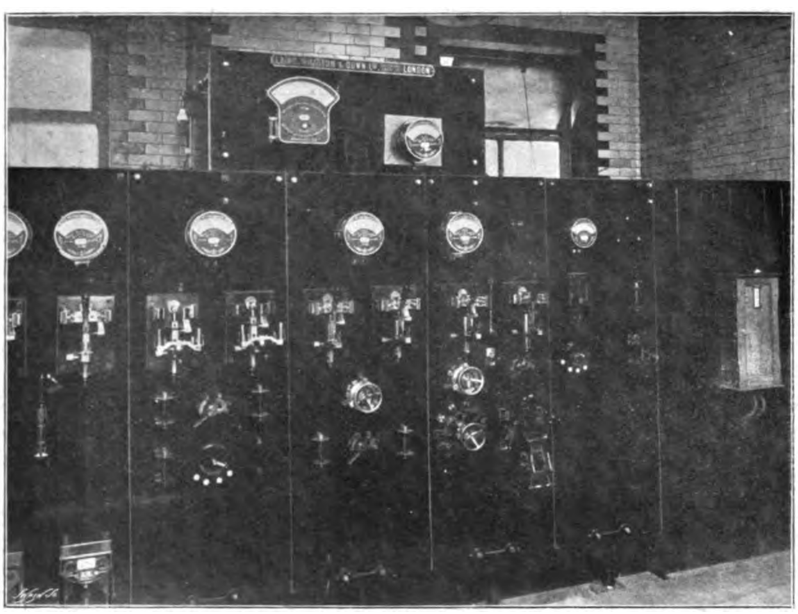
Upon entering the electricity works it is not easy, at first, to differentiate the tramway plant from that devoted to lighting, because, as will be seen by referring to the general view, the tramway generator and its engine are placed about the centre of the room, and is somewhat over-shadowed by the lighting plant that has been added during the past year.



View of Truck.

A solidly built generator, made by the Electric Construction Corporation, driven by ropes is the chief feature, indeed, at the moment, the only one of the tramway plant. The generator is of the four-pole type, having an output of 220 amperes at 500—550 volts. The engine which drives this plant was formerly employed in driving one of the lighting alternators. It does not differ very materially from the other horizontal steam motors used in these works, the only alteration being the substitution of a heavier fly-wheel than was formerly used, the increase in weight being about 100 per cent. In one corner of the building foundations are being made for a motor alternator, which will act as a kind of intermediary between the lighting and the traction systems.

This plant will consist of a continuous current machine, which will be connected by ropes to an alternating current motor. By driving this set from the alternating current circuits, the continuous current machine will be able to supply energy to the tramway circuits; but Mr. Wilmshurst is relying on this plant to be more useful than that. A battery of accumulators has been provided, and it is proposed to obtain a supply of electricity from this to drive the continuous current machine as a motor, and thus reverse the alternator for the purpose of supplying the lighting load at the time of minimum demand. This is the first instance in this country where accumulators have been used indirectly to supply electricity for alternating current circuits. Primarily, of course, the battery of accumulators has been laid down for the benefit of the tramway plant; but in Mr. Wilmshurst's programme it is destined to fill a good many parts.



Switchboard.

Practically it will fulfil three functions; firstly, it will act as a fly-wheel to the whole system; secondly, it will run the whole of the tramway service during the peak of the lighting load, and it will run the early morning cars; and, thirdly, by reversing the motor alternator, it will run the alternating lights during the hours of light load. Another important advantage of the battery from the lighting point of view, is that it will be possible, in all probability, to shut the station down at night, which will be a novel experience in an alternating system. This arrangement gives some indication of the way in which the combination of a tramway and lighting system materially helps the lighting side of the undertaking. The battery is made up of 270 cells of the well-known Chloride type. Each cell is made up of 63 plates placed in lead boxes, and the whole battery will discharge 150 amperes for 9 hours, 200 amperes for 6 hours, and 300 amperes for 3 hours. A motor-driven booster, which adds 150 volts to the traction bus bars, is provided for charging the battery.

The tramway switchboard is placed in a separate room, much after the manner of the lighting board. It will be seen from the illustration that as regards arrangement it does not differ greatly from other tramway boards. It is built up of a series of black marble panels fixed on an iron frame. It is essentially fireproof, and being built some distance from the wall, permits of easy access to the back. There are six panels:—(1) Feeder, (2) generator, (3) motor-alternator, (4) battery and booster, (5) Board of Trade, (6) voltmeters. An ammeter is provided on each board, and the feeders and generator panels are furnished with automatic cut-outs. The connections of the board are clearly shown in the diagram, but it may be observed that the instruments for testing the fall of potential in the rail are placed in a substation in the town. An Aron meter on the battery board indicates the charge and discharge of the battery.

The circuit breaker is of the Cutter type, and as we have not previously described it in these columns, the following description, taken from "Modern Switchboards," by Albert B. Herrick, may be interesting. The illustration shows the construction of this circuit breaker in side view, and in part section. "The main current circulates around the solenoidal coil, B, and tends to draw into the solenoid the movable plunger, C. The initial position of this plunger in the solenoid is determined by the adjusting screw, M. When the current is sufficient to overcome the weight of the plunger, it is drawn into the coil with constantly increasing velocity, due to intensified magnetic action, as the polar distance or air space is decreased. When nearing the upward limit of its travel, having acquired a high momentum, it impinges upon the trigger, N, through the medium of the push-pin, E. The immediate result of this is the release of the switch-arm by the displacement of the retaining catch, F. The upper projection, H, of the trigger, N, is thrust against the striker plate, K, thereby utilising the energy of the current to start the movement of the switch arm. This movement is intensified and sustained beyond the point of final rupture between the switch contacts by the thrust of the spring, O, which is released from compression by the initial action of the trigger. Thus the contact arm is thrown away from the contact terminal and the circuit is opened." Auxiliary carbon contacts are provided, which preserve the metallic contacts from the deleterious effects of an arc.

THE OUTSIDE WORK.

The line at the present moment is not a long one, and is under four miles in length, but the gradients and curves probably make it the most remarkable electric line in the country. A consideration of the sections of two portions of the line will demonstrate the natural difficulties that have had to be contended with in Halifax. We do not suppose there is a greater length of level track than 100 yards in the whole system, and in addition to the excessive gradients there are many sharp curves, one or two having a radius of only 30 feet. The section of line which traverses Gibbet Street and High Road Well is most remarkable; it is $1\frac{1}{2}$ miles in length, and from one end to the other there is a rise of over 375 feet, which practically gives an average gradient of 1 in 20. We give an illustration of the car standing at a point on the descent, but it does not altogether demonstrate the severity of the gradient. Though the present lines are steep enough, we believe the extensions, for which Parliamentary sanction has been partially obtained, include gradients of 1 in 10, which is almost equivalent to mountain climbing. We believe that an off hand opinion, based on a perfunctory survey of the town, would have declared against an electric tramway system and it is not surprising to find that cable tramway men considered electricity to be impossible. The results have completely falsified these views, and it is apparent that there are few places which cannot be worked by electrically-propelled cars. It is not surprising to learn that to propel a car up one of the gradients calls for an expenditure of current of nearly 100 amperes, practically equivalent to 65 H.P. used continuously from end to end. This is to some extent counter-balanced by the cars being able, on the return journey, to travel from one end of the line to the other without any current whatever; the cars, as a matter of fact, travelling from end to end of the line on the brakes. The question of brakes in a place like Halifax is naturally a serious one; in addition to the ordinary brake operated by hand, there is a slipper brake and an electric emergency brake provided on the cars. The slipper brakes are made to rub on the surface and in the groove of the rail, and the wear on the inner surfaces of these, which is of wood, is so great that they require to be renewed every day.

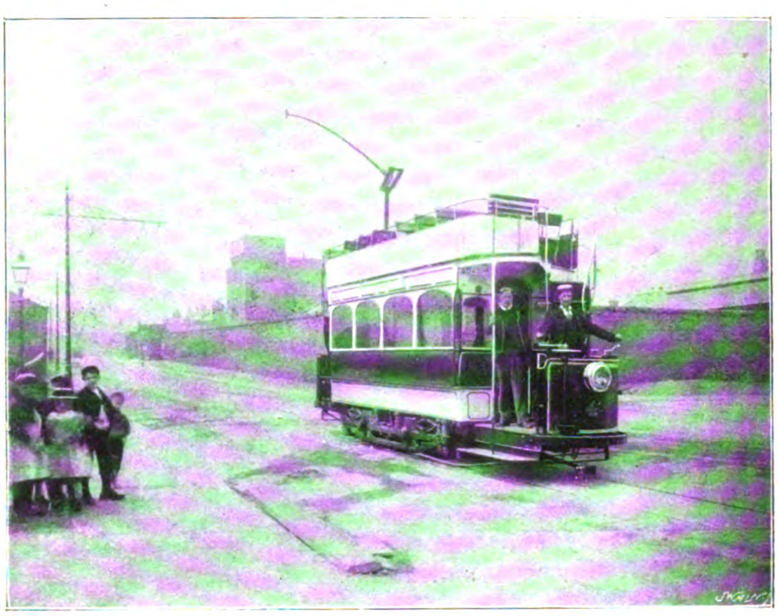
STREET VIEWS.

The slipper brake is operated by the driver through the agency of a hand wheel placed directly under the ordinary hand brake. It is obvious that the difficulties of the road call for the exercise of considerable skill in the operation of the cars, and the Halifax Corporation have engaged three or four skilled motorneers, who will drive the first series of cars and instruct new drivers.

Although the expenditure of energy to drive the car is occasionally heavy, it is quite likely that the consumption of current will not exceed one unit per car mile, owing to the cars travelling considerable distances without consumption of electric energy.

The gauge of the track is 3 feet 6 inches, the rails, which are of the girder section, weighing 98 lbs. per yard. The dimensions will be seen in the sectional drawing. The Columbia rail bond is used throughout, and is No. 0000 gauge ·46 inch. There are two bonds to each rail, cross bonds being used every 90 feet.

The principal features of this bond, which have been already alluded to in these columns,* consist of the ends or heads of the bond being placed in a thimble, which is placed in a hole in the rail. The contact of the rail and bond is made by a wedge expanding the thimble against the hole in the rail, as will be seen from the sectional drawing. The holes in the rails were drilled after the rails were laid, thus ensuring contacts being clean; the bonds were afterwards coated with tar.



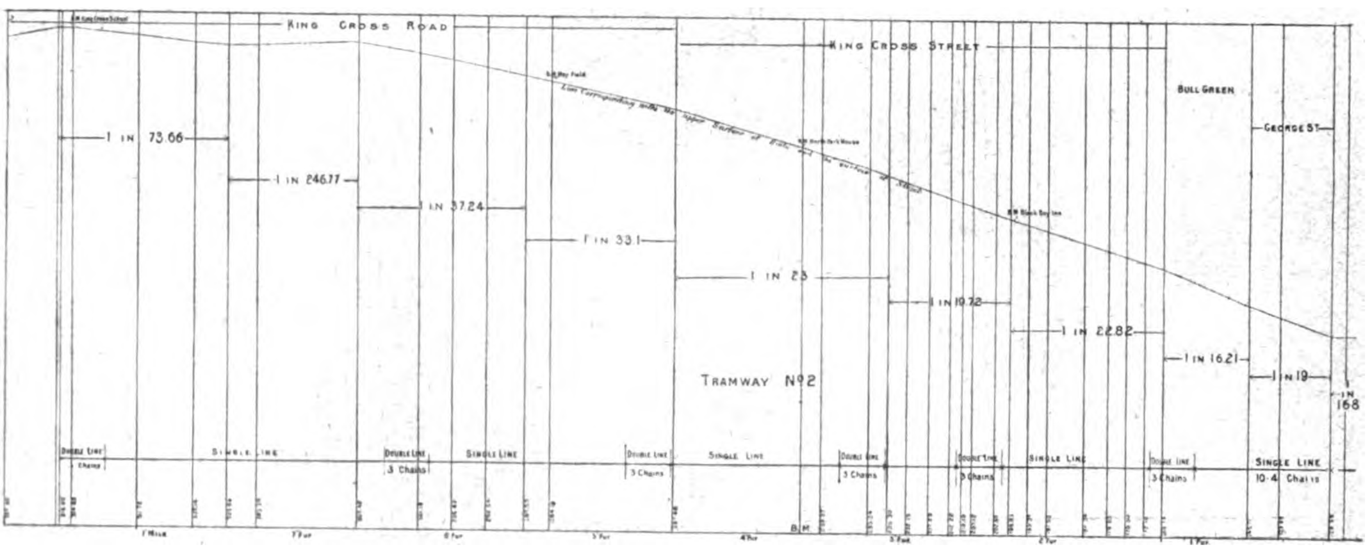
VIEW OF CAR ON LINE.

Although the line is for the most part only single track, two trolley wires are used nearly throughout the system, thus avoiding frogs. They are of 0 gauge, ·324 inch diameter, and are carried on side poles in the manner shown in the illustrations. The poles, which are of the steel tubular type, made by Messrs. Spencer & Sons, are placed 40 yards apart

* September 24th, 1897.

at the edge of the kerb, the arms supporting the trolley wire varying from 5 to 15 feet in length. In the centre of the town arc lamps of the alternating current type are suspended from the arms; the transformers for these are placed in the base of the steel posts, and the arrangement has proved so satisfactory, that an addition of 30 to the already existing 40 will be made before the winter. Owing to the large glow lamps. Outside seats are provided, the trolley of the Dickinson type being carried on a pillar some feet above the roof of the car. There is seating accommodation for 20 inside and 24 outside, the weight of each car complete being about 7 tons.

The car shed, which has been erected at the end of the Gibbet Street section, will accommodate 18 cars. It is



Section of one Route.

number of telephone and telegraph wires erected overhead, quite an elaborate system of guard wires has been rendered necessary, but with the eventual disappearance of the overheard telephone wires the necessity will soon cease. The guard wires are of galvanised iron, No. 7½, and are fixed about 2 feet above the trolley wire; they are efficiently earthed at different points. In accordance with what is now common practice, the overhead wire is arranged in half-mile sections, the boxes at these points containing four switch fuses and two Garton lightning arresters.

Two armoured feeders run from the works to a sub-station in the centre of town, and from here three cables radiate to Ward's End, King Cross, and Gibbet Street. A telephone and pilot wire cable, consisting of three 7/20 cables, is laid along side each feeder. All these cables are vulcanised bitumen. The feeders have ·15 square inch sectional area, and the return feeder (section ·33 square inch) being drawn in Doulton casing, and spare ways are left for extensions.

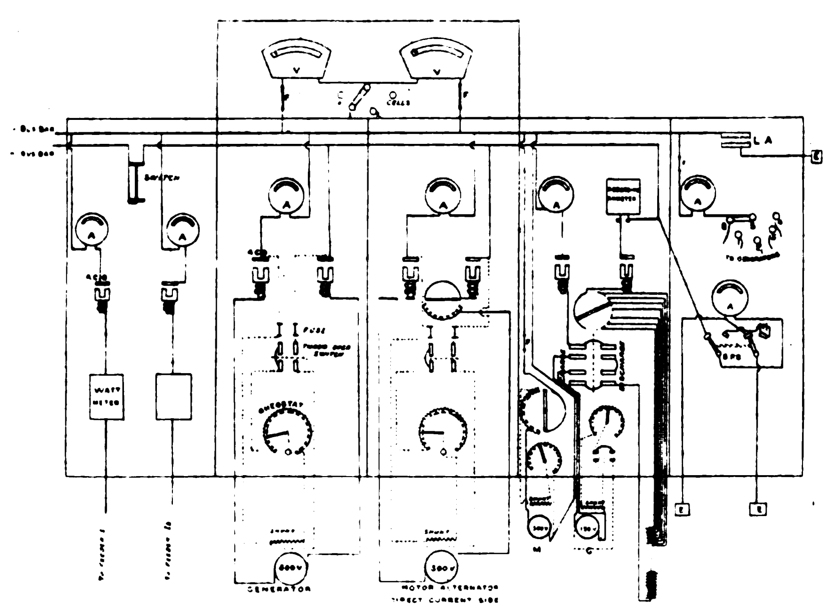


Diagram of Switchboard.

At the sub-station, which is an extension of a transformer lighting station, where the feeders are brought, feeder switches are arranged by which the various sections of the line can be controlled. At this point are also fixed the Board of Trade measuring instruments.

There are 10 motor cars at present, the trucks being of the Peckham type, having a wheel base of 5 feet 6 inches. The bodies are very similar to those employed on the Leeds lines, and are excellently designed and finished; they have been made by Messrs. Milnes & Son.

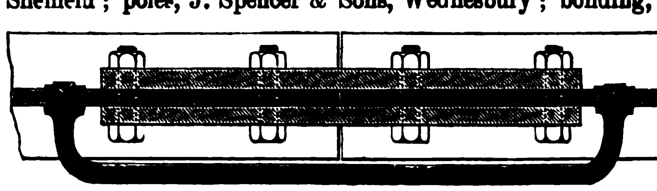
Each car is fitted with two motors of the E.C.C. enclosed type, B.T.H. controllers of the K type, and are lighted by 10

provided with inspection pits and equipped with a 6-ton travelling crane. Alongside are arranged repair shops, mess room, manager's office, &c.

It may be interesting to mention that the service of cars commences at 5.30 a.m., there being half-hourly cars till 8 a.m., when a 10-minutes' service is continued throughout the day. The two routes overlapping in the centre of the town constitute a five-minutes' service from there to the station. The speed in the town is limited to 7 miles an hour, and there are fixed stopping places.

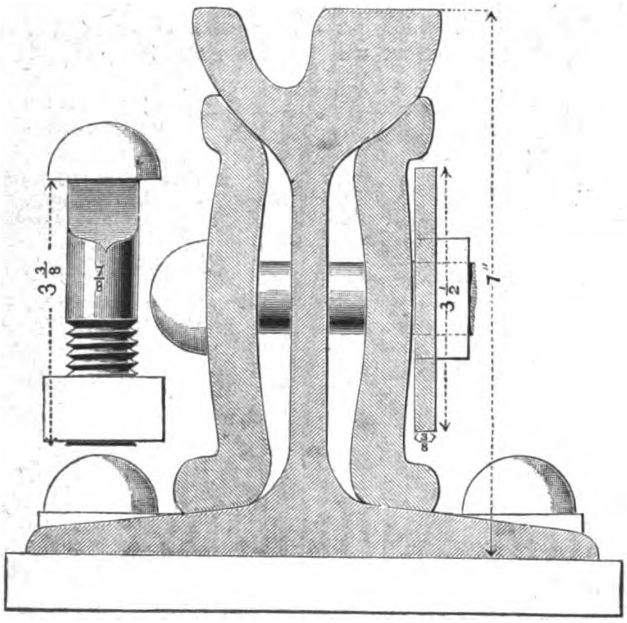
The tramways are controlled by a specially constituted Tramways Committee, which purchase current from the Lighting Committee at 2d. per unit. The Lighting Committee furnish the plant, the feeders, and the necessary feeding switches and so forth, but the rest of the equipment, including the overhead wire, is supplied by the Tramways Committee.

The following is a list of the principal contracts and contractors:—Car shed, J. Charnock and Sons, Halifax; rails, The Leeds Steel Works; points, Askham Brothers & Wilson, Sheffield; poles, J. Spencer & Sons, Wednesbury; bonding,



overhead equipment, car-trucks, motors, trolleys, generators, &c., The Electric Construction Company, Wolverhampton; car bodies, G. F. Milnes and Co., Birkenhead; accumulators, The Chloride Electric Storage Syndicate, Clifton Junction; switchboard, Laing, Wharton & Down.

The work has been superintended by the borough engineer,



SECTION OF RAIL AND FISH PLATE, AND DETAIL OF BOLT AND NUT.

Mr. E. R. S. Escott, the borough electrical engineer, Mr T. P. Wilmshurst, the traffic manager, Mr. Fred Spencer, while Mr. N. H. White has represented the Electric Construction Company.

We are especially indebted to Mr. T. P. Wilmshurst for the aid that he has given us in compiling the foregoing account of what is a most interesting system.

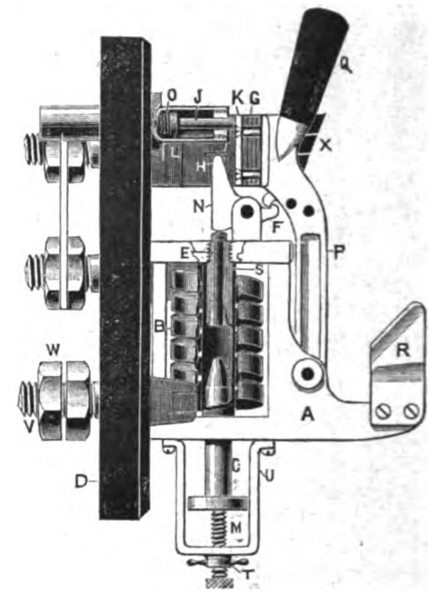
ELECTRICAL CABS IN PARIS.

THOUGH originally the spirit motor, useful enough for country work, made a fairly brave show in Paris, the electric cab seems, as in London, to be coming to the front, as it certainly ought to do in a city of asphalte paving. The cab trials of the Automobile Club just completed included only one vehicle of the petroleum order, all the rest being electrical. In fact, the Paris cab companies have made numerous experiments, which have caused them to throw over the petroleum cab and adopt electricity.

The Krieger cab, as illustrated in the *Engineer*, much resembles the electrical cabs in London. The Jeanteaud cab is after the fashion of the well known fiacre, while the cab of the Compagnié Générale des Transports was placed on a very long wheel base, and weighed 1,662 kilos by reason of possessing rapid charging accumulators, put in under a mistaken idea as to conditions to be met.

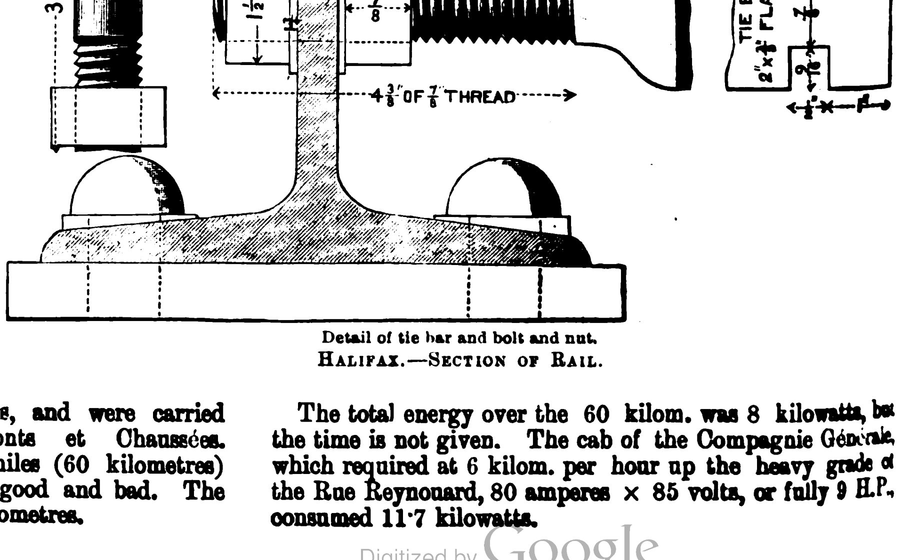
Preliminary tests were first made on the maximum speeds each cab could attain, their brake power, reversal facilities, and hill climbing capability. These were made on the gradients of Suresnes and Mont Valerian and along the Seine banks, and were carried out by M. Forestier, of Les Ponts et Chaussées. Then followed three routes of 37 miles (60 kilometres) each, of various description of road, good and bad. The average speed attained was 13 to 15 kilometres.

In the Krieger cab 866 of the total 1,360 kilos are upon the front wheels, and the cab carried three passengers and 70 kilos of baggage. Its Fulmen accumulators required seven to eight hours to charge. The front axle carries two motors geared to a toothed wheel bolted to the front wheels, which both drive and steer. The cab varied its expenditure of energy from 24 amperes at 92 volts at a speed of 18 kilom. per hour



HALIFAX.—SECTION OF CUTTER AUTOMATIC CIRCUIT BREAKER.

along the Champs Elysées and Avenue de l'Alma. It then mounted the macadam of the up grade Rue de Magdebourg at 6 kilowatts per hour, discharging 56 amperes at 85 volts, or, say, 8 H.P., next passing over bad and soft macadam at 15, 20, and 26 amperes, and finally down the Champs Elysées, registering 8 amperes, the motors now partially recuperating the accumulators. The effect of road surface was very marked. Level wood required 20 amperes, macadam 26, dry asphalte, at a lower speed, 15. Up hill at low speed, on greasy granite, 36, and again on asphalte 18, 16, and 22 amperes, according to speed.



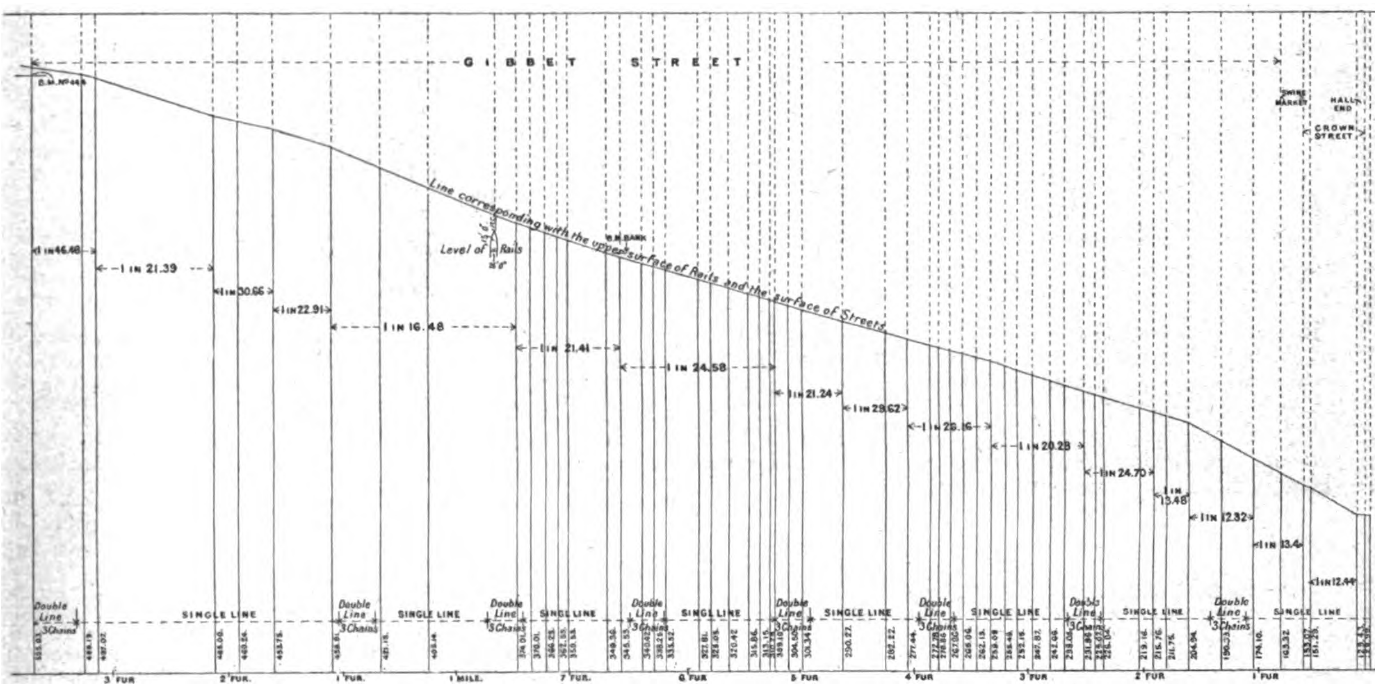
Detail of tie bar and bolt and nut.
HALIFAX.—SECTION OF RAIL.

The total energy over the 60 kilom. was 8 kilowatts, but the time is not given. The cab of the Compagnie Générale, which required at 6 kilom. per hour up the heavy grade of the Rue Reynouard, 80 amperes × 85 volts, or fully 9 H.P., consumed 11·7 kilowatts.

The Jeanteaud cab—two passengers—carried its accumulators, of Fulmen type, in front, and a simple motor geared to the rear axle. It expended at the rate of $7\frac{1}{2}$ H.P. on the Rue de Magdebourg, but on the whole course of 60 kilometres about 8·5 kilowatts in $4\frac{1}{2}$ hours, an average of about $2\frac{1}{2}$ H.P. for a very respectable speed. The Peugeot cab—with a two-cylinder motor—is well spoken of by the *Engineer*, and is faster than the electric cabs, and there is no vibration when running, though this is bad when standing—our own experience also.

It consumed 13 litres of petroleum spirit in running 60 kilometres, or say, fully $2\frac{3}{4}$ gallons, and it used at the same time $1\frac{3}{4}$ gallons of cooling water.

This corresponds with, say, 0·6 of a lb. of fuel per mile. Thus, such a vehicle would run from London to St. Albans and back, with about 24 lbs. of fuel, or, say, 3 gallons.



HALIFAX.—SECTION OF ANOTHER ROUTE.

The trials all point to the conclusion to which previous experience points, that for city work the electrical cab is coming to the front, and for country roads, less suitable for accumulators and less convenient as regards re-charging, the spirit motor will find its chief field, leaving the heavy work probably to steam. We would not at present advise the trial of electricity beyond narrow limits.

CONTRACTS OPEN AND CLOSED.

(*Continued from page* 882.)

Bulgaria.—June 27th. Some little time ago the municipal authorities of Sophia, Bulgaria, invited tenders for the concession for the electric lighting of the public streets of the city, and for the construction and working of an electric tramway. The authorities are again inviting tenders, until the 27th inst., for this concession, particulars of which may be obtained from above.

Cardiff.—June 28th. The Corporation wants tenders for two water-tube boilers for the electricity works. Particulars from the borough electrical engineer, Mr. Appelbee; also see our "Official Notices" June 17th.

East London (Cape Colony).—June 28th. The Town Council is inviting tenders for erection of buildings and the supply of electric lighting machinery, electric tramcars, plant, rails, &c., and for their maintenance for six months from completion. Particulars from Messrs. Dyer & Dyer, 17, Aldermanbury, London, E.C., on payment of £5, repayable on the receipt of a *bonâ fide* tender.

Edinburgh.—June 30th. The Corporation wants tenders for the supply of copper strip for electric conductors. Particulars from the resident electrical engineer, and see our "Official Notices" June 17th.

France.—June 30th. Tenders are being invited by the municipal authorities of St. Laurent de la Salanque, a small town of about 4,500 inhabitants in the Pyrenées Orientales, for the concession for the electric lighting of the public streets. Full particulars may be obtained from, and tenders to be sent to, Le Maire, de St. Laurent de la Salanque, Pyrenées Orientales, France.

France.—July 7th. Tenders are being invited by the French Post and Telegraph authorities in Paris for the supply of 760 metrical tons of galvanised iron wire, and 617,000 porcelain insulators. Particulars may be obtained from, and tenders to be sent to, Le Sous-Secretariat d'État des Postes et des Telegraphes, Rue de Grenelle, 103, Paris.

Hammersmith.—July 4th. The Vestry wants tenders for the supply of eight 25-kw. transformers. Particulars from the Vestry Clerk (Mr. W. P. Cockburn), Town Hall; also see our "Official Notices."

Heckmondwike.—June 30th. The directors of the Heckmondwike Industrial Co-operative Wholesale Society want tenders for an electric light installation (about 500 lights) including generating plant for their premises. Consulting electrical engineer, Mr. Walter Leake, 51, Victoria Buildings, Manchester. See our "Official Notices" June 17th.

Hull.—July 1st. The Corporation wants tenders for wiring and the supply of fittings for the East Hull Baths. Particulars from the city engineer (Mr. A. E. White). See our "Official Notices" June 17th.

Leeds.—June 29th. The Council requires tenders for two engines and dynamos of about 1,000 H.P. each; also for 50 electric tramcars. Particulars from Dr. John Hopkinson; also see our "Official Notices" June 17th.

Melbourne.—August 16th. The City Council is inviting tenders for the supply and delivery of arc lamp carbons. See our "Official Notices."

Newington.—July 1st. The Vestry of St. Mary invites tenders for the construction, supply, and erection of boilers, pumps, steam and water mains, water tank, surface condenser, fuel economiser, &c., for the electricity works in Penrose Street, Walworth. Consulting engineers, Messrs. Kincaid, Waller & Manville. See our "Official Notices" June 17th.

Shanghai.—August 10th. The Shanghai Municipal Council invites tenders for the supply of two 100-kw. direct coupled steam alternators, switchboard, and water-tube boiler. Particulars and specifications to be obtained from Messrs. John Pook & Co., 8, Jeffreys Square, St. Mary Axe, E.C., to whom tenders have to be sent. See our "Official Notices" this week.

St. Pancras.—July 12th. The Vestry wants tenders for condensing plant, steam pipes, &c., for the Regent's Park generating station, 47, Stanhope Street, N.W. Particulars from the chief clerk, Electricity Department offices, 57, Pratt Street, N.W. See our "Official Notices" this week.

Tunbridge Wells.—June 27th. The Corporation wants tenders for the electric wiring of the new baths in Monson Road. Particulars and specifications at the Borough Surveyor's Office.

Victoria.—June 24th. The Council of the city of Hawthorne (Colony of Victoria, Australia) is inviting tenders for the supply and erection of buildings, boilers, engines, dynamos, transformers, mains, meters, arc lamps, poles; also running the plant for three years. See our "Official Notices" March 11th.

Wimbledon.—June 27th. The District Council wants tenders for the installation of the electric light mains and fittings in the new depôt buildings in Queen's Road, Wimbledon. Particulars from the Council's engineer, Mr. C. H. Cooper. See our "Official Notices" June 17th.

York.—June 24th. The Corporation is inviting tenders for the erection of an electric light station. Particulars from the City engineer, Guildhall.

CLOSED.

Ayr.—The Police Commissioners have given the contract for the new electric light posts to Messrs. Macfarlane, Glasgow.

Bristol.—The City Council has given an order to Messrs. D. Parsons for electric lamp posts (£1,467) for street lighting; and to Messrs. Willans & Robinson for an additional engine at £2,255.

London.—The London County Council on Tuesday referred to committee for consideration, and report the following tenders opened for the supply of engines and dynamos for the electric lighting of the Crossness outfall works:—

J. Fowler & Co., Leeds (for two dynamos and accessories only)	£860
W. R. Renshaw & Co., Stoke	4,497
Calvert & Co., Manchester	4,600
Scott, Anderson & Beit, Sheffield	4,750
Safety Concentric Wiring Company	4,990
Laing, Wharton & Down	5,455
Edmundson's Electricity Corporation	5,530

The following tenders for cables and wiring for the same installation were similarly referred to committee:—

Fowler, Lancaster & Co.	£2,560
National Electric Free Wiring Company	2,630
J. H. Pickup & Co.	2,712
Scott, Anderson & Beit	2,770
Calvert & Co.	2,800
British Insulated Wire Company	2,898
Allingham & Fennell	2,943
H. T. Rogers	2,950
Safety Concentric Wiring Company	3,250
Laing, Wharton & Down	3,484
A. H. Wood	4,880
J. Jenkins & Sons	5,050
T. H. Taylor	5,800
G. Stegman	6,225
Sax, Slatter & Co	6,500
Walsall Electrical Company	6,912

Yarmouth.—The Council has given Messrs. Gray and Palmer the contract for electric light wiring and fitting at the Isolation Hospital, at £73 odd.

FORTHCOMING EVENT.

1898.

Friday, June 24th at 5 p.m.—Physical Society. Agenda:—1. Exhibition of an Apparatus illustrating the action of two coupled Electric Motors, by Prof. Carus-Wilson; 2. Exhibition of Weedon's Expansion of Solids Apparatus, by Mr. J. Quick; 3. "On the Theory of the Hall Effect in a Binary Electrolyte." By F. G. Donnan, M.A., Ph. D.

NOTES.

New Cable.—The cable ship, *Faraday*, left the works of Messrs. Siemens Bros. & Co., Woolwich, on Wednesday afternoon with some 670 miles of submarine cable on board for the West Indies, to the order of the West India and Panama Telegraph Company. The manufacture and testing have been supervised by Sir Samuel Canning and Mr. T. E. Gatehouse, and the cable is certainly one of the best ever made, and reflects every credit upon the contractors. Mr. Graham, of Messrs. Siemens's staff, accompanies the expedition as electrician-in-charge.

Personal.—We understand that Mr. Walter Riggs, A.I.E.E., has resigned his position as outdoor manager to the Liverpool branch of the Westminster Engineering Company, Limited, of 27—31, Regency Street, Westminster, to take up an appointment on the Peninsular and Oriental Steamship Company.

Local Authorities and Electric Lighting.—The Bill to confirm the electric lighting provisional orders which have been granted by the Board of Trade to the Vestries of Bermondsey and St. Marylebone having been referred to a Select Committee, objection has been taken, on behalf of the vestries, says the *Times*, to the right of the companies to appear before the Committee in opposition to the orders being confirmed. The question of the *locus standi* of the companies will therefore have to be decided by the Court of Referees. The companies who have lodged petitions against this Bill, and whose *locus standi* is now called in question, are the London Electric Supply Corporation, the Metropolitan Electric Supply Company, the County of London and Brush Provincial Electric Lighting Company, the Chelsea Electric Supply Company, and the St. James's and Pall Mall Electric Light Company.

The following letter on this subject has appeared in some of the London papers, from the pen of Mr. J. B. Braithwaite, jun., whose interest in electrical companies is well known:—

27, Austin Friars, E.C., *June 18th.*

Sir,—The importance to investors in electric lighting undertakings of the questions raised by the Bill now before Parliament under which the Vestries of Marylebone and Bermondsey are seeking to obtain powers to compete with existing electricity supply companies within their area, and the fact that my firm has acted as brokers to many important electric lighting issues, must be my apology for addressing you upon this subject.

Something like £5,500,000 nominal capital is now invested in electricity supply companies in the metropolis, on the security of provisional orders granted by the Board of Trade and confirmed by Parliament after the local authority had (*a*) declined to undertake the supply themselves, and (*b*) given their consent to the application for a provisional order by the company.

In most districts two companies are in competition, thus protecting the public against any fear of a monopoly. In all cases the local authority has the right to purchase the companies' undertaking at the expiration of 42 years from 1889, thus securing the reversion of the business to the ratepayers within a reasonable time.

It should be borne in mind, that under the Electric Lighting Act of 1888, the vestries and other local authorities had an equal right with any company to apply for and obtain the grant of provisional orders for the supply of electricity within their areas, and in practice the Board of Trade has always insisted upon the consent of the local authority being obtained to the application of any company for a provisional order.

The local authorities have thus had to face the question of undertaking the supply themselves in preference to allowing a company to do so, and in many cases where they decided to do so, the Board of Trade have given them the provisional order, and refused all applications made by companies. In many cases, however, after full consideration, and obtaining the best expert advice possible, the local authority decided not to undertake the supply itself, but to support the application of a responsible company in preference.

Thus, with the consent of the local authorities in various parts of the metropolis, electricity supply companies are now engaged in supplying the public, and now that the shareholders have risked their capital and through their enterprise the industry has been proved to be a profitable one, it would seem unreasonable that the local authority should be allowed to turn round and reverse its former decision and undertake the supply of electricity itself in competition with the company, whose undertaking it has the right to purchase at the end of a period of years.

Should this practice be allowed, it would be obviously extremely unjust to those who have invested their money in proving the possibility of electricity being supplied at a profit, and would effectually prevent any future companies being formed for any industrial enterprise in which in the event of success they will have to face competition from local authorities using the ratepayers' money against them.

No company can object to fair competition, but when a local authority first encourages a company to incur large expenditure, and then, when the business proves to be profitable, brings in money borrowed on the rates to deprive them of the fruits of their enterprise, it is not competition, but——

If it is desired that power should be given to local authorities to reverse the decision which many of them came to many years ago not to undertake the supply of electricity themselves, it seems only reasonable that, as a condition of the provisional order being now granted to them, they should at least be required to come to some equitable arrangement for the purchase of the company or companies which may already be supplying electricity in their district, and doubtless in Committee a clause embodying this or some other method of effectually safeguarding the interests of the existing supply companies will be introduced.

Apologising for the length of this letter,

I am yours faithfully,

J. B. Braithwaite, Jun.

The Metropolitan Electric Supply Company, Limited has issued a statement of its case against the provisional order promoted by the Vestry of Marylebone seeking powers to enter into competition with it. The memorandum concludes thus:—"Having regard, therefore, to the whole circumstances, it is very respectfully but firmly submitted that to give a local authority, without sufficient cause, power to compete with a company efficiently exercising powers granted by Parliament with the consent of that local authority, would be contrary to the intention and policy of Parliament, not only in respect of electric lighting, but also of gas, water, and tramway undertakings, and would, by the shock to public confidence, gravely discourage investment in any enterprise which depended for success on a fair and reasonable interpretation of the intentions of Parliament. It is believed that Parliament has never given powers to any corporation to compete with a company authorised by private Act or provisional order to supply gas, water, or tramway service, and if there is any precedent in the case of electric lighting, it has been created by the Board of Trade without the attention of Parliament having been directed to the question, in consequence of the confirming Bill not having been opposed."

Obituary.—The death is announced of Mr. John Henry Beckwith, M.I.M.E., who had been for the past 30 years connected with Galloways, Limited, engineers, Manchester. For the greater portion of this period he acted as works manager, and for the past 10 years, as a director of the company. He took great personal interest in the various International Exhibitions with which Messrs. Galloways' name has been closely identified, and designed many installations of engines, &c., for rolling mills, hydraulic installations, and other purposes.

We regret to hear of the death, which occurred on 14th inst., of Mr. William Rickard, the founder and sole proprietor of the Ashbourne Road Mills, Derby, where he had for years past carried on business as a wire manufacturer and coverer, and cable manufacturer. The business will continue to be carried on under the same management as heretofore.

We are sorry to learn of the death of Captain Davies, managing director of the Exchange Telegraph Company, which occurred on Tuesday last, at the age of 73. He had been managing director of the company since its inception in 1872, and, with Sir J. Anderson and Mr. Cyrus Field, was one of its founders. Prior to his connection with the Exchange Telegraph Company, Captain Davies had been in the service of the Pacific Steam Navigation Company and the Peninsular and Oriental Steam Navigation Company.

We read, with regret, in our American exchanges, of the death of Dr. Chas. E. Emery, Ph.D., which took place at Brooklyn on June 1st, heart failure being the cause. Dr. Emery was well known in America as a consulting engineer, and his name will be familiar to our readers in connection with the controversy on steam engines for electric traction. Thirty years ago Dr. Emery had charge of the construction of U.S. war and other vessels. In the eighties the Institution of Civil Engineers, London, awarded him the Telford Prize for a paper read by him. He was a prominent member of the American Society of Mechanical Engineers, and was president in 1896-7 of the New York Electrical Society, as well as a member of the American Institute of Electrical Engineers. He was a non-resident professor of Cornell University. He was also a member of the American Society of Civil Engineers. An exchange says that "he was not only an engineer in theory, but in actual practice, and had several patents for important improvements in machinery." He was connected with the New York Steam Company as consulting engineer at the time of his death.

Glasgow Technical College Scientific Society.—On 11th inst. the members of this society visited the new works of Messrs. Mavor & Coulson, Limited. At a meeting of committee held later the report of Dr. H. Dyer (convener of the teaching staff of the college) on the papers sent in for the society's annual competition, was read. The report stated that the paper on "Multiphase Electrical Machinery," signed "Electra," was a production giving evidence of considerable knowledge of the subject, and was recommended for the award. The author was Mr. A. Stewart, to whom the gold medal will accordingly be presented.

Marriage.—On 13th inst. Mr. Frank Christy, senior partner of the firm of Christy Bros., electrical engineers, of Chelmsford, was married at Leominster to Miss Clara Nellie Geaussent.

The Institution of Electrical Engineers' Conversazione.—There was a large and brilliant company at the Natural History Museum, Cromwell Road, on Thursday, 16th inst., for the Institution Conversazione. The guests were received by the President, Mrs. Swan and the Council. An excellent programme of music was performed by the string band of the Royal Engineers under the conductorship of Mr. J. Sommer. Everything passed off very satisfactorily. Among those present were the following:—

Mr. J. W. Swan, F.R.S., President.

Prof. W. G. Adams, F.R.S.
Mr. G. L. Addenbrooke
Mr. H. Alabaster
Mr J. F. Albright
Mr. L. Andrews
Prof. W. E. Ayrton, F.R.S.
Sir B. Baker, K.C.M.G., F.R.S.
Mr. Shelford Bidwell, F.R.S.
Sir A. R. Binnie
Mr. M. Blumbach
Mr. S. L. Brunton
Prof. Capper
Prof C. A. Carus-Wilson
His Excellency the Chinese Minister
Mr. Latimer Clark, F.R.S.
Mr. Dugald Clerk
Prof. F. Clowes, F.R.S.
Mr. S. Cowper-Coles
Capt E. W. Creak, R.N., F.R.S.
Mr. R. E. Crompton
Sir William Crookes, F.R.S.
Sir A. Durston, K.C.B.
Mr. H. Edmunds
Prof. Ezaroff
Mr. S. Evershed
Mr. C. E. Fagan
Mr. W. P. J. Fawcus
General Festing, C.B., F.R.S.
Prof. G. F. FitzGerald, F.R.S.
Sir W. H. Flower, K.C.B., F.R.S.
Prof. George Forbes, F.R.S.
Prof G. Carey Foster, F.R.S.
Sir E. Frankland, K.C.B., F.R.S.
Mr. E. Garcke
Dr. W. Garnett
Dr. J. H. Gladstone, F.R.S.
Mr. W. T. Goolden
M. Gyeorguiewsky
Prof. F. L. V. Harcourt, F.R.S.
General Sir R. Harrison, K.C.B. (Inspector-General of Fortifications).
Admiral Lord John Hay
Prof O. Henrici, F.R.S.
Dr. E. Hopkinson
Prof. W. H. Hudson
Prof. D. E. Hughes, F.R.S.
Mr. Holman Hunt
Lord Kelvin, G.C.V.O., F.R.S.
Prof. A. B. W. Kennedy, F.R.S.
Lord Loch, G.C.B.
Sir Philip Magnus
Mr. W. G. McMillan (Secretary
Sir Henry Mance, C.I.E.
Major-General J. Mann, R.E.
Master of the Saddlers' Company
Master of the Salters' Company
Mr. H. S. Maxim
Mr. H. W. Miller
Sir S. Montagu
Mr. W. M. Mordey
Mr. S. Morse
Mr. Kenric B. Murray
Sir Hugh Owen, K.C.B.
Major Flood Page
Sir W. Peace, K.C.M.G.
Dr. W. H. Perkin, F.R.S.
Prof. J. Perry, F.R.S.
Mr. J. Denison Pender
Mr. W. H. Preece, C.B., F.R.S. (President Inst. Civil Engrs.)
Sir A. Ramsay
Dr. W. Ramsay, F.R.S.
Mr. J. S. Raworth
The Rev. A. Robertson
Sir E. M. Shaw, K.C.B.
Mr. Dane Sinclair
Prof. R. H. Smith
Mr. James Swinburne
Mr. Cameron Swan
Sir D. Tennant
Prof. S. P. Thompson, F.R.S.
Dr. T. E. Thorpe
The Rev. Dr. Wace
Prof R. M. Walmsley
Mr. F. H. Webb
General C. E. Webber, C.B.
Mr. Henry Wilde, F.R.S. (Honorary Member)
Sir E. L. Williams
Mr. J. Wimshurst, F.R.S.
Mr Edward Woods
Sir H. Trueman Wood
Mr. C. H. Wordingham

Water-Tube Boilers in Ships of War.—Perhaps before these lines are in print an opportunity may have presented itself for testing water-tube boilers in actual war service. We are informed that the Spanish ships *Pelayo* and *Christobal Colon*, the latter an armoured cruiser, have Niclaussé type boilers, and these have been spoken of as better than the Belleville type. It is thus extremely probable that information of a practical kind may be forthcoming. We have a very poor opinion of any steam boiler, water-tube or any other kind, if exposed to the shock of a shell exploding within it. We may be wrong, but we think any injury to the boilers of a war vessel would expose such vessel to immediate defeat. Of course, the failure of one boiler, if it does not actually explode, may only result in cutting it out of service, but what of the flood of hot water and more or less escaping steam at a critical moment. Even at best a ship would be merely a floating battery; it could not manœuvre, and if it lost all its steam, it is questionable if it could work its guns. There would be neither water-power, compressed air, nor electricity.

Presentation.—Mr. J. C. A. Ward, of St. Pancras, who has been appointed superintendent of mains under the Glasgow Corporation, was, previous to his departure, presented by the St. Pancras Vestry electricity staff with a handsome gold chain with 1898 sovereign attached, upon which a suitable inscription was made.

The Parliamentary Electrical Energy Committee.—In the *Chorley Guardian* for Saturday last, Lord Balcarres, M.P. for Chorley, who, it will be remembered, was a member of the Select Parliamentary Committee on Electrical Energy (generation and supply), writes some notes regarding the Committee's proceedings. He says:—

I cannot claim that the direct results of our labours have been very satisfactory. The Committee was equally divided in opinion, and on a dozen critical occasions our votes were equal in number—four on each side. The Committee was initiated by the Lords; we sat in their House, and deliberated according to their standing orders. It is strange that in so business-like an assembly as the Upper House, there is no escape from the dilemma of a tie. The chairman has no casting vote, and when a division shows equal numbers, the question is settled in the negative. So our report is a document which few members of the Committee would accept as a solution of the problem; indeed, I question whether it satisfies a single member of the Committee; I certainly would refuse to sign it as an expression of my own opinions. However, our report is not mandatory, and the inquiry has not been useless by any means. In the first place we have collected valuable evidence from expert witnesses; we have shown how prejudicial legislation has been to the development of electrical industries, and how the consumer has been obliged to pay unreasonable prices for his light. In short, we demonstrate the urgent necessity for a careful modification of the 1882 and 1888 Acts. Moreover, this is the first time that Parliament has seriously examined the important progress of recent science. The powers of the Board of Trade are large, but they should be widened. The powers of municipal bodies are also large—so large that private enterprise is discouraged. Some corporations want to get the whole business into their own hands; the London County Council wishes to abrogate the rights of 40 local authorities in the metropolis—some of which have populations of 250,000, and even 350,000. Many technical questions arise, and it would not be of interest for me to refer to them here. One of them, however, has a general bearing upon the position of all local authorities. It is provided that, after a certain period, local authorities may buy up the local companies, or any part of their plant—mains, for instance—situated within their own area. This right was given when lighting was the prime function of electricity. Lighting is a civic, communal obligation, and the local authorities should have this privilege. When absent in the case of private gas companies, the public is protected by the sliding scale. But in a few years time lighting will be a subsidiary matter—sometimes nothing more than a bye-product. Should local authorities retain the option to purchase undertakings which supply energy in bulk for motive purposes to factories, workshops, or railways? The distinction between electricity in bulk and electricity for lighting should be defined; the task is difficult, I admit, because one concern can supply both. But discrimination is not impossible, and unless it be achieved, there will be hopeless irremediable confusion when the time for statutory purchase arrives. The Board of Trade should note that lighting is communal, and that energy for motive power is commercial. In the case of the proposal mentioned above, it will be impossible for all the local authorities interested—150 or more of them—to agree among themselves as to the purchase of a huge undertaking which has mains under every authority, transforming stations under others, and one vast generating engine house in the district of a country authority. One might as well ask a group of local authorities to buy up a railway company or the Manchester Ship Canal. Is it not a fit subject for legislation?

The Blackwall Disaster.—It is the unexpected that happens, and surely in the whole category of accidents, nothing more unforeseen than the terrible calamity with which the launching of the warship *Albion* terminated has ever occurred. The sympathy of everybody in the United Kingdom will be extended to the relatives of the unhappy victims of this act of thoughtlessness—for it appears that no blame can be attributed to anybody but to those who became immersed—and also to Mr. Hills and the staff of the Thames Ironworks in this their hour of trial. Especially will electrical men feel for the young electrician, who, if report is to be credited, was suddenly confronted with the dead bodies of his aged mother and young, recently married, sister, who were brought into the dynamo room where he was in charge, and which, for the time, was turned into a mortuary.

The "Arc Works" Sports.—The annual sports in connection with the Arc Works' club (Messrs. Crompton & Co., Limited) took place on Saturday at Chelmsford, in glorious weather. There were 19 events.

Municipal Corporations Association.—On 14th inst. a meeting of the Municipal Corporations Association was held in London to consider, among other things, the Manchester Carriage and Tramway Company's Bill, the Midland Electric Provisional Order Bill, and the General Power Distributing Company's Bill, all of which propose to supply electrical power in bulk to the local authorities and private consumers. The secretary was instructed to watch the progress of the Bills in Parliament, and should the exigencies of the situation require concerted action, to call a further meeting of the Corporations Association.

Electric Search Lights as Weather Signals.—The *Monthly Weather Review* for February contains a note (reproduced in New York *Science*) on the use of electric search lights for the purpose of disseminating weather forecasts. The search light of the U.S.S. *Maine*, which was at the time nearly completed, was, in February, 1895, loaned by the Navy Department to the Weather Bureau for temporary use in Chicago, in experiments designed to test the efficiency of such a means of distributing warnings of coming important weather changes. The light, which had a lens 30 inches in diameter, and whose candle-power was estimated at about 100,000, was erected on the roof of the Auditorium Building in Chicago, at an elevation of 270 feet above the level of the street. It was used but once, on February 28th, 1895, in giving a warning of a coming cold wave, the light being slowly revolved at the rate of one revolution in five minutes. The night was dark and cloudy, and the signal was seen at a distance of 20 miles. A number of experimental trials were also made, and it was concluded that search lights are not useful for the purpose of disseminating forecasts except under the most favourable circumstances. The compiler of these "Notes" recalls that a number of years ago a similar attempt was made during one summer to flash weather forecasts from the summit of Mount Washington, in New Hampshire (6,279 feet). This was a private enterprise, in the nature of an advertisement, but was fairly successful as far as the distribution of the forecasts was concerned.

The Telephone an Aid in Emergency.—Several dramatic incidents were reported in connection with the flood at Shawneetown, Ill., a few weeks ago, but, says the *Western Electrician*, none possess more interest than the heroic attempts that were made by the telephone company's employés to give the alarm and summon relief. Cypress Junction, which is five miles from the scene of the flood, was the first place to hear the news. The bulletin came by long-distance telephone. It was of dramatic and horrible brevity: "The levee has broken! The water is rushing in from the bend a mile and a half up the river. Already 250 people are drowned in the lower part of town, and——" At this point the operator sending the message ceased speaking, the wires went down, and all efforts to regain connection with Cypress Junction failed. A few particulars were received at Evansville, Ind., some time afterward. Two citizens of Shawneetown who had escaped the flood rowed a skiff to a small town near by, and telephoned the brief facts of the catastrophe. They had but few details to give. An appeal for aid was received by the Mayor of Evansville later in the evening. The message was transmitted by a telephone lineman, who climbed a pole four miles above Shawneetown and made a temporary connection to call for aid. Other towns in Indiana were also notified and a few details were thus gathered. The manager of the telephone exchange at Shawneetown gave Mount Vernon its first definite news of the big inundation at the little city down the Ohio River. His message contained the following statement:—"I am four miles from Shawneetown now. I escaped, and made my way here with a portable telephone. I climbed up a telephone post and made a connection, and that is how you are getting the news." The telephone company's employés proved themselves to be heroes of the occasion. Their energetic and intelligent efforts ensured immediate relief for the sufferers, and demonstrated again in no unmistakeable manner the importance to every community of electrical communication with the outside world. Had it not been for the telephone, neighbouring cities could not have been notified of the dire necessities of the people of Shawneetown, and relief expeditions could not have been summoned as speedily as they were in this case.

Smoke Nuisance.—The Metropolitan Electric Supply Company, Limited, were summoned at Bow Street on Wednesday for not complying with a magisterial order calling upon them to abate a smoke nuisance. It will be remembered that the company was fined for a number of cases on May 18th, but the nuisance was not abated. Counsel on behalf of the St. Giles Board of Works said that there were about 30 other summonses since the last cases were heard. It was shown that the company were using the best coal now in the market, but to prevent smoke with this coal they would be bound to reconstruct their furnaces, which would take 10 or 12 months, and involve enormous expense. After a lengthy hearing, Sir James Vaughan said he was satisfied that the company had done all in their power to mitigate the nuisance, and marked the summonses "No conviction." It was stated that the prosecution was forced on the Vestry by the L.C.C.

A batch of similar summonses against the Charing Cross and Strand Electric Supply Corporation were withdrawn by the St. Martin's Vestry.

A Danger in Using Gas Voltameters.—Users of gas voltameters should bear in mind that gases prepared by electrolysis are reputed to possess great activity. They will know what is meant by the active condition of a gas. In the *Zeitschrift für Elektro-Chemie*, Vol. 4 (14), page 342, F. Winteler discusses this subject, and points out a danger which is certainly associated with the use of gas voltameters. When the oxygen and hydrogen are collected together in one tube, it may happen, when the tube is nearly full of the explosive mixture, that the electrodes project into the gas. If the electrodes possess the power of occluding gases they may cause an error by inducing the slow recombination of the gases, or the recombination may be so rapid as to produce an explosion. In any case, this is due to the occlusion of the gases by the electrodes, and not to any special activity of the gas. Reference is also made to another source of error in voltameters, viz, the solubility of the oxygen in the electrolyte, and its diffusion to the cathode, where it is again reduced.

NEW COMPANIES REGISTERED.

Alliance Electrical Company, Limited (57,770).—Registered June 14th, with capital £1,000 in £1 shares, to carry on the business of electricians, electrical, gas, and mechanical engineers, artificers in metal and wood, slate workers, suppliers of electricity, and electrical apparatus manufacturers. The subscribers (with one share each) are:—J. E. Coles, Llewellyn, West Chislehurst Park, Eltham, engineer; C S. Northcote, Harefield, South Sydenham Park, electrical engineer; T. Jons, Enderby, King's Norton, Worcester, electrical engineer; W. R. N. Grimley, 3, Marlborough Road, Ealing, W., engineer; W. Nicholson, 10, Barnsbury Grove, N., accountant; H. L. Ashford, 104, Ritherdon Road, Upper Tooting, designer; J. W. H. Humphreys, 177, Beston Road, Hanwell, manager. The number of directors is not to be less than two, nor more than five. The subscribers are to appoint the first. Registered office, 8, Heddon Street, W.

Medical Electro-Thermic Generator Company, Limited (57,773).—Registered June 14th, with capital £5,000 in £1 shares, to acquire the invention of A. E. Greville, for the application of heat electrically produced for medical purposes, and to manufacture, sell, and deal in medical, electrical, and thermal appliances. The subscribers (with one share each) are:—J. S. Jarvis, 2, Staple Inn, W.C., solicitor; H. E. Greville, 2, Staple Inn, W.C., solicitor; G. Hickson, Towcester, Northamptonshire, clerk; H. Stedman, Towcester, physician; H. B. P. Lomas, Buxton Hydro., Buxton, proprietor; J. E. Harburn, Thorncliffe, Buxton, surgeon; T. W. Precious, 1, Norland Gardens, Norland Road, W., clerk. Registered without articles of association. Registered office, 2, Staple Inn, Holborn, W.C.

Stiens & Earle, Limited (57,784).—Registered June 15th, with capital £20,000 in £1 shares, to adopt an agreement with P. Stiens and E. J. V. Earle, and to carry on the business of electricians, electrical, mechanical, and consulting engineers. The subscribers (with one share each) are:—H. Tyler, Old Hall, Thurmaston, Leicester, boot merchant; A. E. Bennett, Bella Vista, Streatham, S.W., electrical engineer; E. Earle, Porchester Lodge, Streatham Common, clerk; H. Le Marchant, Stoneleigh, Clapham Common, merchant; H. R. Mann, 53, Claremont Road, Highgate, clerk; J. Weaver, 5, Applegarth Road, Brook Green, W., manager; H. Pope, Carnbrea, Palace Gates Road, Wood Green, secretary. The number of directors is not to be less than two nor more than seven. The subscribers are to appoint the first. P. Stiens and E. J. V. Earle are to join after allotment; qualification, £100; remuneration as fixed by the company. Registered office, 139, Queen Victoria Street, E.C.

Hiram S. Maxim Electric Lighting and Engineering (Pioneer) Syndicate, Limited (57,800).—Registered June 16th, with capital £10,000 in £1 shares, to acquire a certain invention as applied to electric lighting by H. S. Maxim, and to carry on the business of electricians, mechanical engineers, suppliers of electricity, and electrical apparatus manufacturers. The subscribers are:—J. de Meray, 1, Rutland Gate, S.W., gentleman, 4,000 shares; F. A. English, Addington Place, Surrey, landed proprietor, 4,000 shares; J. T. Thompson, 116, Nevill Road, Stoke Newington, gentleman, one share; M. Devenish, 7, Cavendish Place, W., gentleman, one share; F. Cook, 53, Greyhound Road, Kensal Rise, N.W., clerk, one share; C. F. Gillard, 95, Queen's Road, N.E., gentleman, one share; A. J. Rawlinson, First Avenue Hotel, Holborn, surveyor, one share. The number of directors, and the names of the first, are to be determined by the subscribers; qualification, £100; remuneration as fixed by the company. Registered by Williams & Neville, Winchester House, E.C.

Doe Portable Electric Light and Power Syndicate, Limited (57,803).—Registered June 16th, with capital £40,000 in £1 shares, to adopt an agreement with G. O. Scott, and to acquire, develop, and turn into account any patents relating to the production, treatment, storage, application, distribution, and use of electricity. The subscribers (with one share each) are:—P. Dawson, 5, Nevern Mansions, South Kensington, engineer; J. E. Ward, Broad Street House, E.C., chartered accountant; H. Lomas, 47, Church Road, Wimbledon, engineer: H. H. Broadley, 14, Warwick Street, Pall Mall, late captain; E. R. James, Denstone, Culverden Road, Balham, engineer; W. J. Bidley, 11, Henry Street, Kennington, accountant; W. W. Borman, 39, Victoria Street, S.E., engineer. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first. Qualification, 250 shares; remuneration as fixed by the company. Registered by C. Dickinson, 39, Victoria Street, S.W.

Vice Versâ Portable Electric Lamp Syndicate, Limited (57,806).—Registered June 16th, with capital £40,000 in 10,000 preferred and 30,000 deferred shares of £1 each, to acquire British patents Nos. 10,444 and 18,628, of 1897, for "improvements in portable electric batteries" and "improvements in portable electric primary batteries," to adopt an agreement dated June 7th with C. H. Cole, and to develop, turn into account, and deal in such patents. The subscribers (with one share each) are:—F. D. Kinnell, 35, Great St. Helens, E.C., manufacturer; T. F. E. Kinnell, Hotel Victoria, S.W., gentleman; F. J. Marriott, 35, Great St. Helens, E.C., secretary; J. G. Hillam, 30, Moorgate Street, E.C., financial agent; J. J. Beaven, 32, Old Jewry, E.C., engineer; W. R. Reece, 36, Copthall Avenue, E.C., agent; M. R. Field, 36, Copthall Avenue, E.C., agent. The number of directors is not to be less than two nor more than five. The subscribers are to appoint the first. Qualification, £100; remuneration, 10 per cent. on the net profits divisible. Registered by J. A. Bartrum, 9, Old Jewry Chambers, E.C.

CITY NOTES.

The Drop in Shares.

The following table shows the fall in the market quotations of Electric Lighting Companies' ordinary shares since March 9th.

	March 9th.	June 22nd.
Charing Cross	13½—14½	11—12
Chelsea	11½—12	7½—8½
City of London	28—29	25—26
County of London	14¾—15¾	12—13
House-to-House	11—12	8—9
Metropolitan	20½—21½	14—15
Notting Hill	20—21	15—16
St. James	18½—19½	15—16
Westminster	17½—18½	14½—15

It is hardly necessary to say that this extraordinary fall is due to the unreasonable scare following on the granting of an electric lighting order to the Marylebone Vestry.

Official Announcements re Companies.

The *London Gazette* for June 17th contains notice by the Registrar of Joint Stock Companies to the effect that the following have been struck off the register and are dissolved:—

Birmingham House-to-House Electricity Company.
Caustic Soda and Chlorine Syndicate.
Electrical Accessories Company.
Electric Light and Power Share Trust.
Exeter Electric Light Company.
Irish House-to-House Electricity Company.
Lancashire and Cheshire House-to-House Electricity Company.
Liverpool House-to-House Electricity Company.
Manchester House-to-House Electricity Company.
Midland House-to-House Electricity Company.
Nightingale Automatic Electrical Machine Company.
Northern House-to-House Electricity Company.
Pacific Telegraph Company.
Railway Electrical Fog Signal Syndicate.
Railway Electric Reading Lamp Company.
South of England House-to-House Electricity Company.
Universal Arc Lamp Syndicate.
Western House-to-House Electricity Company.
Wrexham and District Electric Supply Company.

Notice has been given that the following will be struck off in three months unless cause is shown to the contrary :—

Automatic Electric Sign Company.
Canterbury Electricity Supply Company.
Electric and Automatic Engineering Company.
Electric Guest Call Company.
Electric Light Regulating Syndicate.
Electric Time Distributing and Clock Company.
Electro-Mechanical Photographic Syndicate.
Engineering Review, Limited.
Gloria Electrolytic Incandescent Light Company.
"Harp" Arc Lamp Syndicate.
Knooferl-Bonn Dental and Electrical Manufacturing Company.
Manchester Suburban Electric Supply, Limited.
Pioneer Syndicate of the Capital and Counties Electricity Supply Company.
Silicon Electric Lamp Syndicate.
Town and Village Electric Light and Power Company.
West Australian Electrical Trunk, Power and Lighting Company.

The Electric and General Investment Company, Limited.

The report of the directors to be submitted to the ninth ordinary general meeting of the shareholders to be held at Winchester House, Old Broad Street, London, E.C., on Tuesday, June 28th, 1898, at 3 p.m., states that the profit and loss account shows a gross profit on the transactions of the year of £31,946 13s. 8d., and after deducting all general charges, and the interim dividend already paid on the ordinary shares, there remains a net balance of £25,719 1s. 10d. available for distribution. The directors recommend that this sum be dealt with as follows :—

	£	s.	d.
Ordinary Shares—			
To the payment of a further dividend at the rate of 30 per cent. per annum for the six months ended May 31st, 1898	£3,000	0	0
To the payment of a bonus of 10 per cent. for the year ended May 31st, 1898	2,000	0	0
These payments, with the interim dividend of 10 per cent. previously paid, will make a total distribution of 35 per cent. for the year upon the capital paid up on the ordinary shares.			
Founders' Shares—			
To the payment of a dividend of £30 per share for the year ended May 31st, 1898	3,000	0	0
To the payment of a bonus of £20 per share for the year ended May 31st, 1898	2,000	0	0
Ordinary Shares Reserve Fund—			
To the payment to the trustees of such fund of...	7,859	10	11
Founders' Shares Reserve Fund—			
To the payment to the trustees of such fund of...	7,859	10	11
	£25,719	1	10

The above-mentioned payments will be subject to the deduction of income-tax.

The trustees for the founders' shares reserve fund propose to distribute to the holders of such shares a sum of £20 per share out of the proceeds of investments sold and dividends received in respect of the fund, making a total distribution of £70 on each founders' share. The directors retiring this year are Mr. George Herring and Mr. B. H. Van Tromp, who, being eligible, offer themselves for re-election. The auditor, Mr. G. T. Rait, also retires, but offers himself for re-election. It is proposed to make the dividends payable on June 28th, 1898.

Greenwood & Batley.

The report of the directors of Greenwood & Batley, Limited, for the year ended March 31st last, to be submitted at the general meeting to be held in London on 25th inst., states that, after providing for the interest on the debentures and for the expenses of management, writing off the sum of £2,500 for depreciation, and making a provision of £500 for doubtful accounts and allowances, the accounts show a net profit of £8,658, to which has to be added the balance brought forward, £1,409, making a balance now available of £10,067. The directors recommend that out of this sum a dividend of 7 per cent. should be paid on the cumulative preference shares, which will absorb £7,028, leaving a balance of £3,039 to be carried forward. An agreement has been entered into under which the company has sold its Russian business to the Russian Engineering Company, Limited, for £19,000, payable half in fully-paid ordinary shares and half in fully-paid 6 per cent. cumulative preference shares of that company. The amount received has been written off capital expenditure. Although under this agreement the goodwill of the Russian business is transferred to the Russian Engineering Company, Limited, it is stipulated that this company shall act as the sole agents of the Russian company for the purchase in England of all materials, machinery, or other articles, and are also to manufacture all such special machinery or parts of machinery as that company may require from England for the next 25 years, and a considerable business has already resulted under these conditions. The directors considered it necessary to join the federated engineering employers in resisting the 48 hours' demand, and this action brought about a strike which practically stopped the producing power of the works for seven months out of the year under review. The works are fully employed at the present time, and the contracts on hand and in negotiation give good reason to hope that the business of the present year will be remunerative. The plant, buildings, and machinery have been maintained in efficient working order and condition, £5,176 having been expended during the year under this head, and charged to revenue. The directors regret the loss of their colleague, Mr. George Greenwood, who had acted as a managing director of the company since its formation, and who died in April last.

Birmingham Electric Supply Company, Limited.

The shareholders of this company met at the Queen's Hotel, Birmingham, on Friday last, Mr. H. Buckley (chairman) presiding, to consider the proposed sale of the undertaking to the Corporation. The proceedings were conducted in private. It was understood that the following resolution, moved from the chair, and seconded by Mr. G. Albright, had been carried with practical unanimity :—"That the provisional agreement produced and read at this meeting providing for the sale of the company's undertaking and assets to the Corporation of Birmingham, at the price and upon the terms therein stated, be approved, and the directors of the company be requested to take all necessary steps to carry such agreement into effect." A further motion was unanimously adopted, moved by Mr. G. H. Kenrick, and seconded by Colonel Wilkinson, granting the directors a sum of £2,000 for their services.

Davey, Paxman & Co., Limited.—The prospectus of this company, inviting applications until yesterday afternoon for £100,000 4 per cent. first mortgage debenture stock at 102 per cent., has been before the public this week. This well-known engineering and boiler-making firm of Colchester has now more orders on hand than at any previous date, and it has become necessary to erect new shops, and to provide additional plant and further working capital, for which £30,000 of the present issue of debenture stock will be appropriated. The assets, exclusive of goodwill and the value of patents and licenses, are put at £175,132. Messrs. Bramwell & Harris, and Wheatley Kirk, Price & Goulty, have made a valuation, and this accompanies the prospectus.

The Electrical Company, Limited.—This company which is the English branch of the Allgemeine Electricitäts Gesellschaft, has had, we understand, a successful year's work. The net profit for the year ending March 31st, 1898, after writing off for depreciation, doubtful debts, and for the whole of the furniture, cost of accumulators, dynamo, wires, &c., was £2,3€4. The reserve fund has been increased by £750; £490 has been distributed to directors, managers, and as bonuses to employés, and a dividend declared of 10 per cent.

Electric Horse Promotion Syndicate.—The *Star* of 17th inst. says that the directors of the Electric Horse Promotion Syndicate, Limited, "have returned to subscribers for the shares the amounts of their subscriptions. We also learn that the inventor of the electric horse apparatus, Mr. A. H. R. Pulman, through his solicitor, Mr. Sydney C. Peters, of 81, Cannon Street, E.C., has given notice for the rescission of the contract, dated February 7th, 1898, for the sale of the patent rights of the said invention."

Eastern Extension, Australasia and China Telegraph Company.—The directors of the Eastern Extension, Australasia and China Telegraph Company, Limited, have declared an interim dividend for the quarter ended March 31st last of 2s. 6d. per share, free of income-tax, payable on July 15th. The coupon on the company's 5 per cent. Australian Government subsidy debentures, due on July 1st next, will be paid on and after that date at Messrs. Barclay & Co.'s bank.

The Shannon Electric Power Syndicate, Limited.—Sir Henry Grattan-Bellew, Bart., of Mount Bellew, County Galway, has been elected to the directorate of this syndicate, in place of Mr. J. Bannatyne, resigned.

TRAFFIC RECEIPTS.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending June 1[illegible]th, 1898, were £2,835 12s. 4d.; corresponding period, 1897, £2,441 6s. 4d.; increase, £394 6s.

The City and South London Railway Company.—The receipts for the week ending June 19th, 1898, were £974; week ending June 20th, 1897, £1,093; decrease, £119; total receipts for half-year, 1898, £25,532; corresponding period, 1897, £25,308; increase, £224.

The Dover Corporation Electric Tramways.—The receipts for the week ending June 18th, 1898, were £152 6s. 9d.; total receipts to June 18th 1898, £2,851 2s. 6d.

The Dublin Southern District (Electric) Tramways Company.—The receipts for week ending Friday, June 10th, 1898, were £748 2s. 5d.; corresponding week last year, £814 0s. 9d.; decrease, £65 18s. 4d.; passengers carried, 110,303; corresponding week last year, 121,265; aggregate to date, £11,711 12s. 6d; aggregate to date last year, £12,362 6s. 4d.; decrease to date, £650 13s. 10d.; mileage open, 8 miles.

The Liverpool Overhead Railway Company.—The receipts for the week ending June 19th, 1898, amounted to £1,440; corresponding week last year, £1,389; increase, £51.

The Western and Brazilian Telegraph Company, Limited.—The receipts for the week ending June 17th, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,982.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, June 15th.	Closing Quotation, June 22nd.	Business done during week ended June 22nd, 1898. Highest.	Lowest.
137,400l	African Direct Telegraph, 4 % Debs.	100	4 %	...	...	100 —104	100 —104	...	...
25,000	Amazon Telegraph, shares	10	...	...	...	7 — 8	6½— 7½	...	...
125,000	Do. do. 5 % Debs. Red.	100	...	...	...	93 — 96	93 — 96	...	...
923,960l	Anglo-American Telegraph	Stock	£2 9s	£2 13s	3 %	64 — 67	64 — 67	65¼	...
3,038,020l	Do. do. 6 % Pref.	Stock	£4 18s	£5 6s	6 %	116 —117	116 —117	117¼	116
3,038,020l	Do. do. Deferred	Stock	...	...	...	16¼— 16¾	16¼— 16⅝	16⅝	16¼
130,000	Brazilian Submarine Telegraph	10	7 %	7 %	7 %	15½— 16	15½— 16	15⅞	15 9/16
75,000l	Do. do. 5 % Debs. 2nd series, 1906	100	5 %	...	...	112 —116	112 —116	...	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	4 %	...	2¾— 3¼	2¾— 3¼	...	...
10,000,000$	Commercial Cable	$100	7 %	8 %	8 %	180 —190	180 —190	...	...
918,297l	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	105 —107	105 —107	106	...
224,850	Consolidated Telephone Construction and Manufacturing	10/-	1½%	2 %	...	1/16 — 3/16	1/16 — 3/16	...	...
16,000	Cuba Telegraph	10	8 %	8 %	7 %	6½— 7½	6½— 7½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	14½— 15½	14½— 15½	15	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 11	10 — 11	...	...
30,000l	Do. do. 4½ % Debs., Nos. 1 to 6,000	50	4½%	4½%	4½%	103 —106%	103 —106%	...	...
60,710l	Direct United States Cable	20	2¼%	2½%	...	10½— 11	10½— 11	11	10⅞
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	101 —104	101—104	...	...
400,000	Eastern Telegraph, Nos. 1 to 400,000	10	6½%	6½%	...	17¼— 17¾	17¼— 17¾	17⅝	17⅜
70,000	Do. 6 % Cum. Pref.	10	6	6 %	...	18½— 19½	18½— 19½	...	...
89,900	Do. 5 % Debs., repayable August, 1899	100	5 %	5 %	...	101 —104	101 —104	...	...
1,302,615l	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	123 —127	123 —127	124	...
250,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	7 %	17½— 18	17½— 18	17⅞	17½
25,200l	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	5 %	5 %	100 —104	100 —104	...	...
100,500l	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	5 %	5 %	101 —104	101 —104	...	...
320,000l	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	126 —129	124 —128	...	...
35,100l	Eastern and South African Telegraph, 5 % Mort. Deb., 1900 red. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	...	100 —104	100 —104	...	...
46,500l	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	...	101 —104	101 —104	...	...
300,000l	Do. 4 % Mort. Debs., Nos. 1 to 3,000, red. 1909	100	4 %	4 %	...	101 —104	101 —104	...	...
200,000l	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	4 %	4 %	...	105 —108%	104 —107%	104	...
180,227	Globe Telegraph and Trust	10	4½%	4½%	4½%	11½— 12	11½— 12	11⅞	11⅝
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6 %	16¾— 17¼	16¾— 17¼	17¼	16⅞
150,000	Great Northern Telegraph, of Copenhagen	10	10 %	10 %	10 %	29 — 30	29½— 30½	29¾	...
160,000l	Do. do. do. do. 5 % Debs.	100	5 %	5 %	5 %	100 —103	100 —103	...	...
97,000	Halifax and Bermuda Cable, 4½ % 1st. Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	99 —104	99 —104	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	50 — 53	50 — 53	...	...
100,000l	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	6 %	6 %	108 —111	108 —111	...	...
28,000	Montevideo Telephone, 6 % Pref., Nos. 1 to 28,000	5	4 %	4 %	4 %	2¼— 2¾	2¼— 2¾	...	...
484,597	National Telephone, 1 to 484,597	5	5½%	5½%	6 %	5⅝— 5⅞	5½— 5¾	5¾	5½
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	16	15
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5⅜— 5⅝	5⅜— 5⅝	5½	5 7/16
1,329,471l	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	101—106	101—106	104¼	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	⅝— ¾	⅝— ¾	11/16	...
100,000l	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	4 %	4 %	4 %	105 —108	105 —108	...	...
11,839	Reuter's	8	5 %	5 %	5 %	8 — 9	8 — 9	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	136 —141	136 —141	...	...
58,000	United River Plate Telephone	5	4 %	5 %	...	4 — 4½	4 — 4½	...	...
146,733l	Do. do. 5 % Debs.	Stock	5 %	...	...	104 —107	104 —107	...	...
15,609	West African Telegraph, 7,501 to 23,109	10	4 %	nil	nil	3½— 4½	3½— 4½	...	...
213,400l	Do. do. 5 % Debs.	100	5 %	5 %	5 %	99 —102	99 —102	...	...
64,269	Western and Brazilian Telegraph	15	3 %	2 %	3½%	11⅜— 12¼xd	11½— 12xd	11⅜	11½
33,129	Do. do. do. 5 % Pref. Ord.	7½	5 %	5 %	5 %	7¼— 7¾xd	7¼— 7¾xd	...	...
33,129	Do. do. do. Def. Ord.	7½	1 %	nil	½%	4½— 5xd	4½— 5xd	4½	...
389,521	Do. do. do. 4 % Deb. Stock Red.	Stock	...	...	...	104 —107	104 —107	...	...
88,321	West India and Panama Telegraph	10	⅞%	1 %	⅞%	½— ¾	½— ¾	⅝	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	7½— 8	7½— 8	7 11/16	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	5 — 7	5 — 7	...	...
80,000l	Do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	5 %	106 —109	106 —109	...	...
1,163,000$	Western Union of U.S. Telegraph, 7 % 1st Mort. Bonds	$1000	7 %	7 %	7 %	105 —110	105 —110	...	...
160,100l	Do. do. do. 6 % Ster. Bonds	100	6 %	6 %	6 %	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

Present Issue.	NAME.	Stock or Share.	1895.	1896.	1897.	June 15th.	June 22nd.	Highest.	Lowest.
30,000	Charing Cross and Strand Electricity Supply	5	5 %	6 %	7 %	12 — 13	11 — 12	12	11⅜
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	...	...
26,000	*Chelsea Electricity Supply, Ord., Nos. 1 to 10,277	5	5 %	5 %	6 %	8 — 9	7½— 8½	8¼	7½
60,000	Do. do. do. 4½ % Deb. Stock Red.	Stock	4½%	4½%	4½%	115 —117	115 —117	...	...
50,000	City of London Electric Lighting, Ord. 40,001—90,000	10	5 %	7 %	10 %	26 — 27	25 — 26	26¼	23¾
10,000	Do. Prov. Certs. Nos. 90,001 to 100,000 £5	10	...	...	...	18 — 19	17½— 18½	18	15 7/16
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16½— 17½	15 — 16	16	15
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	129 —134	127 — 132	130½	128½
30,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—30,000	10	nil	nil	nil	13 — 14	12 — 13	13⅜	12
10,000	Do. do. do. Nos. 30,001 to 40,000 £4 paid.	10	...	...	...	6½— 7½	6 — 7	6⅝	6
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	14½— 15½	14 — 15	14½	14
17,400	Edmundsons Elec. Corp., Ord. Shares 1—17,400 £4 paid	5	...	...	...	3½— 4½	3½— 4½	...	...
10,000	House-to-House Electric Light Supply, Ord., 101 to 10,100	5	...	...	4 %	8½— 9½	8 — 9	8¾	7¾
10,000	Do. do. 7 % Cum. Pref.	5	7 %	7 %	7 %	10½— 11½	9½— 10½	...	...
62,400	*Metropolitan Electric Supply, 101 to 62,500	10	4 %	5 %	6 %	15 — 16	14 — 15	15½	13½
220,000l	Do. 4½ % First Mortgage Debenture Stock	...	4½%	4½%	4½%	117 —121	117 —121	119½	...
6,452	Notting Hill Electric Lighting	10	2 %	4 %	6 %	17½— 18½	15 — 16	...	...
31,980	*St. James's and Pall Mall Electric Light, Ord.	5	7½%	10½%	14½%	16 — 17	15 — 16	16	15
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 10	9 — 10	8½	...
50,000	Do. do. 4 % Deb. Stock Red.	Stock	...	...	4 %	107 —110	107 —110	107	...
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2 — 2½	2 — 2½	2¾	2¼
79,900	Westminster Electric Supply, Ord., 101 to 80,000	5	7 %	9 %	12 %	15 — 16	14½— 15	15	12½

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation June 15th.	Closing Quotation June 22nd.	Business done during week ended June 22nd, 1898. Highest.	Lowest.
30,000	British Electric Traction	10	...	...	...	15¾—16¼	16—16½	16½	16
10,000	Do. do. 6 % Cum. Pref. 30,001—40,000 £7 pd. (issued at £2 10s. prem. all pd.)	10	...	...	...	7½—8	10½—11	...	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	3	2½%	nil	nil	1¾—2	1¾—2	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	nil	4 %	2⅛—2⅜	2⅛—2⅜	...	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	110—114	110—114	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red. ...	Stock	...	...	...	101—104	101—104	...	...
19,894	Central London Railway, Ord. Shares	10	...	...	...	9¾—10¼	9¾—10¼	10⅛	10
129,179	Do. do. do. £6 paid	10	...	...	...	5¾—6¼	5¾—6¼	6	5⅞
59,254	Do. do. Pref. half-shares £1 paid ...	...	...	...	...	1¼—1¾	1¼—1¾	...	...
67,680	Do. do. Def. do. £5 paid ...	...	...	...	...	4¼—4¾	4¼—4¾	...	...
630,000*l*	City and South London Railway	Stock	$1\frac{3}{16}$%	$1\frac{9}{16}$%	1⅛%	68—71	68—71	69½	...
22,500	Do. do. Ord. shares, Nos. 1 to 22,500 £2 pd.	10	...	...	...	1¾—2¼	1¾—2¼	...	...
82,850	Crompton & Co., 5 % 1st Mort. Reg. Debs., 1 to 743 of £100, and 901 to 1,070 of £50 Red.	...	...	...	...	88—93	88—93	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	5 %	5½%	...	2¼—2¾	2¼—2¾	...	...
17,139	Do. do. do. "A" Shares, 01—017,139	5	5 %	5½%	...	4—5	4—5	...	...
194,023	Do. do. do. 4 % Deb. Stock Red. ...	100	...	...	...	103—105	103—105	...	...
110,000	Electric Construction, 1 to 110,000	2	5 %	6 %	...	2½—2¾	2½—2¾	$2\frac{11}{16}$	2⅝
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 ...	2	7 %	7 %	...	3¼—3⅜	3¼—3⅜	3⅜	...
111,100	Do. do. 4% Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	106—108	106—108	...	...
91,196	Elmore's Patent Copper Depositing, 1 to 70,000	2	...	...	...	½—¾	¼—½	...	...
67,275	Elmore's Wire Manufacturing, 1 to 69,385, issued at 1 pm.	2	...	...	...	⅜—⅝	¼—½	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	10½%	7 %	7 %	9—11	9—11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ord.	10	8 %	10 %	12 %	21½—22½	21½—22½	22¼	20⅞
3,000	Do. do. do. 7 % Pref.	10	7 %	7 %	7 %	18½—19½	18½—19½	19½	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½%	4½%	4½%	110—115	110—115	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	10 %	21—22	21—22	...	...
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	102—106	102—106	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	2⅞%	2⅞%	3¼%	$10\frac{7}{16}$—$10\frac{9}{16}$	10⅜—10½	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15¾—16¼	15¾—16¼	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	35—38	35—38	37	...
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102—105	102—105	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	...	...	124—127	116—119	120½	115

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 10½.
House-to-House, 4½% Debentures of £100, 105—108.
Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 12—14; 1st Preference Cumulative 6%, £5 (fully paid), 7½—8½. Debentures, 107—110. Dividend, 1897, on Ordinary Shares 10%.

London Electric Supply Corporation, £5 Ordinary, 3½—4.
*T. Parker, £10 (fully paid), 15.
Yorkshire House-to-House Electricity, £5 Ordinary Shares fully paid, 8¼—8¾. Dividend for 1896—6%.

* From Birmingham Share List. Bank rate of discount 3 per cent. (June 2nd, 1898).

THE MUNICIPAL ELECTRICAL ASSOCIATION, 1898.

ELECTRIC TRACTION.

By Robt. C. Quin, A.I.E.E., B.E. and T. Engineer, Blackpool.

It goes without saying that the subject of electric traction is so important and extensive that it is impossible to deal with it comprehensively in a paper of this description. The author proposes, therefore, to set forth as briefly as possible the salient points of the subject and to invite discussion upon them, rather than to detail at length any particular system or systems of electric traction.

Road.—In the author's opinion, the road, or permanent way, is one of the chief factors which determine the success or failure of any electric traction undertaking, inasmuch as its condition will have a much greater effect upon the maintenance costs, and consequently, the financial result, than would probably be the case with any other system of traction.

Considerable difference of opinion seems to exist as to how this track should be constructed—whether the rails should be 43 lbs. per yard as upon the Giant's Causeway line, or 92 lbs. per yard as upon the Blackpool line—whether the gauge would be 3 feet or standard gauge.

The weight of the rail must, of course, be proportioned to the weight of the cars running thereon, and to the soil upon which the rails are laid; but it would appear to the author that the present practice errs too much on the side of lightness.

It will be admitted on all hands that smooth running is essential to the longevity of the rolling stock; and that this cannot be attained without rigidity of construction, smoothness of running surface, and accuracy of gauge.

In order to insure these desirable ends it is essential, in the first place, that the track should be well laid on a good solid foundation, accurately gauged, and substantially cross-tied. The usual cross-tie for tramways purposes is 1½ inches by ½ inch strap hammered round at each end, and threaded and bolted through the web of the rails; but at Hamburg—at which place it has been the author's privilege to investigate the permanent way construction—things are done on a decidedly better plan. Here the rails, which weigh 106 lbs. per yard, are cross-tied by an I shaped girder, 4 inches deep, which passes under the bottom flanges of both rails, and is secured at each end by two substantial and adjustable chairs. These ties are placed about 6 feet apart.

The rails also are not butt jointed, but have a half and half lap joint, with a longitudinal cut through the web about 10 inches in length. The fish plates securing these are 2 feet 10 inches long fastened by six ⅞-inch bolts. The fish plate on the tread side of the rail passes under the bottom flange as far as the web.

This class of rail joint is one which, in the author's opinion, very nearly approaches the ideal. It has unbroken running surface, is rigidly constructed, and has a large rail to rail contact.

The cross-over roads at Hamburg are also of unique construction. At these points the groove of the rail is gradually shallowed until at the actual crossing point it is ⅜ inch as against 1¼ inches at other parts of the rail. The flange of the wheel projects 1 inch; hence at these points continuity of running surface is attained by riding on the flange of the wheel.

Generator.—Shall it be high speed, slow speed, direct coupled, belt, or rope driven: if with the latter shall the fly-wheel be placed upon the engine or the dynamo—are questions which have been ably dealt with in the technical press by Mr. J. S. Raworth. On the question of fly-wheels, the author begs to state *his* opinion that the fly-wheel should be left at the factory, as there is quite sufficient fly-wheel effect in a tramcar. The author further ventures to suggest that what is required is not so much uniform speed of the engine, or uniform E.M.F. of the line, as uniform motion of the tramcars, and, in his experience, neither of the former are absolutely essential to the attainment of the latter.

Slow speed engines, direct coupled and belt driven alike, are doing good service in traction work, both in this country and on the Continent. But of these, so far as regards modern plant, he cannot speak from personal experience. He has within his charge for lighting purposes, however, engines varying in speed from 80 to 5,000 revolutions per minute. The traction plant is of the latter order, *i.e.*, direct coupled, Parsons steam turbines, electrically governed. These turbines have been working since June, 1897, to the present time, and seem well adapted for the purpose. Their efficiency is extremely good; the attention and cost of up-keep at present extremely small, while the automatic regulation is everything that could be desired.

The extent to which this range of regulation is called upon depends, of course, in a very large measure, upon the weight of the cars, the number of starts per hour, the gradients, and, finally, the starting gear.

Motors.—Gearing and Starting Arrangements.

Motors.—The motors for traction purposes should certainly be of the enclosed type, as far as possible watertight; and their capacity such as to enable them, on an emergency, to develop, for short periods, at least three times their normal power.

The truck, carrying the motor or motors, should be rigid in construction—flexibility being given solely to the supports of the car body, and of the motor.

The efficiency of a traction motor, though, of course, an important point, is not of such great moment as with stationary motors. The question of weight, as well as efficiency, has to be considered; and the question, after all, amounts solely to how much power it will require to move the total weight of car, equipment and passengers, a given distance at a given speed, on a given length of track.

The efficiency, again, should be greatest at certainly not more than three-quarters of the maximum power of the motor, or preferably at its usual working load.

The arrangements for oiling should be such, that while giving efficient lubrication, oil should not be able to obtain access to the inner portion of the case. Certain makers of traction motors now cover the bottom coil of the field magnet with sheet lead. This is a good preventative of failure due to the access of moisture, dirt, or oil; but it would be better if these could be entirely excluded.

In the author's experience the weakest point in a traction armature is at the junction of the winding and the commutator. Great flexibility should be allowed at that point, and the armature coils and laminations cannot be too rigidly fixed. The sudden starting with heavy loads on heavy gradients is very apt to spring the windings, and snap their connection with the commutator.

There seems at present to be no settled practice as to the number of motors to be fixed upon a car. The author considers, however, that two motors should always be installed, either of which should be sufficiently powerful to take the car home in case the other breaks down. Further, that the starting arrangements should be such, that the two motors are placed in series with a resistance, and with one another at starting, and that under normal working conditions they should be in parallel, series-wound motors, of course, being used.

The question of gear now appears to be reaching finality, but it has passed through many phases. In the early days chain gear was generally adopted with doubtful success. Worm gear followed, but seems now to be gradually giving way before spur gearing.

The tramcars in the author's charge are at present all driven by worm gear. The worms are steel, 4½ pitch, having three parallel threads. The worm wheels are gun metal. The whole is contained in an oil case. The worm is fitted with end thrust ball bearings. Worm gearing, if well fitted, is efficient, but the wear and tear are great, so that it does not long remain in an efficient condition. The worm gear is now being replaced by single reduction gear.

The nature of the controlling gear has an important bearing upon the economic working of a traction system. It has not only an immediate effect upon the revenue account, but affects also the life of the motors and of the generators, not to speak of the comfort of the passengers. Moreover, with good controlling starting gear, the maximum current taken momentarily by the car is considerably reduced, and with many cars working, and therefore many cars starting simultaneously, the amount of generating plant is most appreciably affected.

Within the author's experience, cases have arisen under working conditions of the maximum current being eight times greater than the normal; this, of course, being with crude starting gear. If this maximum were not to exceed the normal by, say, 50 per cent.—and it certainly need not—the necessary amount of generating plant would be very considerably reduced.

As bearing upon the question of the effect of controlling gear upon the life of motors, an incident which happened not very long ago may, perhaps, point a moral. A certain car, fitted with a series resistance and multiple contact switch as starting gear, stood upon a heavy gradient. The engineer in charge ventured to start the car, the immediate effect of which was to burn out a motor armature. On a second occasion, under similar circumstances, he again attempted to start, but this time burnt out the armature of one of the generators. But, not to be beaten, he repeated the operation under somewhat different conditions. The car was now equipped with a series parallel controller—the motors being the same. On this occasion he was successful, as on all subsequent occasions when this experiment was tried.

Cars.—Double-deck cars are almost invariably used in England for urban tramway purposes. The practice, however, on the Continent is just the reverse. With the exception of Paris, single-deck cars seem to be the rule. The correct size of a car and the number of passengers it should carry, are questions which cannot be settled until the conditions of traffic are known. If the line is double throughout a large number of cars can be conveniently worked. If it is a single line, and loops, the workable number of cars becomes limited, and their capacity therefore must be proportioned to the requirements of the traffic.

If the amount of traffic varies within wide limits during certain portions of the day, or at certain seasons of the year, it would appear to the author advisable to attach trailers to the motor cars at those times, rather than to carry a heavy dead load of car weight the whole time.

While on this point, the author would suggest that some better unit of efficient working might be established than the cost per "car mile." What is a car mile? Is it a trailer car carrying 15 passengers and weighing 3 to 4 tons; a motor car carrying 30 passengers, and weighing 7 to 8 tons; or a motor car carrying 80 to 90 passengers and weighing anything up to 23 tons? He would suggest "ton mile" as a better unit.

System of Feed.—The preceding remarks apply with equal force to all methods of electric traction, but the most debatable feature in the question is the means to be adopted of conveying the energy from the generator to the motor.

The trend of technical, as also of public opinion in this country, appears to be in favour of overhead. It is, the author believes, admitted by all that it is the cheapest method; but some have qualms as to its sightliness and safety. These points it is obvious, with a little skill and forethought, can be easily provided for.

Strong posts of ornamental construction are now obtainable, and when used for the joint purpose of lighting the street and supporting the overhead conductor cannot be objected to by the most critical.

The overhead line must always be in evidence, but it is remarkable how accustomed one can become to it, so much so as not even to notice its presence.

The best means of ensuring safety is good work, first-class materials, and sound construction. The gauge of the trolley line should be not less than 000 S.W.G., although 0 (B. & S.) appears to be the general thing on the Continent.

Two overhead conductors should be provided even for single line and loops, being, the author considers, cheaper in the end than spring frogs and other expedients.

Section blocks should not, under any circumstances, be placed in curves, also they should be provided (when trolleys are used) with guard checks to prevent the trolley wheel jumping the line when passing.

The span wire system of support appears best suited to high rates of speed, and is convenient in narrow streets where supports can be attached to the houses, but it necessitates a great number of straining wires at curves which are not sightly.

The life of the overhead line is greatly affected by the class of contact making apparatus which is employed. Certainly, the life appears longer with the rolling wheel than with the sliding bar. Whether the advantage which the bar has at curves and junctions sufficiently compensates for this, the author cannot say.

With a trolley line well erected and fitted with guard checks at cross-overs and junction frogs, there should be little risk of the trolley wheel jumping the line, but nevertheless, such a contingency must be provided for. In the first place, the trolley head, when free from the line, should not be able to rise to any great extent from its working position. In the second place, should it happen that the trolley jumps the line when the car is proceeding at high speed, and the head of the trolley locks against one of the supports (either bracket arm or span wire), something must give way. What will prove to be the weakest link cannot, of course, be given for certainty, but should it happen to be the trolley standard, accidents are likely to occur. The author suggests that it would be best to provide the weakest link in the shape of a loose trolley head, and that this trolley head should be anchored by an insulated cord to the trolley arm, say, 3 feet from the top end. The only result then of the locking of the trolley head would be its dropping free from the arm.

It is necessary, where telephone or telegraph wires crossing the overhead conductor, to provide some means for preventing these wires, in the event of their falling, from making contact with the overhead conductor. There are two ways of doing this: the first is to fix an insulator, such as a wood or other moulding, on the top of the conductor at those points; the second is to suspend above the trolley line one or more guard wires. These latter seem to be preferable, as in practice the wood moulding works loose, and makes considerable noise by vibration when the cars are passing. The guard wires should be stranded and capable of withstanding as great a stress as the trolley line itself. They should, the author also considers, be efficiently connected to earth. If this is so, a telephone wire coming in contact with the overhead line and the guard wire causes a short circuit and a cut-out at the generating station.

With overhead system a rail return is almost invariably used, and, therefore, the question of bonding and of the earth circuit should be considered at this point.

For all practical purposes the conduction from rail to rail by fish plates and bolts must be neglected, and it becomes necessary to provide electrical bonds across these rail joints of the same equivalent area as the rail.

The rails the author is now using have an area equivalent to a square inch of copper. The bonds consequently should have this section. Under these circumstances it is preferable to use two bonds, as one of a square inch section would be inconvenient.

The heads of the bonds should have a contact area of at least 2½ square inches, and should be of such construction as not to render them liable to work slack. It is a good thing, in calculating the fall of potential upon a given line, to allow 20 per cent. for increased resistance due to the slackening of the bonds. Even with this bonding, unless the disposition of the gas and water mains has been carefully considered, the Board of Trade limit of stray earth current is likely to be exceeded.

If a gas or water main crosses the track or approaches the vicinity thereof, and from that point takes a shorter route to the neighbourhood of the station earth than do the tramway rails, or has along that line of route a less resistance than the corresponding tramway return, it will take a greater proportion of the current than is allowable; then, parallel to that gas or water main, an insulated conductor should be laid from the point of the tramway rails above mentioned to the negative terminal of the dynamo.

Conduit.—The local conditions necessary for the successful working of a conduit system are, the author considers, freedom from sand and mud on the roads, good drainage, and a wide slot. The conductor should not be visible from the surface of the street, and should be frequently supported on insulators. It is necessary to have a wide groove in order to obtain an efficient form of collector or plough, as not only has it to contain the insulated conductors, but it must also be mechanically strong. The groove of the conduit should in all cases be parallel to the lines, and the conductor should not be continued across the points or cross-overs, as in these cases it would necessarily be exposed.

Generally, conduits contain two insulated conductors, and this, to the author, seems preferable. It cannot be said that conduit systems have, up the present, been successful enough to warrant their general adoption. Recently, the author inspected four different conduit systems, but only two of these were then working.

The initial cost of a conduit system varies from 30 to 200 per cent. in excess of the cost of an overhead system, and the up-keep, even where the conditions are favourable, is about 10 per cent. greater than with the overhead.

Accumulators.—The accumulator system of traction certainly possesses very great advantages, the principal of which is that the service of cars is not dependent on the maintenance of one system of feed, each car being entirely independent; but we have carefully to consider at what cost this independence is obtained. The crux of the whole question is the cost of carrying a useful load of passengers a certain distance, and for this purpose it is as well to see how the question is affected by the adoption of storage cells. There are three heads under which additional expenditure is entailed; first, the interest upon the additional capital required for the installation of the cells, and also their depreciation; second, the cost of propelling the additional dead load; third, the inefficiency of the cells.

With cars running all day with one charge, the weight and cost of cells are both very great as a comparison of the cars used in Dresden for overhead line only, and of the cars at Charlottenburg for accumulators, will testify. Dresden cars, carrying 40 passengers, weigh 8 tons; Charlottenburg cars, carrying 42 passengers, weigh 23 tons. In both cases the useful load of passengers is approximately 3 tons. The cost of the accumulators used on the latter cars is about £750 per car.

The cost of traction accumulators varies from £75 to £125 per ton, the former figure being for rapid charging and discharging short-distance cells.

The author was much interested in the statements made by Mr. Epstein in his Institution paper (on the authority, he believes, of the Hanover Tramway Company) that the cost of the accumulator system of working there was only ·2d. per car mile greater than the overhead system, and he must confess, when making his recent visit to Hanover, he did so with the intention of ascertaining how that ·2d. was arrived at. To a certain extent he was unsuccessful, the cost of the up-keep of the cells not being obtainable; but he believes that the figures which he has obtained are sufficient to effectually disprove that statement.

There is in Hanover one line of rather less than 10 miles worked entirely by accumulators, the cars working that line being also equipped for the overhead, so that they are interchangeable with cars working on the combined system. They weigh 11½ tons, and carry 36 passengers. The time occupied in running this journey, exclusive of charging and stoppages, is 45 minutes. The cells are charged at two stations *en route*, at one of which eight minutes charge is given at constant potential, and at the other 25 minutes. The accumulators are placed under the seats, each car being fitted with 208 cells of Tudor type, and there are three plates in each cell. The weight of these cells is approximately 2 tons, and the installation cost of each car £200. *The energy taken per car mile on this track was* 1·5 *units.*

Although the up-keep cost of the cells was not obtainable, the average life of the cells was given at about 18 months, and, moreover, additional cars have to be provided on the accumulator line, as several cars are always occupied charging.

There is also another line at Hanover worked on the overhead system. Here the cars carry 32 passengers, and weigh 6 tons. *The energy taken per car mile of these latter cars was* ·68 *units.*

On the *combined overhead and accumulator* system, with cars similar to those in use on the accumulator line, the *energy taken per car mile was* 1·37 *units.*

Leaving the initial cost of the accumulators out of the question, there is the effect on the revenue account to be considered.

With rapid charging low capacity cells (which are really the only ones worth considering), the weight of cells for a five miles' journey with one charge is about 1 ton for every 3¼ tons of car and passengers. Therefore, with a car and passenger load of 13 tons, we must have 4 tons of accumulators. As every ton mile on a given road requires the same expenditure of energy, it follows that the energy given to the motors to propel this car will have to be increased approximately 30 per cent.

Opinions differ as to the efficiency of these cells, but generally the users of them consider that the watt-hour efficiency is about 60 per cent., and the author does not think the figure is far wrong. Therefore, the energy of charging these car-carried cells has to be increased 117 per cent., owing to their inefficiency and weight. Further, the wear and tear of the road and cars is increased by the additional weight.

The life of the plates of the cells is variously given by the users as from one to two years, by the representatives of the makers as from two to three years; but the majority of the users do not find much difference between the life of positive and negative plates. The cost of the up-keep of cells is given by the various tramway companies using them, at from ¾d. to 3½d. per car mile, and the author thinks a fair average may be taken at 1½d. Assuming the cost of current to be ·75d. per unit, and ·7 of a unit to be taken without cells, figures the author does not think advocates of accumulators will cavil at, the cost of energy with the overhead system would amount to ·325d., and with accumulators to 1·14d., or an additional cost of ·62d.

This added to 1½d. for the up-keep of the cells per car mile, gives us the additional cost of 2·12d., neglecting the extra wear and tear of the cars and road.

Now consider the capital cost. The overhead system per mile of double track costs complete, including bonding of the rails, steel posts (on span wire or bracket system) about £1,600. If these posts are used for street lighting purposes, the cost of the posts should be divided equally under the two heads, reducing the overhead cost to £1,000 per mile of double track, with a 2½ minutes' service, and cars travelling eight miles per hour there will be six cars on the mile section, and, with the weight of the accumulators given, each car would cost £300 to equip, or £1,800 per mile of double track.

Again, if charging stations were adopted with, say, 15 minutes' charge, six additional cars would be required at an additional cost per mile of £560, making altogether a sum of £2,360 per mile.

With a slow service of cars the initial cost of the accumulators would probably be less than the overhead, but the additional cost of 2·12d. per car mile (with only 20,000 miles per car per annum) capitalised is equivalent to the sum of £3,530, bearing 5 per cent. interest for each car running.

Combined Systems.—Various combinations of the three systems before enumerated, have been adopted. More generally, it is a combination of the overhead line and accumulator system, but in all cases of which the author has cognisance, the adoption of accumulator systems has been not a matter of choice but of necessity.

When the necessity arises, the author would desire to point out most strongly that the dead load of the cars in proportion to its useful load, should be as small as is compatible with stability of structure. That arrangements should be made that the additional dead load of the accumulators is carried only so far as is absolutely necessary. It is therefore advisable to so arrange the battery that it can be detached as a whole from the car at the junction from the overhead line.

A great deal has been said from time to time as to the effect of the acid upon the cars and trucks, and of the odour of sulphuric acid which pervades the cars when the cells are placed under the seats. From what the author has seen of modern systems constructed on these lines, he can give his assurance that these complaints are not well founded; and, if it were not for the inconvenience of detaching the battery as a whole from the car under these circumstances, he would certainly recommend the cells being placed beneath the seats.

Where the conditions are such as would permit of the working of a conduit system, and in the absence of permission to use the overhead, the author considers the combination of overhead and conduit much more preferable than the use of accumulators. The additional weight carried is negligible and the working cost decidedly lower than with accumulators.

There have been many attempts to devise improved methods of electric traction, to obviate the disadvantages of the systems above remunerated, but they, one and all, have drawbacks peculiarly their own, which have hitherto prevented their general adoption. The names of these systems are legion.

The conclusions arrived at by the author all tend to the opinion that in the present state of electric traction engineering there is but one good and reliable and cheap system, and that is the overhead. Where a combination is necessary and conditions are favourable, overhead and conduit combined comes next in order of merit. That as at present constructed accumulators are not, from a commercial point of view, a satisfactory solution of the traction problem.

ELECTRIC TRACTION.

By J. E. Stewart, Borough Electrical Engineer, Derby.

The paper I venture to lay before this Association will, I fear, be disappointing to my engineering brethren, as it will more concern the chairman of committees, and gentlemen who have the responsibility of leading the policy to be pursued by corporations, and of voting the necessary funds for the purpose of carrying out such schemes, and what I have to say is with a view of promoting discussion, and to obtain the advice of these gentlemen so that other or all towns may see for themselves what is the best policy to be pursued with regard to street railways or tramways that this Association can recommend. I do not wish it to be understood that I necessarily recommend or advise upon any of the points I lay before you, but do so solely with a view of gaining myself the knowledge of what you consider the best course to follow.

There are several towns which are now considering the question as to the advisability of buying up the existing horse tramlines, and are wondering what is to be done with them if they become corporate property, and some are trying to arrive at that stage when they are prepared to vote for an electrical equipment, and then, further on, what scheme of electrical traction shall be adopted; after that, whether a separate power house shall be laid down, or the current taken from their existing plant in the electricity supply works.

Starting with the assumption that the electricity supply works is now in the hands of the corporation, and that the tramways are also the property of the corporation, and that it has been decided to equip the same with electric motor cars.

The first consideration is, shall the current be supplied from the existing works?

This, I believe, should be answered in the affirmative, for the sufficient reasons that the same buildings, boiler, power and plant, will answer the purpose, and the necessary spare plant will not be augmented, but, on the contrary, considerably reduced in proportion to the output, as accumulators would be introduced to, as far as possible, reduce the necessity of adding plant to take the load over the lines, when the maximum load for the ordinary supply occurs at the same time as the traction load.

Secondly, the cost of keeping accounts will be very much reduced, as the work that is necessary to keep the electricity works accounts will not be added to as would be the case when a separate power house is laid down.

The power used would be metered as for an ordinary consumer, and charged for as such.

The interest and sinking fund on the capital outlay on buildings will not be increased, or only slightly so, which would not be the case if a separate power house were decided upon.

The same staff of men would practically do, or, in any case, with a small increase only necessary.

The same engineer would, in consequence, control the whole supply, and would, of course, be handsomely recompensed for the added responsibility. I recommend Glasgow Corporation as a pattern to all our esteemed chairmen of committees. These have raised the engineer's salary to begin with.

Having decided so far, that the one works should do all the work necessary to supply electrical energy for whatever purpose it may be required, it cannot too carefully be considered as to what arrangements should be made to save confusion and friction between committees or the various departments into which the work of corporations is divided.

The committee, I think, should be composed of a definite number of gentlemen, which should be divided into two sub-committees. One to be responsible for the supply of electricity, arranging of prices and managing the supply works. The second to be responsible for the tramway's equipment and management, and each should report its recommendation to the ordinary committee meetings. The necessity for this, or some similar method of working, is as follows:—

Where tramways are laid down certain mains will have to be laid; at the same time arrangements could and should be made, where they have not already been made, for laying mains or ducts for the purpose of supplying current to the ordinary consumers along the line of route, and the apportionment of the work would be made by the committee as to how the capital charges should be allotted, and incidentally save the cost of opening the streets a second time.

All the posts, where any are used, should be arranged for the purpose of the electric lighting of the streets, and the charges treated in the same manner as before.

These considerations are reasons also why the engineer of the one concern should also be the engineer of the other.

This arrangement of committees would save any troubles as to difference of opinion as to the charges that are too likely to occur, when one committee is or may be trying to force the hands of another committee. At the same time, each sub-committee would be powerful enough to have the charges reconsidered at any time that was considered necessary, and also they would have all the information at their hands to come to a fair conclusion in the matter.

The charges of supplying service mains to the tramway premises should be borne by the electric supply works, and the current meters there and the feeders for the tramway system should be, of course, a charge against the tramway concern.

It will be apparent by this arrangement that the tramways will be in a far better position to pay its way than if it had to supply all the necessary buildings, plant and staff to run a system of its own, and the electricity works would be in a far better position to turn out energy at a cheap rate if its machinery is working all day at a full, or considerably increased rate of output, and consequently this would mean reduced charges for current all round.

The town will be the richer in every way from this arrangement.

Where the electric supply works are the property of a company, it is much to be desired that the whole supply should be controlled from the same works, as, in the course of time, most of these works will undoubtedly become the property of the corporation, but the price per unit must be arranged, and the supply given to the corporation with safe guards, in this direction; that the corporation shall not be called upon to pay (should they desire to purchase before the license expires) more for the machinery and plant used than that which it originally cost, less the sinking fund paid on same, and that the company's capital shall be valued less the profit made upon the supply to the corporation; that is, supposing the corporation supply increased the dividend of the company by 1 per cent., this would naturally enhance the value of the shares in the market, and the corporation without the safeguard would be required to find this amount should they determine to purchase before the license expires. There are difficulties in this arrangement, but it would be idle to say that they cannot be overcome. The difficulties will chiefly be those of apportionment of the cost of generating the current for the tramway supply, and of the apportionment of the profit made on this supply.

Conduit Systems.

The opinions expressed almost universally is that they are, for various reasons, undesirable, more especially where an ordinary system of horse traction is now laid down, as the cost of the conversion is so great, that it practically makes it impossible to make any adequate return upon the capital outlay; perhaps with the exception of where the traffic is so great, that there is practically a continuous stream of cars passing, but it certainly would be out of the question in outlying districts.

The enormous disturbance necessary to the streets is also a very serious matter, and the dislocation of the traffic during the course of the works, leaving out altogether the question of the cost.

Drainage is also a difficult matter, the cleaning of the conduit a constant source of expense.

Children's hoops and such like matter getting into the conduit are causes that make for damage to the collectors and stoppage of the cars.

Cushion tyre and solid tyred bicycles would be wrecked and personal damage done to the riders, not to speak of the modern narrow tyred carriage wheel.

Accumulator System of Traction.

The great advantages of this system are, that any car is self-contained—the speed can be varied considerably—not necessarily necessitating any disturbance of the existing road—although I fear there are few roads in the country that it would be economised, or upon which it would be safe to run accumulator cars without relaying the rails for these reasons:—

The great weight of the cars, and also the necessity of much stouter rails when vehicles are self-propelled—this is common to any sort of electric traction of course—but more so with accumulator cars, owing, as before said, to the great weight of the cars; and also, the average tramway groove is not deep enough for self-propelled traffic.

The disadvantages are:—

Great weight—about 30 per cent. of the total weight being taken up in the weight of the accumulators—which have to be carried whether the cars is carrying one passenger or is fully loaded.

The fact that it is practically impossible with our present experience to work satisfactorily on hilly roads, and the inability of attaching trailing cars—owing to the rapid deterioration of the accumulators.

The necessity of having to take the cars off the road for the purpose of having another set of cells put on board the car.

Smell of acid which will certainly get into the car, and it is very objectionable—it having the tendency of causing sneezing and consequent large absorption of whiskey to keep off the influenza which people are inclined to believe they have caught in consequence.

Rapid deterioration of the plates, and consequent heavy cost to keep up. This item alone is the principal cause of the want of success.

The course of construction is somewhat on a par with the overhead system, varying with the number of cars run per hour.

System depending upon automatic devices for the purpose of making contact at stated places as the car passes over, or on which one has to rely for the purpose of making the disconnection, are, for obvious reasons, out of the question—even if the only reason was the great number of such automatic devices necessary, and the likelihood or possibility at any time of one not acting properly, thereby causing a pressure of 500 volts to be exposed on the road for all and sundry to come in contact with.

The Overhead System.

This system is by far the most economical to work, and the up-keep is also the lowest.

The greatest argument in its favour being that, with this system, it can readily be charged to accommodate itself to any great or small improvement that may be made from time to time in the system of electric traction in the future, with the least waste of installed plant. But I anticipate that these improvements are only likely to be made in details.

The maximum degree of flexibility is obtained by this system also.

Trailing cars can be added and the average speed kept up. This also applies to the conduit system.

And perhaps the strongest reason for adopting this system is that every town which has sent deputations around to gather information has reported in its favour, and that it is found cheaper to work, completely under control, and that the overhead equipment is not considered or found to be an eyesore in the towns where it has been properly installed.

The argument that the overhead line is in the way of fire escapes is got over by the fact that most modern escapes are made for transport in a horizontal position, and a pair of pliers and rubber gloves is a simple way of overcoming the difficulty if the fire occurs on the route of the line, and it becomes necessary to stop the service before the engine and staff can arrive to switch of at the stated section.

Additional Reasons why Mechanical Traction should be Adopted.

Three electric cars can carry as many passengers and travel the same mileage as four horse cars, with a consequent saving of the wages of one driver and conductor; or, putting it another way, with the same number of cars costing the same for drivers' wages and conductors' also, 30 per cent. more miles can be run with quite 30 per cent. more customers, as, what has been proved in every case with both railways and street traction is, that the faster and greater the service the faster the receipts go up.

A Few Considerations why Local Authorities should have the Control of the Tramway System.

Firstly, all streets and work carried out under or upon them should be under the local authority. It is common knowledge and experience that, whenever a street has been carefully laid and repaired, there the gas company, &c., come along and begin cutting it about; whereas, if the whole of the matters concerning the streets and what is below was under the corporation control, these matters could in 50 or 60 times out of 100 be done just before, or whilst the repairs were under way, thereby saving great expense, and criticism from the ratepayers.

The whole of the inhabitants are directly interested in rapid transit, therefore, it is to the town's advantage to own the tramways.

Also, it is much better to raise revenue by indirect taxation than by rates; therefore, all towns should get as much control of such means of obtaining revenue as possible. We all feel some compunction in the paying of rates, but none of us object to pay a price for an article, or a service done for us, a part of which goes towards paying rates or reducing the existing rates.

When to Purchase.—Given that a local authority has decided to take over the street system, and to equip it with an electric system of traction; I believe it would pay any corporation to obtain control of the system at the earliest possible date after having once made up their minds to do so, and this time I believe might, with advantage, be about three years before the license lapses, for one very strong reason; it would prevent the tramway company from laying rails during that period which would not be serviceable for electric cars. And it would also prevent the liability of the corporation being placed in the position of having to find the cost that a company could, if they so desired, make a corporation pay by relaying, during the last year or two, the whole system of rails, and those rails not suitable for the purpose of power traction; and thereby making the purchase as expensive as possible with a view of choking them off.

If this course, viz., the purchase was made at the earliest date possible, the corporation, of course, would have to pay, as part of the purchase, the dividends that might or would be paid during the number of years that still remained before the license expired, also the directors' fees, and should the manager, &c., or other officials be dismissed in consequence, it would only be fair to compensate them also; but with all this, it would be much cheaper in the end to purchase upon these terms, than necessarily leave the purchase until the last minute.

The following figures are taken from three small works and three large ones.

The small works generate the increased number of units generated, at the average cost of 1·043d. per unit.

Adding a proportion of the charges for interest and sinking fund, brings the cost up to 1·243d. per unit.

Works.	1895. Units sold.	1895. Total costs.	1895. Per unit.	1896. Units sold.	1896. Total costs.	1896. Per unit.	Increase units sold during the year.	Cost of generating the added units.	Cost of added load per unit.	Cost per unit for interest and sinking fund.	Total costs interest and sinking fund per added unit generated.	Charge per units tramway section.
Edinburgh	888,335	£6,181·33	1 67	1.721,557	£8,105 66	1·13	833,238	£1,924·33	55	·2		
Manchester	1 748,244	£13.111·83	1 80	2,508.588	£15,156 05	1·45	760,344	£2,044 22	64	2		
Westminster	2,830,396	£27,242 55	2·31	3,503,054	£30,505·76	2·09	672,658	£3.263·21	1·16	·2		
								Average	783	·2	·983	1·983d.
Nottingham	171 654	£1,995	...	297,185	£2,687	...	115,531	£692	1·43	·2		
Huddersfield	227.753	£2,723	...	304,163	£3,003	...	76,410	£280	·88	·2		
Portsmouth	406,118	£3,486	...	839,392	£5.980	...	433,174	£1,494	·82			
									3 13	·2	1·243	2 243
									1 043			

Therefore it is shown that these works could afford to sell that number of units at 1 74d. per unit, and make a handsome profit of ½d. per unit on the transaction.

And the larger works show as to what the costs are likely to fall to, with the growth of electricity supply works.

The total works' costs for the increased number of units generated is shown to average ·783d. per unit, and with the added allowance for interest and sinking fund on the capital outlay of ·932d. per unit, showing that these works could afford to supply electricity at 1·483d. per unit, at a profit of ½d. per unit as before. The interest on the capital is calculated at 3 per cent., and the sinking fund at 3 per cent. also; therefore, above the ½d. per unit profit shown, an allowance of 6 per cent. is paid already on the capital outlay.

REPORT OF THE CAPE OF GOOD HOPE GOVERNMENT ELECTRICIAN AND INSPECTOR FOR THE YEAR 1897.

Treasury, Cape Town,
Cape of Good Hope,
March 14th, 1898.

REPORT OF THE GOVERNMENT ELECTRICIAN AND INSPECTOR FOR THE YEAR 1 97.

The As is'ant Treasurer.

(1) *Work done under the Appointment.*

Sir,—Application has been made for statutory powers for electrical supply. Such powers are granted in England in the form of a provisional order of the Board of Trade, such procedure being less expensive than that of a private Bill, and securing uniformity in the conditions of concession and liabilities. A model order, following the form of provisional order of the Board of Trade, has been drafted, but, as the matters dealt within it are for the most part beyond the limits of the Electric Lighting and Power Act, 1895, which relates almost exclusively to securing the safety of the public and the protection of telegraphs, consideration has been given to the necessity for and the terms of further legislation on this subject.

No new mains for electric supply have been laid in Cape Town, and only a few extensions have been made in the suburbs of Cape Town, owing to the fully loaded condition of the generating plant in each case.

The remarks in my Report for 1896 upon the unsatisfactory condition of the electric supply system in Cape Town, and the absence of systematic testing, appear to have been justified by the occurrence of several fires which have been attributed to defective wiring. These defects having been on private property, cannot be dealt with by the Government, but the matter having been referred to me, I have pointed out that the fire insurance companies have in their own hands a remedy which is most satisfactorily applied in Europe and in America, namely, the enforcement of regulations for proper insulation and workmanship.

The Government Electrical Laboratory, which has been so well and liberally accommodated for nearly two years at the South African College, has been removed to a room in the General Post Office.

The system of electrical measurements by potentiometer has proved to be suitable for the purpose of this Laboratory, and the standard cells which are relied upon in this system have been compared together once a week, and have been found to agree well together.

A number of voltmeters and amperemeters have been sent to the Laboratory by the Cape Government railways and from the Royal Observatory for comparison with the Government standards, and a voltmeter and an amperemeter belonging to the Town Council of Cape Town were tested at their works, the current, 400 amperes, being more than could be obtained at the Laboratory. Only one supply meter has been sent in for examination. A recording voltmeter for the Tramway Company has been tested, and testing instruments have been lent to the General Post Office and to the Cape Town and Suburban Electric Light Company.

I have been further indebted for voluntary assistance in the Laboratory to Mr. W. H. Logeman.

The electric tramway in the southern suburbs of Cape Town, from Rosebank to the Liesbeek Bridge, was inspected on June 3rd. The Port Elizabeth Electric Tramway, from the corner of Walmer Street and Union Street to the corner of Prince Alfred's Park, was inspected on June 14th; and on July 19th the hill sections of the Port Elizabeth tramways were inspected, and careful tests were made of the brakes on the unusually steep gradients, under various conditions of speed and wetness of the rails. These tests gave very satisfactory results, and the plant and equipment of the Port Elizabeth Tramways is in general well designed and constructed. On August 17th the Cape Town Suburban Tramway from the Liesbeek Bridge to the Crown Hotel, Claremont, was inspected, and all these sections of tramways, after certain alterations, were opened for public traffic.

After the Cape Town Suburban Tramway to Claremont had been at work for a few weeks, tests showed that the electric pressure causing leakage of electric current in the ground between the tramway works and the end of the rails, largely exceeds the limit permitted by the regulations. Calculation showed that at this rate the pressure between the Wynberg terminus of the line and the works would be about 6½ times the limit permitted by the regulations. After being called upon to comply with the regulations, the tramway company somewhat reduced this pressure by replacing certain defective work which had been destroyed by electrical corrosion underground.

The remainder of the line as far as the terminus at Wynberg was inspected on December 28th, and a test of the pressure was made between the works and Station Road, Wynberg. The pressure was found to considerably exceed the limit permitted by the regulations, and the leakage, which has seriously disturbed, and in some cases has suspended, the telegraphic service, is corroding the water-pipes underground. The line was conditionally opened for public traffic in order to afford the tramway company time for taking steps to remedy this defect.

Several accidents, including an outbreak of fire, have been caused by the fall of the telephone wires across the trolley wire. The tramway company have not hitherto been called upon to protect, in accordance with the Regulations, wires which cross the road in groups of less than six, but this exemption has now been withdrawn.

Other tramway accidents, one having a fatal result, have occurred, but not being of an electrical nature, they have not come officially under my notice.

(2) *Work other than under the Appointment*

On my visit to Port Elizabeth in June I inspected the telephone lines with the view of re-arrangement with regard to the tramways, and to the site of the new Post Office.

In July I inspected and reported to the Department of Public Works upon the generating plant for electric supply in the General Post Office at Cape Town, and on the electric lifts in that building, so far as related to their conformity with the specification.

Alterations in the electric lighting of the Assembly Chamber and of the Council Chamber of the Houses of Parliament, and schemes for electric lighting of the Valkenberg Asylum and on Robben Island, have been referred to and reported on by me.

The Municipal Councils of Queenstown, Worcester, and Cradock have applied to me for advice on general electric supply, and on the utilisation of water-power for this purpose, and tenders for the supply of machinery have been submitted to me. I have reported that since no specifications had been prepared the tenders were not satisfactory; they were not sufficiently explicit; could not be compared, and none should be accepted. I recommended that a consulting engineer should be employed to act for these Councils.

The Municipal Council of Woodstock asked my advice as to the lighting of 120 street lamps. I reported that the running of a special electric lighting plant for such a purpose would be more expensive than gas lighting. I gave some information on a general electric supply for the district, and estimated the working expenses at about 7½d. per unit, exclusive of interest and depreciation.

Owing to numerous accidents by electric shocks from the tramway in Cape Town, the question of providing means to enable the police to give aid was discussed, and I drew up a set of instructions to the police.

I have been applied to for, and have given advice on, the equipment of a physical laboratory for the Huguenot College at Wellington.

In the Government Electrical Laboratory I have made comparative tests of the illuminating power of certain brands of paraffin oil, and I have, at the request of the Government Marine Biologist, constructed and experimented with an electrical thermometer for observing the temperature of the sea at different depths.

(Signed) A. P. Trotter,
Government Electrician and Inspector.

APPENDIX.

Government Notice.—No. 873, 1897.

Treasury, Cape Town,
September 13th, 1897.

The following instructions to the police with regard to their action in the event of electrical accidents are published for general information.

By order,
H. M. H. Orpen,
Assistant Treasurer.

Treasury, Cape Town,
Cape of Good Hope,
September 13th, 1897.

Electrical Accidents.

Instructions to the Police.

If a wire falls in a street in which the electric tramway runs, and the end hangs loose, or lies on the ground, the best thing to do is to *leave it alone* until one of the tramway company's staff comes. In such a case the best thing that a constable can do is to prevent anybody from touching the wire.

If a wire, as it lies on the street, is an obstruction to the traffic, it may be pulled on one side by means of a stick, a walking-stick with a hooked handle would do well, or it may be moved by using rubber gloves. It would be better to allow the traffic to be impeded than that the constable should leave the wire in order to get the gloves from the nearest station.

The thick wires which run above the middle of the street are called trolley wires. They convey the current to the cars. Smaller wires, called span wires, are stretched across the streets to support the trolley wire. Other small wires are erected in some streets for the purpose of preventing telephone wires from falling on the trolley wire. If a telephone wire falls and is kept by the guard wires from touching the trolley wire, or if it touches a span wire, and does not touch the trolley wire, no shock can be given by it. If the loose end is an obstruction to traffic, and if it can be drawn away and tied up without any risk of touching the trolley wire while doing so, this may be done. Rubber gloves should be used. If there is any risk of touching the trolley wire with the wire which is to be handled, it is better to *leave it alone*, and to see that nobody else touches it until a tramway man comes.

If a wire falls across a trolley wire, or the trolley wire itself touches the tramway rails, there will be a violent flash. When this flash occurs, an automatic switch at the tramway works will be opened, and the electric supply will be cut off on the section on which the accident has happened. The trolley wire is divided into sections of half a mile in length. As long as the switch is open, no tramcar can run on that section, and the wires are harmless. As soon as the attendant at the works sees the automatic switch fall open he will try to close it, in case the cause has been a momentary one. If, however, the wire still lies touching the rails, he will be unable to keep the switch closed. The same thing may happen if a wire falling on the trolley wire touches a tramway pole, electric lighting pole, telegraph pole, or other metal work connected with the ground; but this is not certain.

It is very undesirable to make a connection between a wire and the tramway rails or any other metal work intentionally, because the flash which will occur will be so brilliant that it will unnecessarily alarm the bystanders, and may so dazzle the constable who causes it to touch that he may be unable to see anything for a minute or so.

It is a good thing to keep the wire on the rail if it touches at all. It may be held there with a stick, but it is advisable not to hold it there by standing on it, since, if the rail is dirty, a slight shock, but enough to cause the person standing to fall, might result.

If the end of a wire hangs loose in the street, and is an obstruction to traffic, a rope or piece of strong string may be put round it with a "half hitch," without touching the wire with the hands, and it may then be drawn on one side. Great care must be taken in doing so, that it touches no other wire, pole, or metal work.

The electric pressure (500 to 570 volts) used by the tramway is not sufficient to give a fatal shock to a human being. It is sufficient to produce serious burns. The pressure used for electric lighting in Cape Town is 220 volts between any wire and the earth. The highest pressure between any wires accessible to the public is 440 volts; 220 volts would probably kill a horse. A pressure of 2,250 volts is used in Rondebosch and in the neighbouring districts, but the wires are not accessible to the public. The pressure on the service wires is about 100 volts.

If a wire falls on a person and winds round him, or becomes entangled in the clothing, the wire should be pulled away with a stick, or by wrapping the hand in a dry coat, or by means of rubber gloves, taking special care that the wire does not touch the skin either of the victim or of the rescuer.

A severe electric shock may produce sudden stoppage of the respiratory and heart muscles. If the stoppage of the heart's action is complete, it is doubtful if anything can be done; but in some cases the stoppage is not complete, and animation is only suspended. The condition is similar to that of apparent death by drowning, and the well-known method of producing artificial respiration should be resorted to without delay.

Summary.

If a wire falls harmlessly, leave it alone, and prevent anyone from touching it.

Only the trolley wire, or the wire touching it, does mischief.

The electric current is, as it were, always trying to pass from the trolley wire direct to the tramway rails, or through the earth to the rails.

A shock can only be felt when the body forms part of a path by which the current can pass from the trolley wire to the rails.

The electric current cannot pass through *dry* wood, cloth or rope.

(Signed) A. P. Trotter.
The Government Electrician and Inspector.

THE TELEPHONE INQUIRY.

(*Continued from page 864.*)

The Select Committee on Telephones sat again on Thursday, Mr. Hanbury presiding.

Sir James Ferguson said he was Postmaster-General from December, 1891, to August, 1892, and he joined the board of the National Telephone Company in 1896. Before he visited the Post Office on his appointment, he had an interview with the Chancellor of the Exchequer, when the Chancellor mentioned a matter of great difficulty in the Post Office, viz., the management of the telephones. Mr. Goschen pointed out that the telegraph revenue had been apparently injured by the operation of the telephones, and it was thought necessary to do something to put the matter on a better footing. The Post Office felt that the only proper course to pursue was for the Post Office to purchase the telephones, but the Treasury decided not to do that. He said he would endeavour to fall in with the policy of the Government, and very soon after he went to the Post Office he set the department to work to frame a scheme. He suggested that they should find out the Government's policy and the company's policy, and see how far they could be reconciled. The result was, that a scheme was submitted to the Treasury embodied in a Treasury Minute. A Bill was introduced by himself for the purpose of taking more powers by the Post Office, and to some extent the Telephone Company. That Bill was referred to a Select Committee, and, incidentally, the whole scheme of the Government was explained in detail. The Committee reported on the motion of Mr. Shaw-Lefevre, in favour of the Bill, but recommended that the terms of the licenses should not be extended. With that reservation, the Committee thought the responsibility of the agreement with the company should lay with the Government, but that the details should be laid before Parliament. That was the report of June 16th, 1892.

The Chairman: The reservation being that these licenses should not extend beyond 1911?—Yes; the chairmen of the companies urged that the licenses should be extended to enable the companies to recoup their capitals.

Continuing, Witness said the reservation referred undoubtedly to the existing licenses. Moreover, there was so strong an assumption that the telephones would revert to the State in 1911 that the question of new licenses did not arise. The Bill passed both Houses with hardly any discussion. Still, the agreement with the company hung fire through the indisposition of the company to accept it, and their desire to get some better terms. As the Committee was aware, it was not until just before the Government quitted office that the agreement was initialed by himself and by the chairman of the company. Those heads of agreement had the full concurrence of the Chancellor of the Exchequer. They were studied with the greatest care by the Chancellor who went over them line by line, and he personally conducted negotiations with the chairman of the Telephone Company. He believed that the Chancellor had four meetings with Mr. Forbes, and he never knew a gentleman more closely cross-examined in his life. Only a few days ago Mr. Goschen informed him that he was responsible for every line in the agreement. He mentioned that because it seemed to be thought that the signing of the agreement before the Government left office was a hasty decision. That was plainly disproved before in the House of Commons on March 22nd, 1892, he stated in the plainest terms, the whole purport of the agreement. The two telephone companies who had absorbed all the others, introduced private Bills in order to obtain increased power for carrying on their business, because they were so restricted by the terms of their license that the system was greatly hampered. He opposed the second reading of the first of those Bills, viz., that of the New Telephone Company, and pointed out all that had been done.

The Chairman: All we want to know is how the heads of the agreement with the company were signed on the very evening that the Government was defeated. We have the facts that the heads of the agreement were well known to the Chancellor of the Exchequer representing the Government, as well as to yourself, and had his full concurrence. Now they were signed on the day on which the Government was defeated. Were they so signed with the knowledge of the Chancellor of the Exchequer?—Certainly. I must point this out that my honour is at stake in this matter. I submit to the Committee that it has been suggested here in many questions that this agreement was hastily entered into on the eve of the Government leaving office. I am concerned to point out to the Committee that the full terms then initialed were stated to Parliament repeatedly, not only on this occasion but before the Select Committee, and explained with the greatest detail without reserve. That is most important in view of the suggestions which have been made. I observe that at the last meeting of the Committee it was suggested that I had entered into an understanding with the chairman of the company before he signed the agreement, which was not contained in the Treasury Minute, and which I think it was stated was a secret understanding.

That was so stated?—Then it is an utter misapprehension.

In the first place the heads of agreement were signed with the consent of the Chancellor of the Exchequer and with his knowledge?—Certainly.

Was it a fact that the chairman of one of the companies objected to sign that agreement?—He was very reluctant to sign it, as he had been all along, and he only eventually signed it on my assuring him that it was the intention of the Post Office to carry out the granting of areas in a reasonable manner.

Did he act for both companies?—No; I think the Duke of Marlborough came in afterwards. I am pretty sure of that.

Was your assurance given to both companies, or only to Mr. Forbes, the chairman of the National Company?—As far as my memory serves me, I only remember giving it to Mr. Forbes.

Therefore, whatever the effect of that assurance, it can only refer to the agreement signed by the National Company? -It was not any new assurance. It was only a repetition of what had been stated before the Telegraph Bill Committee.

The heads of agreement were signed subsequent to this report?—Certainly.

If the agreement was to carry out all that had been arranged or said before the Committee, why was this promise, instead of being a verbal one, not put into the agreement?—The answer is that it was clearly understood that these areas are subject to further arrangement.

That is in the agreement. It was with these words that Mr Forbes found so much objection, that he would not sign until he had got a verbal promise?—Yes. I said to Mr. Forbes: "Certainly, the Post Office will carry it out in a reasonable manner," and my successors have done so.

The Chairman, to Mr. Lamb: That is what you said?

Mr. Lamb: That was my evidence before the Committee.

The Chairman, to Sir James Ferguson: Who was present when the agreement was signed?—I should think probably Sir Arthur Blackwood and Mr. Lamb.

Was any record made of it?—I cannot tell you.

I tell you frankly why I ask all these questions. It is simply this: the Post Office have very largely extended the areas which were conceded to the company under the agreement, and I gathered from Mr. Lamb that the Post Office rather took the view that in consequence of your promise the Post Office were under some obligation at the request of the company to enlarge these areas. The agreement does not say so?—Second-hand evidence is not worth much, but I used from time to time to ask Mr. Arnold Morley how the agreement got on, and he said that the settling of the areas was a very difficult affair, and took a long time. I had a relative on the directorate of the company, and he told me the same thing. I assure the Committee that the view I took, and the view I always understood was taken, was that it was a great convenience to the public that the areas should be extended.

That may be so, but these areas have been extended by the Post Office since these questions regarding the Telephone Company reached an acute stage, and unless there was some strong reason binding the Post Office to so extend the areas during this critical period, some members of the Committee might think that the Post Office should have held its hand. The agreement, as it stands, undoubtedly does not require the Post Office to do anything of the sort, but Mr. Lamb certainly seemed to think that your promise had rather forced the hands of the Post Office?—I never heard it suggested until Tuesday, and I believe that what I said to Mr. Forbes was simply in conformity to what was said before the Committee.

Did it go in any way beyond what was known in the agreement to the public?—Not in my opinion in the spirit of it, but certainly it did as to the letter of it. Mr. Forbes said he did not think it was plain, and I said he might be quite sure that the Post Office would come to reasonable terms about the areas.

Did anything you said to Mr. Forbes in any way bind the Postmaster-General, or qualify his discretion, or really convert the word "may" in this agreement into "shall"?—I can only repeat what I understood all along, that we were going to make reasonable terms about the extension of areas, and I assured him of that.

Further questioned by the Chairman, Witness said that no record was made of the promise. The Post Office knew what had been done, and if they pointed it out to his successors he considered they would be bound by it. He felt sure that Mr. Morley's views were exactly the same as his own in the matter. He sat beside him at the committee which sat in 1895, and they held exactly the same views, that in the interests of the public the areas should be reasonably dealt with. He thought any minister might say: "You may be sure that the Treasury will be fair," without any record being made of it. As to whether that might be thought to assume that the Postmaster-General would not be fair, he could only say that Mr. Forbes wanted something more, and that something appeared to be supplied by what he promised.

The Chairman: May I put it briefly like this. The heads of agreement say the Postmaster-General "may" do so. Did your undertaking amount in any shape to the pledge that the Postmaster-General must do so and should do so?—You may put it in that way that I thought the Postmaster-General should make such fair agreement.

"Shall" or "should?"—"Will;" that is what I understood by it; "will treat the company fairly in the matter of areas."

Is that not assumed already in the agreement?—I do not think it went beyond the agreement.

I put this concrete case. As I read the heads of agreement, it would certainly not have been incumbent upon the Postmaster-General to extend these areas during the present year of this rather acute crisis. The Post Office have extended them, and we gather from Mr. Lamb's evidence that they have extended them because they were pledged, not by the actual words of the agreement, but by these words, coupled with your assurance?—You may take it in that way. I left it in the hands of the Postmaster-General.

And therefore it would have been quite possible for the Postmaster-General to refuse the extension of these areas?—Certainly. It did not bind him to give an extension of every one.

Do you consider that the discretion of the Postmaster-General for the time being was absolutely unfettered, that your words did not bind him to grant these areas except under the heads of agreement as signed?—They expressed the sense in which I viewed that agreement.

Mr. Bartley: Do we understand really and truly that there was no verbal understanding outside this agreement in 1892?—I think not, unless you consider what I have said on this. That must be a matter of opinion.

Do you consider the Post Office only morally and legally bound by the terms of the agreement?—No. I think they were bound to interpret the agreement liberally and reasonably.

Further examined, Witness said he thought the Chancellor of the Exchequer agreed that there should be a liberal interpretation of the agreement. Mr. Forbes was reluctant to enter into the agreement because he considered they were giving up a really valuable part of their privilege, while at the same time the so-called concessions offered him were really necessary for the development of the business. When he (Witness) said that he was sure the Post Office would deal reasonably with the company in the matter of areas, he signed the agreement. It was the kind of thing which often happened.

Mr. Bartley: Must not the verbal arrangement have been very substantial to induce him to sign?—I cannot go beyond what I have said.

You wish the Committee to understand that this promise which changed Mr. Forbes's opinion as to signing the agreement, was so insignificant that it really did not amount to anything at all?—It did not amount to anything fresh beyond what was mentioned before the Telegraph Bill Committee.

Although it changed Mr. Forbes's opinion?—It caused him to sign it at the last moment. It did not change his opinion.

But we had it from Mr. Lamb that he absolutely refused to sign?—I do not think he flatly refused to sign.

Sir James Woodhouse: Did you regard what you said as any qualification of the agreement signed?—Certainly not. It would not be binding on this Government if they chose to repudiate it.

By Mr. Nicol: The company held the trunk lines, and gave them up, and they had to make some concession to the company. He considered that the reasonable assurance he gave to the company was in the interests of the public, as leading to the further development of the system.

Questioned by Mr. Colville: The agreement had led to an immense development of the telephone system. No application was made during his time by municipalities for telephone licenses. The first application of the Glasgow Corporation was in 1893.

By Sir James Howorth: He was not so sure that the telephone had increased in other countries enormously as compared with England. His impression was that it had not. The Commissioner at the Glasgow inquiry was of opinion that the rates charged in England were not excessive. He thought if the telephones were taken from the hands of the company they should be worked by the Post Office. He saw no objection in principle to the municipalities working the telephones, but he saw the greatest possible objection to having competing systems in the same area.

Mr. Bennett was recalled, and answered a few more questions, and the Committee adjourned.

The Select Committee on Telephones resumed its sitting on Tuesday last, Mr. Hanbury presiding.

Mr. J. Williams Benn, chairman of the Highways Committee of the London County Council, in reply to the Chairman, said that, generally speaking, no preference was shown to the County Council as regarded charges by the National Telephone Company. For exchange lines they paid the list charges.

The Chairman: What is that?

The Witness: That is £17 per annum for a five years' agreement. He then gave particulars of the other charges which the company levied upon the Council for their various lines.

Can you tell us how far telephone users in London have suffered financially owing to absence of competition?—Yes; but before I go into that question I should like to refer to the offer made by the New Telephone Company in 1892 to supply London with an up-to-date service. The company was already in successful operation in Manchester, under the title of the Mutual Company, and whereas it started in February 28th, 1891, with only 66 subscribers, after 13 months' working it had over 1,000 instruments in connection. With regard to the disappearance of that company, he submitted that the telephone users of London since that date had been mulcted to the extent of the difference between the charge of 12 guineas, which the New Company offered the service for, and the £17 which was paid to the National Company. If an average of 10,000 subscribers be taken from 1892 to 1898, the difference in price, to be reckoned only at £4 per annum, it would show a loss to the telephone users of London of nearly £300,000. Some 3,000 firms entered into an arrangement to to be supplied with a service by the New Company at the 12 guinea rate.

By Mr. J. Stuart: That was about May, 1892.

The Witness then referred to steps which the County Council had taken to ascertain whether the telephone users of London were satisfied with the existing service, and he said that in 1895, out of 2,500 subscribers communicated with, 1,305 were generally dissatisfied. They had just lately been sending round to ascertain what was the present position of those persons who were then complaining, and so far they had succeeded in dealing with 561 cases. They found that there were now satisfied with the service 8 persons, 53 had changed their address, 36 had discontinued through dissatisfaction, 245 were still dissatisfied for various reasons. The general summary of the complaints was as follows:—General inefficiency, 65; delay in getting connection, 213; indistinctness, 189; ringing off before conversation was finished, 196; failure to get connection on account of being engaged, 217.

Were they picked cases or taken haphazard?—Oh no, they were not picked cases by any means.

Can you tell me whether the London County Council have formed an opinion as to any substantial benefits which would be derived by their constituents from the working of the telephone service being in their own hands?—Speaking with a knowledge of the resolutions adopted last week at a conference between the Council and the local authorities of London, we say that if the Post Office will enter into the matter on the basis of honest and thorough competition, that there would be no necessity for the London County Council to take up this work.

But failing the Post Office doing as you desire?—Failing the Post Office, we could do very much better for London as regards price and efficiency than the National Telephone Company. We have advantages in regard to wayleaves, fire stations, and probably, through the co-operation of the local authorities, other public buildings, which would not be available to the National Telephone Company, and therefore, altogether, we could manage this thing more efficiently and cheaper.

That is a general statement—can you give us information as to where the particular advantages come in?—I think it would be better to refer you to the engineer for that portion of the evidence. From figures which were supplied by the engineer, I think it will be found that a telephone service can be provided for London at a charge of £10 per subscriber during the first five years, reduced to £9 afterwards, or possibly a smaller sum. Continuing, Witness said that on that basis they estimated that no charge would fall upon the county rate. It would be impossible for the Council to enter upon an undertaking that their license should terminate in 1911, without some provision that at all events their outlay up to that date should be forthcoming from the State. They would certainly ask for some guarantee that if their license terminated in 1911 they should receive back the structural value of their plant at all events. They would not ask anything for goodwill.

You don't think that the London County Council would put itself under the same terms with regard to purchase of their plant as the National Telephone Company?—No, I don't think in the interests of the ratepayers we could recommend such a course.

What is the shortest period the London County Council would think it fair to the ratepayers to undertake this work?—We could not undertake this work unless we had the whole of the life of the plant laid down.

And you put that at 40 yea s?—That is the average.

Do you expect to tap a different stratum of subscribers?—Yes. Our belief is that if the subscription in London were reduced to £10 or £9 it would induce a very large number of the class of small shopkeepers to take advantage of the telephone service.

When you speak of £10 you must recollect that there are two kinds of subscription in London—that for firms and that for private persons. Is your £10 for firms?—Certainly. We should be prepared to undertake private persons at a proportionate reduction. Continuing, Witness said that the position of the Council was rather different to that of provincial councils as regarded the control of the streets for the purpose of taking them up for the laying of lines, &c.

It would be within the right of a vestry to refuse to grant the County Council power to take up its streets?—That is so at present, but the London County Council would have to come to Parliament for powers, and it is quite possible that under such an Act, some provision might be made to remove that difficulty.

Would the London County Council ask for special powers, which are not given to its assumed competitor, the National Telephone Company?—I may say that if the London County Council were able to control the streets, as the National Telephone Company is, in conjunction with the Post Office, I don't think we should have any great difficulty in the matter.

Supposing the Post Office were to enter into the same agreement with you—as they have entered into with the National Telephone Company—as regards laying wires, would you require any fresh legislation?—Well, we should be able to proceed under that arrangement.

By Mr. Bartley: The National Telephone Company had paid substantial sums to the various competing companies which they had bought out. The purchase price of the whole 13 companies now represented by the National Telephone Company represented a capital of about 3 millions. He had analysed the figures, and had come to the conclusion that the constructional outlay of the company might be put down at £1,800,000, which left paper capital to the extent of £1,400,000, and a careful examination of the accounts of the company showed that the dividend to meet that paper capital had been almost entirely raised from London. Londoners were paying £76,000 a year in order to find the dividend on that paper capital.

Do you think that if competition were introduced into London we should get back the advantages which the National Telephone Company was anxious to prevent, by buying up the other companies?—Certainly.

By Sir James Woodhouse: You are of opinion that competition would be a good thing?—I say that under present circumstances it is a necessity.

You say that the local authority would be the best competitor?—Yes.

By Mr. Stuart: Where companies had been bought up in the country for considerable amounts, a reduction had been made in the charges, and London had had to pay the dividends of the company by its high rates.

The National Telephone Company is under no obligation to supply. —it may. In these figures that you have given us with reference to the London County Council, have you proceeded on the assumption that you should be under an obligation to supply as well as the right to supply?—Yes. We have regarded it as a great grievance in London that the National Telephone Company is not under any obligation to supply. We have received numerous complaints from persons wishing to have telephonic communication, but who the National Telephone Company refuse to supply, and we have in our figures taken it as an obligation to supply. The figures which he had placed before the Committee, continued the witness, only referred to the London County Council area, and he believed they could be very considerably improved upon if they included the National Telephone Company's area, which was much wider.

Replying to Mr. Cohen, Witness said that the figures he had given had not been approved by the London County Council in its corporate capacity. He believed, however, that they would be endorsed by the Council when opportunity offered.

By Mr. Colville: He had considered the question of the London County Council competing with the National Telephone Company, and he believed that if it had a license, it would be able to compete successfully at reduced rates.

Sir Henry Howorth: Your calculations were made upon the basis of not making any profit?—Yes; our idea is that we should serve the citizens.

Do you think that municipalities would be justified in embarking on a large scale on undertakings of this kind which are made for the needs of only a small portion of the community without a considerable profit?—I don't agree that the telephone service can be described as meeting the needs of a small class, because it must be evident that if the telephone is a necessary adjunct to commercial and business firms, then the advantages which result in an increase of business must extend to the carmen and the warehousemen. I say that the telephone service is necessary to business life of the country, and that it is in no sense a service which can be described as confined to the wealthy or business classes. Continuing, the witness said that unless the municipality was protected in the matter of telephone monopoly, the same way as it was protected in the case of gas and water undertakings, he considered it was their duty to step in and provide such a service. He had not contemplated the municipalities licensing the local authorities to undertake the work, as he thought it would be unfortunate to multiply the licensing authorities.

You say that the present company has refused to serve individuals —what inducement would there be for the company to refuse to supply, unless it was because they considered it would be too expensive?—The policy of the company, I believe, is that unless a sufficient number of persons in a district apply to be connected, they will not supply a single individual.

But surely you don't propose that the Municipality should introduce telephonic communication at a certain loss?—We say that in giving London a telephone service, we are bound to take the unprofitable with the profitable. Just in the same way as the Post Office serves districts which are distinctly unprofitable, we say that we must do this with the telephone for the convenience of London.

Re-examined by the CHAIRMAN: You propose that the London County Council should work the telephone service at such charges as would just pay the cost, and not that a profit should be made for the relief of the general rates?—That is so.

Replying to further questions, the WITNESS said the London County Council had not considered the question as to whether they would prefer to limit the working of the telephone service to their own area, or whether they would go outside.

Sir ALEXANDER BINNIE (chief engineer of the London County Council) was examined in reference to his estimate which he had prepared for supplying London with a telephone service. He explained that the estimate was based on the supply of the Council's area only, and not the London area of the National Telephone Company. Supposing they were to extend the service, the estimate would have to be slightly increased. The estimate was not based upon actual tenders, but upon prices which had been furnished to him by various manufacturers.

What is your estimate of a service for London?—£8 per subscriber, exclusive of the Post Office royalty.

But including the royalty?—Then I arrive at the figures just given by Mr. Benn—£10 to commence with, and £9 afterwards.

How long do you calculate that a license ought to run?—To render it remunerative, I agree with Mr. Benn that a license should run for 40 years. Continuing, WITNESS said that supposing the County Council were granted a license now which would expire in 1911, he reckoned they would have to make a charge of £15 or £16 per subscriber.

Mr. BENN said that there would be a lower charge for private persons than the £10 or £9 mentioned in your estimates for business firms?—All my calculations were based upon a rental of £10 and £9 respectively. Of course, we might be able to make a reduction for private persons within their own limited district, but that question has not entered into my calculations at all.

The Committee adjourned.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1898.

Compiled expressly for this journal by **W. P. THOMPSON & Co.,** ***Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.***

12,617. "Improvements in the means or apparatus for controlling and regulating electric motors." C. A. CAIUS WILSON. Dated June 6th.

12,631. "Tell-tale indicator for electric mast-head and side-lights of ships." A. R. TURNER. Dated June 6th.

12,636. "Improvements in electric switches." J. G. DIXON. Dated June 6th. (*Complete.*)

12,667. "An improved device for fitting reflectors, shades, globes, or the like, to electric incandescent and other lamps." C BARTENSTEIN. Dated June 6th.

12,670. "Improvements in the production or generation of electrical currents." J. POPPER. Dated June 6th.

12,673. "An apparatus for trimming electrotype and other blocks." J. I. GIBSON. (W. C. Dalbey, United States) Dated June 6th.

12,680. "Improvements relating to electric alternating current cable systems." F. CLOUTH. Dated June 6th. (*Complete.*)

12,699. "Improvements in or relating to electric transformers." J. J. BELLMAN and C. T. RITTENHOUSE. Dated June 7th. (*Complete.*)

12,731. "Improvements relating to electric telegraphs." A. MUIRHEAD. Dated June 7th.

12,754. "Improvements in apparatus for the generation and electrolytic application of electric currents." F. E ELMORE. (J. O. S. Elmore, India.) Dated June 7th.

12,763 "Improvements in and relating to apparatus for electro-therapeutic purposes." W. P. THOMPSON. (A. Maggiorani, Italy.) Dated June 7th. (*Complete.*)

12,765. "Improvements in or relating to the electrolysis of liquids and apparatus therefor." W. P. THOMPSON. (M. Hazard-Flamand, France.) Dated June 7th.

12,774 "Improvements in electric railways." G. F. REDFERN. (B. J. Falk, United States) Dated June 7th.

12,784. "Improvements in electrical rheostats and resistances." L. J. STEELE. Dated June 8th.

12,810. "Magnetic measuring instruments." J. RUSSELL. Dated June 8th.

12,815. "Improvements relating to electrical motors." R. C. JACKSON. Dated June 8th.

12,825. "Improvements in obtaining metals from their fused ores oxides, and salts by electrical action." J. B. DE ALZUGARAY. Dated June 8th

12,829. "A new or improved apparatus for electrically signalling on railways" R MUSCHAMP. Dated June 8th. (*Complete.*)

12,839. "Improvements in electric glow lamp fittings." SIEMENS BROS, & CO., LTD. (Siemens & Halske, Aktien Gesellschaft, Germany.) Dated June 8th.

12,840. "Improvements in electric glow lamps." SIEMENS BROTHERS & CO., LIMITED. (Siemens & Halske, Aktien Gesellschaft, Germany.) Dated June 8th.

12,841. "Improvements in contact rings for electric glow lamps." SIEMENS BROTHERS & CO, LIMITED. (Siemens & Halske, Aktien Gesellschaft, Germany.) Dated June 8th.

12,855. "An electrical indicating apparatus for automatically denoting the position of ships' and other doors and for like purposes." G. HILL. Dated June 8th.

12,860. "Improvements in telegraphy by means of electric light." K. ZICKLER. Dated June 8th.

12,866. "Improvements in electrical circuit-controllers." H. H. LAKE. (N. Tesla, United States.) Dated June 8th. (*Complete.*)

12,877. "Improvements in electric arc lamps." P. SPIES and S. ROBERTS Dated June 9th.

12,890. "Improvements in the method of and means employed for connecting the guard wires of electric cables." R. BOSTOCK and F. A. CHEETHAM. Dated June 9th.

12,893. "Improvements in safety devices for electrical circuits." L. J. STEELE. Dated June 9th

12,897. "Pliable support for electric incandescence lamps or other light articles." J. DUGAILL. Dated June 9th.

12,925. "An improved device for holding and supporting telephone 'receivers' and for automatically operating the switch lever." A. BACK. Dated June 9th.

12,926 "Improvements in or relating to electric arc lamps." A. J. BOULT. (M. Baumer, Germany.) Dated June 9th.

12,929. "Improvements in or connected with telephones." F. W. GOLBY. (R C. Stempel, Germany.) Dated June 9th.

12,968. "A new or improved magnetic controlling device." H. EDMUNDS. Dated June 9th.

13,010. "Improvements in electric arc lamps." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (R. Fleming, United States.) Dated June 10th. (*Complete.*)

13,011. "Improvements in clutches for electric arc lamps." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (H. C. Spinney, United States) Dated June 10th. (*Complete.*)

13,012. "Improvements in caps for enclosed electric arc lamps." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (C. E. Harthan, United States.) Dated June 10th. (*Complete.*)

13,020. "Improvements in construction of induction coils in detachable sections." W. J. LE COUTEUR. Dated June 10th.

13,021. "A combined portable manual-power dynamo and accumulator." W. J. LE COUTEUR. Dated June 10th.

13,037. "Improvements in electric glow lamps." THE SPIRAL GLOBE, LIMITED, and B. C. E. PARKER. Dated June 10th.

13,080. "Improved signal or alarm for tramcars, yachts, electric launches, and like purposes." A. H. WORMALD. Dated June 11th.

13,116. "Improvements in conductors for incandescent electric lamps." O. IMRAY. (Carl Auer von Welsbach, Austria.) Dated June 11th.

13,121. "Improvements in electrical accumulators." H. W. COBB. Dated June 11th.

13,137. "A new or improved apparatus or tool holder for carrying carbons or electrodes for use in electric welding, brazing, and the like purposes." G. W. DE TUNZELMANN. Dated June 11th.

13,144. "Improvements in apparatus for electrically controlling engines, electric-motors, and other machinery." W. H. HARFIELD. Dated June 11th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of **Messrs. W. P. THOMPSON & Co., 322, High Holborn, W.C.,** *price, post free,* **9d.** (*in stamps*).

1897.

19,118. "Improvements in dynamo-electric driving apparatus especially suitable for propelling vehicles." P. L. GOLDSCHMIDT. Dated August 18th, 1897. In this electric driving apparatus for motion of the armature, and of the field magnet is respectively transmitted directly to two shafts, in such a manner that the number of revolutions is reduced, in consequence of the relatively independent motion of the field magnet, and of the armature; so that intermediate and differential gearing can be dispensed with, and the shafts rendered independent of each other. 2 claims.

18,628. "Improvements in portable electric primary." O. H. COLE. Dated August 11th, 1897. This relates to those batteries where the electrodes may be immersed or removed from the exciting fluid by reversing the battery. The tubular carbon electrode is formed with circumferential corrugations and fitted with an end projecting platinum contact point. The cell is moulded entire, with one opening for placing and removing the zinc electrode and the exciting fluid. The carbon is fixed within one end of the cell as the latter is moulded; the rubber entering into the corrugations of the carbon and holding between an inner ledge and the cell end, and hermetically closing around the projecting platinum point. The cell is thus moulded with projecting bosses for the respective terminals. There is also a means for connecting the terminals and circuit connections. 2 claims.